

Games-Based Learning Advancements for Multi-Sensory Human Computer Interfaces

Techniques and Effective Practices



Thomas Connolly, Mark Stansfield, & Liz Boyle

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. <i>Martin.Hanneghan,.Liverpool.John.Moores.University,.UK</i>	
. <i>Abdenmour.El.Rhalibi,.Liverpool.John.Moores.University,.UK</i>	

In this chapter, Tang, Hanneghan, and El Rhalibi provide an introduction to games-based learning, and discuss some of the basic concepts, pedagogies, and advantages and disadvantages of this approach to teaching and learning.

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Learning and Teaching with Computer Games in Higher Education.....	18
<i>Nicola.Whitton,.Manchester.Metropolitan.University,.UK</i>	

In this chapter, Whitton examines the rationale for the use of computer games in learning, teaching and assessment within Higher Education (HE). The first part of the chapter focuses on the theory underpinning the use of games-based learning with HE students, examining motivation and engagement, constructivism, collaborative and problem-based learning. The second part of the chapter considers the practical issues of using computer games in actual teaching contexts and presents twelve principles for the design and evaluation of computer games to support learning.

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. <i>Chris.Surridge,.Korea.Advanced.Institute.of.Science.and.Technology,.Korea</i>	
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Until recently, Multi-User Virtual Environments (MUVES) and Virtual Learning Environments (VLEs) or Learning Management Systems (LMSs) have remained separate, with MUVES providing a highly interactive, collaborative environment but little content and VLEs providing features for the storage and delivery of online learning content. In Chapter III, Livingstone, Kemp, Edgar, Surridge, and Bloomfield discuss the Sloodle project that is attempting to integrate Second Life with the moodle VLE and to investigate how this might support learning and teaching with the Second Life platform.

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Jean-Charles.Marty,.University.of.Savoie,.France

. *Thibault.Carron,.University.of.Savoie,.France*

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Continuing the theme of LMSs, Marty, Carron, and Heraud propose a games-based LMS called the “pedagogical dungeon” equipped with cooperation abilities for particular activities. The chapter explains how to keep awareness of the on-going activities while remaining involved in the game itself, and how to provide the teacher with this awareness in an immersive way, making the teacher more involved in the game when feedback is provided on the activity.

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Content Integration in Games-Based Learning Systems..... 73

Marco.A..Gómez-Martín,.Universidad.Complutense.de.Madrid,.Spain

. *Pedro.P..Gómez-Martín,.Universidad.Complutense.de.Madrid,.Spain*

. *Pedro.A..González-Calero,.Universidad.Complutense.de.Madrid,.Spain*

One of the key differentiators between commercial games and games-based learning is content, which should be integrated in such a way that it provides engaging game play while helping achieve the desired learning outcomes by delivering skills and knowledge effectively to the end user. This ability to integrate content effectively is the key to producing “killer” games-based learning applications that deliver demonstrable learning outcomes, business benefits and overall value. In Chapter V Gómez-Martín, Gómez-Martín, and González-Calero provide an introduction to the issues of content integration and present the state of the art in content creation for games-based learning systems, identifying the main challenges to make this technology cost-effective from the content creation perspective.

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Drawing Circles in the Sand: Integrating Content into Serious Games..... 84

Matt.Seeney,.TPLD.Ltd.,.UK

. *Helen.Routledge,.Freelance.Instructional.Designer,.UK*

Seeney and Routledge present lessons learned and case studies that demonstrate why the process of content integration can be so challenging, including the differing experiences from the perspective of

three stakeholders (game designer, instructional designer/learning psychologist and subject matter expert), how to manage preconceptions and balance their priorities. The chapter provides advice on how to facilitate this process, capture the correct requirements and create a design that meets and exceeds the expectations of all the stakeholders involved, including the client/customer and the end user.

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The DODDEL Model: A Flexible Document-Oriented Model for the Design of Serious Games..... 98
Mark.McMahon,.Edith.Cowan.University,.Australia

In Chapter VII McMahon proposes a document-oriented instructional design model to inform the development of games-based learning. The author suggests that the model can form a base for prescribing and managing activities within an industry context but also as a means to teach the instructional design process for serious games within an HE setting. The model defines increasingly granular stages leading to final production documentation for software development. A case study of the initial implementation of the model is discussed in order to contextualise it and provide a basis for future enhancement.

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Daniel.Burgos,.ATOS.Origin.Research.&.Innovation,.Spain
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In this chapter, Burgos and van Nimwegen argue that games-based learning applications are good environments for improving the learning experience and a key component of the application if the provision of feedback to support decision making and to reinforce the learning process. However, the authors point out that too much feedback can make the learner too dependant on external advice when taking the next action, resulting in a weaker learning strategy and a lower performance. By way of example, a case study is presented of an educational planning task simulation with a control group that did not receive destination feedback and an experimental group that did receive destination feedback. An analysis concludes that in this context too much assistance can be counterproductive.

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Patrick.Felicia,.University.College.of.Cork,.Ireland
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For some time, users' emotions and behaviours have been considered to obstruct rather than to help the cognitive process. Even if it is now recognized that learners' personalities and learning styles influence greatly their cognitive process, very few systems have managed to profile users and adapt the educational content accordingly. Furthermore, since the introduction of formal education, it has been argued that learning has lost its playful and emotional aspect, whereby information was transmitted through story telling and play. On the other hand, computer games have become a very popular medium and provide a rich sensory and emotional environment in which players can experience a state of flow and are continue playing for an extended period of time. In this chapter Felicia and Pitt discuss how computer games can

be harnessed to create an educational content that matches users' learning styles and motivations. In this chapter the authors propose the PLEASE model (Personality Learning styles, Emotions, Autonomy, Systematic Approach and Evaluation), which addresses some of educational games design issues (e.g. choice of instructional strategy, type of feedback required, etc.). The model categorizes and profiles users' learning styles in the light of educational and personality theories and defines a set of practical strategies for educational games designers in order to match students' learning styles and provide a user-centred content that is both motivating and educational. The chapter presents experiments carried out to assess the effect of user-centred approaches in educational game design and the results indicate that unless personalities are accounted for in educational games, the educational outcomes could be different or even opposite to the one expected.

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The Use of Role-Playing in Learning.....	157
<i>Marco.Greco,.University.of.Rome. "Tor.Vergata",.Italy.</i>	

In Chapter X, Greco suggests that the use of role-playing is becoming prominent in games-based learning due to its positive effects on learning. In this chapter the author defines role-playing games and proposes a five-dimension taxonomy for serious role-playing games, applying it to a small selection of successful games in five different domains. The intention is to help the reader understand when role-playing should be used, and when it might be useless or detrimental.

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<i>Mari.Hankala,.University.of.Jyväskylä,.Finland</i>	

In the context of computer games, learning is an inherent feature of computer game playing. Computer games can be seen as multimodal texts that connect separate means of expression and require new kinds of literacy skills from the readers. In Chapter XI Tikka, Kankaanranta, Nousiainen and Hankala consider how the computer-based learning tool Talarius, which enables students to make their own digital games and play them, lends itself to literacy learning. Talarius also provides the potential to interweave narrative contents into the games made by it. The learning subject is a children's novel and is narrative by its nature. The focus of this chapter is on the relationship between narrative and learning in computer games, in this case, digital board games and explores how narrative functions of the learning tool support learning in game creation and game playing.

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<i>Colin.Price,.University.of.Worcester,.UK</i>	

In Chapter XII Price discusses an approach to establishing a theoretical basis for the construction of games-based learning immersive environments based upon recognised pedagogical principles. In particular, the chapter considers non-collaborative learning (instructional, teacher-led or autonomous)

and consider collaborative learning. The chapter reflects on the matter of various subject domains with reference to the Unreal Tournament 2004 game engine.

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Sara.de.Freitas,.University.of.Coventry,.UK

Steve.Jarvis,.SELEX.Systems.Integration.Ltd,.UK

One of the often cited issues with games-based learning is the lack of empirical evidence for the approach. In Chapter XIII de Freitas and Jarvis review some of the key research supporting the use of serious games for training in work contexts. The review indicates why serious games should be used to support training requirements and, in particular, identifies ‘attitudinal change’ in training as a key objective for deployment of serious games demonstrators. The chapter outlines a development approach for serious games and how it is being evaluated. Demonstrating this, the chapter proposes a game-based learning approach that integrates the use of a ‘four-dimensional framework’, outlines some key games principles, presents tools and techniques for supporting data collection and analysis, and considers a six-stage development process.

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Pieter.Wouters,.Utrecht.University,.The.Netherlands

Erik.D..van.der.Spek,.Utrecht.University,.The.Netherlands

Herre.van.Oostendorp,.Utrecht.University,.The.Netherlands

Wouters, van der Spek, van Oostendorp examine 28 studies with empirical data from a learning outcome perspective to outline the effectiveness of serious games. The authors conclude that serious games potentially improve the acquisition of knowledge and cognitive skills. Moreover, they seem to be promising for the acquisition of fine-grid motor skills and to accomplish attitudinal change. However, they find from the research that not all game features increase the effectiveness of the game.

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Thomas.Connolly,.University.of.the.West.of.Scotland,.Scotland

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Thomas.Hainey,.University.of.the.West.of.Scotland,.Scotland

In Chapter XV Connolly, Stansfield and Hainey review the literature for evaluation frameworks for games-based learning and identify evaluation measurements that have been taken by other researchers in the field. Based on this work, the authors present an abstract evaluation framework for games-based learning that can be adapted to particular games-based learning interventions.

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<i>Helen.Routledge,.Independent.Instructional.Games.Designer,.UK</i>	

In Chapter XVI Routledge presents a guide for teachers on how to use games-based learning in the classroom. Beginning with a theoretical overview of the change in learning styles and the growing digital divide, the author discusses the impact that games have had on young people. The chapter also provides a practical guide for teachers wishing to integrate games into their classrooms, beginning with an overview of the changing role of the teacher, moving onto preparation guidelines, before finally discussing assessment and practical implementations.

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There is no doubt that computer games are extremely engaging and incorporate features that have an extremely compelling, even addictive quality. It is these highly engaging features of computer games that have attracted the interests of educationalists. However, there are many issues that may prevent computer games becoming a primary tool in education. In the fourth and final part of the book we examine two such issues: gender and disabilities. Understanding the relationship between gender and computer games is extremely important for creating computer games that will function as effective educational tools. While traditional computer games are more popular with males than females, females have a more careful and committed approach to learning and may be more willing to try out new methods of learning including computer games. These opposing influences make it difficult to predict how gender will impact on the acceptance of games for learning. In Chapter XVII, Boyle and Connolly explore whether gender has an effect in games-based learning and suggest that developing educational computer games that will appeal to both males and females adds an additional level of complexity to an already complicated process.

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<i>Michael.G..Meimaris,.National.and.Kapodistrian.University.of.Athens,.Greece</i>	

In Chapter XVIII, Saridaki, Gouscos and Meimaris examine the issues around the application of games-based learning for students with intellectual disability. The chapter investigates the common grounds between methodologies for Special Education Needs/Intellectual Disability pedagogy on the one hand and games-based learning on the other, as well as to explore the potential of using digital games for such students. The usage of digital games in the learning experience of students with intellectual disability is discussed, the ways in which commercial and educational games support various special needs

methodologies and theories regarding intellectual disability pedagogy are examined and findings from the education literature as well as experimental observations and case studies are presented in order to investigate how and to what extent learning-purposed as well as entertainment-purposed games are able to constitute a powerful educational medium for special needs education and its inclusive objectives.

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Foreword

Bolstered by a number of factors, ranging from high profile commercial and critical successes like World of Warcraft to increased funding opportunities from state agencies to the entrance of the Atari Generation into the academy. Regardless, the argument over “Could we (or even should we) design video games for learning?” has been settled. There is a large, growing, diverse group of academics, developers, and government agencies pursuing video games for learning. The time for rhetoric has passed, and time for a mature interdisciplinary field of games, learning, and society has come (Squire, 2007).

This book provides an excellent snapshot of the “state of the art” of the field, particularly in regards to the very hard work of developing games that can produce meaningful learning experiences (which is not to suggest that people do not have such experiences with entertainment games). We see educators wrestling with how to integrate content and game play, something Lloyd Rieber (1996), called the problem of exogenous and endogenous games. That is, how to create game experiences that make academic forms of thinking part of the game play. This distinction, which may seem relatively banal at first, is, I would argue, potentially quite profound as it represents a shift away from *content.delivery* as the goal, and toward one of generating a rich problem solving *context* for thinking (see Squire, 2006). Game-based learning environments potentially: (1) draw on learners goals, intentions, and passions, then (2) build up particularly knowledge and skills, and (3) extend their development of new identities out into the world where they become producers of meaning with digital media. This last feature is something often overlooked by educators, but is critically important to learning in everyday gaming contexts, as we see gamers forming social organizations, writing walk-throughs, designing player guides, and so forth—creating complex artifacts that embody performances of understanding.

We also see researchers wrestling with how to organize work within such fast-moving contexts. We see experimentations building interdisciplinary teams, with an eye toward the non-trivial research task of melding good game play and meaningful academic ideas. One trend emerging from this work is the importance of involving subject matter experts early, but also creating what Valve (designers of Half Life) call a design cabal – a team that understands all aspects of the design. With educational games, the job becomes even trickier as the team must digest learning theory, game theory, and content-specific pedagogical theory. We see these development teams pushing the boundaries of how we think about scoping out these projects, wrestling with how to budget and organize game-based projects, which operate on very different timescales than traditional, linear media. One approach described here is rapid prototyping, fast, iterative cycles of development and research aimed at generating product while also fleshing out theory.

For newcomers to the field, video games and learning can be fascinating and frustrating in that the research work is interdisciplinary, drawing from a number of research traditions. I believe that together, it points to an emerging paradigm that combines social and situated theories of learning with more traditional cognitive / constructivist theories of learning into an integrated environment. The potential

for using the captivating features of games – the way that they seduce us into roles, dangle challenges before us, and present new ways to be in the world draw on the best principles of situated socio-cultural learning theory. The ways that games give personalized assessments and feedback in context draw on some classic principles of cognitive (and even behaviorist) instruction. And, the ways that games provide us complex models to think with may even suggest new theories of learning that we have not yet fully explored (Gee, 2007).

Are we there yet? Not entirely. Many of us have been drawn to video games, as they seem to have “cracked the nut” of the perennial problem of designing interactive, engaging digitally mediated experiences (or at least are in the business of trying to do so). Few games for learning capture this sort of engaging academic play, enabling the kinds of choices and consequences, transgressive play, interactive narrative, construction with digital tools, participation in virtual social systems, and embodied experiences of complex systems. Games are developing very specific ways (design patterns perhaps) of achieving their goals, and as designers of learning systems, it behooves us to understand how they work.

One hope (and pleasant feature of this work) is that as a field, we will not get bogged down in the discussions of “what makes a game”, and rather, what sorts of techniques game designers use. After all, as a research community, I don’t know that we care about games, per se, but rather, how to create good learning (presumably by leveraging game design features). In other words, our goal is not just to create games but to create learning environments based on sound learning principles, many of which are best embodied by games.

This focus on designing learning environments reminds us of the importance of building on the decades of research on learning and instruction as well as in games. We need to build on the general ideas coming from the learning sciences, such as the importance of content-specific pedagogies, as well as those emerging from games. Video game-based pedagogies are somewhat curious in that they require us to leverage the best of what we know about learning and instruction, while also making possible new ways of teaching and thus enable us to explore new theories of learning. This last question – how do games change how knowledge is represented and how we think and learn should continue to be a fruitful area as new technologies and designs emerge. Indeed, like other media before them (books, film), games challenge “what is worth knowing” as they make new ways of knowing possible.

Within my own work, I find the most useful inspiration from games to be to approach problems (from game design to research methods to article writing) to be in asking the question: “How would a game designer do it?” Of course, there is no “one” way a game designer might do it, so to sharpen the focus, how might Eric Zimmerman, Doug Church, Warren Spector, Will Wright, or Sid Meier do it? To begin to think this way, learning game researchers need to interact with such game designers in meaningful ways. Fortunately, such game designers are a generally friendly, curious bunch and plenty of opportunities exist at the European Conference for Games and Learning, The Game Developers Conferences, Serious Games Summits, or at our Games, Learning, and Society Conference. Because video games are a truly global industry, opportunities abound for linking up to established or up and coming firms. Within my own work, this kind of collaboration with game designers – whether it be industry veterans like Eric Zimmerman or up-and-comers like Filament Games has been the most rewarding. I would expect to see more collaboration like this in the future.

References

Gee, J. P. (2007). *Good.Video.Games.and.Good.Learning: .Collected.Essays.on.Video.Games,.Learning.and.Literacy* (1st ed., p. 208). Peter Lang Publishing.

Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations, and games. *Educational Technology Research & Development*, 44(2), 43-58

Squire, K. (2006). From Content to Context: Videogames as Designed Experience. *Educational Researcher*, 35(8), 11.

Squire, K. (2007). Games, learning, and society: Building a field. *Educational Technology*, 4(5), 51-54.

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Preface

INTRODUCTION

Games-based learning (GBL), also sometimes referred to as serious games, is a relatively new field of endeavour that focuses on the exploitation of high-quality computer games and associated software tools for education and training. While computer games have been phenomenally successful within the leisure industry with their inherent ability to motivate, engage and inspire, their application for education and training has had limited success and there remains a number of key challenges that need to be addressed to fully understand and demonstrate the applicability and limitations of this approach. Given that market research suggests that the games-based learning market globally could be worth €500m by 2010, there is a pressing need to address the challenges. However, the research on games-based learning is fragmented and there are still significant gaps in the literature, primarily the lack of empirical and longitudinal studies.

The field of games-based learning show significant promise for overcoming some of the barriers to effective learning for particular groups of learners or particular learning styles. While some potential users are open to the use of computer games for non-entertainment purposes, others are closed and significant work has to be undertaken to demonstrate the effectiveness (or otherwise) of this approach. There are a number of the key challenges that need to be addressed:

- The construction of empirical data to support the assertion that learning with games is effective. While there are studies that review and bring together some of the evidence, this may require further baseline studies that assess the effectiveness and efficacy of games-based learning.
- The investigation of which learners, and in which contexts, games-based learning is most effective. Again this work has begun but much more research is required. There is still a perception that games are fun and not to be used in learning and, although this is changing, more studies that investigate differentiated use of games will help.
- The identification of mechanisms to bring games developers and educationalists together to work together to produce pedagogically-based games-based learning that is effective is key.
- The identification of mechanisms to empower the learner to produce their own content through games. This raises questions as to how the features often provided in a number of game development systems, for creating and editing components such as terrain or physical objects, be extended to include the ability to specify game activities and operations without programming in the formal sense, in order to engage a wide user community in collective learning game development.
- The identification of ways in which tutors can add assessment seamlessly to games-based learning.

- As well as perception shifts on the part of tutors, institutions need to rethink some of their structures to better facilitate games-based learning (for example, to allow for longer periods of learning, informal learning, cross disciplinary learning etc.). This means engaging senior management as to the value of serious games.
- Games technologies are at the forefront of providing multi-sensory immersive human-computer interfaces, and allowing the seamless integration of virtual and physical environments through advances in sensor and display technologies. A key challenge is how these technical developments can be integrated into pedagogical frameworks to allow them to be legitimately used to contribute to the effectiveness of learning.
- Virtual worlds, such as Second Life, are increasingly defining a new paradigm for how online communication, interaction and collaboration take place. Furthermore, they have created new business models of how virtual and real worlds can interact. Clearly it would not be sensible to limit learning experiences within these worlds to simulations of conventional learning methods in reproductions of existing learning spaces. A key challenge is how these systems can be optimally used for learning, including for work-based learning and through the integration of these technologies into business processes.

Thus, the key challenges are strategic, institutional and pedagogic.

Mission and Main Objectives of the Book

The mission of this book is to disseminate knowledge on both the theory and practice of games-based learning, and to promote scholarly inquiry and the development/adoption of best practice in this area. The main objectives of the book are as follows:

1. To provide novice readers with an introduction to the major issues surrounding both the theory and practice of games-based learning.
2. To provide an avenue for the publication of cutting-edge research that will inform both novice and expert readers about leading and emerging games-based learning pedagogy, technologies and their applications to teaching and learning.
3. To showcase examples of current and emerging practice in innovative pedagogy, and demonstrate models of the integration of games-based learning in teaching, learning and assessment.
4. To contribute to the development of best practice through the evaluation and documentation of the successes and pitfalls of various techniques, approaches, and strategies.
5. To analyze and critique recent trends and nascent technologies, in order to propose an agenda or “roadmap” for future research and development in the area of games-based learning for teaching and learning.

Intended Audience

The intended audience for the book is broad, ranging from educationalists and researchers at all levels of education and training, particularly those with an interest in how interactive technologies can be utilised to enhance teaching and learning. The book will also be of interest to other researchers, such as social scientists, psychologists, and computing scientists. The book may also be adopted to support educational technology and eLearning courses at a postgraduate level. In addition, the book will be of interest to

companies involved in the development of games-based learning applications as it will provide an insight into the key challenges facing the industry and approaches to tackling these challenges.

Through a combination of theoretical pieces as well as practical cases or examples of “best practice” in the field, the novice reader will benefit from expert knowledge and learn from the experiences of both researchers and practitioners. Experts will stand to gain from reading the book to stay abreast with the latest developments and trends in this still nascent area, and to obtain exposure to diverse perspectives and approaches to games-based learning.

This book provides a holistic and multidisciplinary discussion on how games-based learning has been used to support teaching in learning in both education and training. At the same time, it examines key challenges in games-based learning from both a theoretical and practical experience. The book aims to make a valuable contribution to the literature by bringing together a broad range of pedagogical, technological and strategic issues. The collection of chapters will hopefully promote the international collaboration and exchange of ideas and know how on games-based learning.

Structure of the Book

In this section, a brief outline of each of chapter is provided.

Section I. Introduction

In Chapter I, Tang, Hanneghan, and El Rhalibi provide an introduction to games-based learning, and discuss some of the basic concepts, pedagogies, and advantages and disadvantages of this approach to teaching and learning. In Chapter II, Whitton examines the rationale for the use of computer games in learning, teaching and assessment within Higher Education (HE). The first part of the chapter focuses on the theory underpinning the use of games-based learning with HE students, examining motivation and engagement, constructivism, collaborative and problem-based learning. The second part of the chapter considers the practical issues of using computer games in actual teaching contexts and presents twelve principles for the design and evaluation of computer games to support learning.

Until recently, Multi-User Virtual Environments (MUVES) and Virtual Learning Environments (VLEs) or Learning Management Systems (LMSs) have remained separate, with MUVES providing a highly interactive, collaborative environment but little content and VLEs providing features for the storage and delivery of online learning content. In Chapter III, Livingstone, Kemp, Edgar, Surridge, and Bloomfield discuss the Sloodle project that is attempting to integrate Second Life with the moodle VLE and to investigate how this might support learning and teaching with the Second Life platform. Continuing the theme of LMSs, in Chapter IV Marty, Carron, and Heraud propose a games-based LMS called the “pedagogical dungeon” equipped with cooperation abilities for particular activities. The chapter explains how to keep awareness of the on-going activities while remaining involved in the game itself, and how to provide the teacher with this awareness in an immersive way, making the teacher more involved in the game when feedback is provided on the activity.

Section II. Design Issues

One of the key differentiators between commercial games and games-based learning is content, which should be integrated in such a way that it provides engaging game play while helping achieve the desired learning outcomes by delivering skills and knowledge effectively to the end user. This ability to inte-

grate content effectively is the key to producing “killer” games-based learning applications that deliver demonstrable learning outcomes, business benefits and overall value. In Chapter V Gómez-Martín, Gómez-Martín and González-Calero provide an introduction to the issues of content integration and present the state of the art in content creation for games-based learning systems, identifying the main challenges to make this technology cost-effective from the content creation perspective. In the subsequent chapter, Seeney and Routledge present lessons learned and case studies that demonstrate why the process of content integration can be so challenging, including the differing experiences from the perspective of three stakeholders (game designer, instructional designer/learning psychologist and subject matter expert), how to manage preconceptions and balance their priorities. The chapter provides advice on how to facilitate this process, capture the correct requirements and create a design that meets and exceeds the expectations of all the stakeholders involved, including the client/customer and the end user.

In Chapter VII McMahon proposes a document-oriented instructional design model to inform the development of games-based learning. The author suggests that the model can form a base for prescribing and managing activities within an industry context but also as a means to teach the instructional design process for serious games within an HE setting. The model defines increasingly granular stages leading to final production documentation for software development. A case study of the initial implementation of the model is discussed in order to contextualise it and provide a basis for future enhancement.

In Chapter VIII Burgos and van Nimwegen argue that games-based learning applications are good environments for improving the learning experience and a key component of the application if the provision of feedback to support decision making and to reinforce the learning process. However, the authors point out that too much feedback can make the learner too dependant on external advice when taking the next action, resulting in a weaker learning strategy and a lower performance. By way of example, a case study is presented of an educational planning task simulation with a control group that did not receive destination feedback and an experimental group that did receive destination feedback. An analysis concludes that in this context too much assistance can be counterproductive.

For some time, users’ emotions and behaviours have been considered to obstruct rather than to help the cognitive process. Even if it is now recognized that learners’ personalities and learning styles influence greatly their cognitive process, very few systems have managed to profile users and adapt the educational content accordingly. Furthermore, since the introduction of formal education, it has been argued that learning has lost its playful and emotional aspect, whereby information was transmitted through story telling and play. On the other hand, computer games have become a very popular medium and provide a rich sensory and emotional environment in which players can experience a state of flow and are continue playing for an extended period of time. In Chapter IX Felicia and Pitt discuss how computer games can be harnessed to create an educational content that matches users’ learning styles and motivations. In this chapter the authors propose the PLEASE model (Personality Learning styles, Emotions, Autonomy, Systematic Approach and Evaluation), which addresses some of educational games design issues (e.g. choice of instructional strategy, type of feedback required, etc.). The model categorizes and profiles users’ learning styles in the light of educational and personality theories and defines a set of practical strategies for educational games designers in order to match students’ learning styles and provide a user-centred content that is both motivating and educational. The chapter presents experiments carried out to assess the effect of user-centred approaches in educational game design and the results indicate that unless personalities are accounted for in educational games, the educational outcomes could be different or even opposite to the one expected.

In Chapter X Greco suggests that the use of role-playing is becoming prominent in games-based learning due to its positive effects on learning. In this chapter the author defines role-playing games and proposes a five-dimension taxonomy for serious role-playing games, applying it to a small selection of

successful games in five different domains. The intention is to help the reader understand when role-playing should be used, and when it might be useless or detrimental.

In the context of computer games, learning is an inherent feature of computer game playing. Computer games can be seen as multimodal texts that connect separate means of expression and require new kinds of literacy skills from the readers. In Chapter XI Tikka, Kankaanranta, Nousiainen, and Hankala consider how the computer-based learning tool Talarius, which enables students to make their own digital games and play them, lends itself to literacy learning. Talarius also provides the potential to interweave narrative contents into the games made by it. The learning subject is a children's novel and is narrative by its nature. The focus of this chapter is on the relationship between narrative and learning in computer games, in this case, digital board games and explores how narrative functions of the learning tool support learning in game creation and game playing.

In Chapter XII Price discusses an approach to establishing a theoretical basis for the construction of games-based learning immersive environments based upon recognised pedagogical principles. In particular, the chapter considers non-collaborative learning (instructional, teacher-led or autonomous) and consider collaborative learning. The chapter reflects on the matter of various subject domains with reference to the Unreal Tournament 2004 game engine.

Section III. Evaluation

One of the often cited issues with games-based learning is the lack of empirical evidence for the approach. In Chapter XIII de Freitas and Jarvis review some of the key research supporting the use of serious games for training in work contexts. The review indicates why serious games should be used to support training requirements and, in particular, identifies “attitudinal change” in training as a key objective for deployment of serious games demonstrators. The chapter outlines a development approach for serious games and how it is being evaluated. Demonstrating this, the chapter proposes a game-based learning approach that integrates the use of a “four-dimensional framework”, outlines some key games principles, presents tools and techniques for supporting data collection and analysis, and considers a six-stage development process. In Chapter XIV Wouters, van der Spek, van Oostendorp examines 28 studies with empirical data from a learning outcome perspective to outline the effectiveness of serious games. The authors conclude that serious games potentially improve the acquisition of knowledge and cognitive skills. Moreover, they seem to be promising for the acquisition of fine-grid motor skills and to accomplish attitudinal change. However, they find from the research that not all game features increase the effectiveness of the game. Following this theme, in Chapter XV Connolly, Stansfield, and Hainey review the literature for evaluation frameworks for games-based learning and identify evaluation measurements that have been taken by other researchers in the field. Based on this work, the authors present an abstract evaluation framework for games-based learning that can be adapted to particular games-based learning interventions. Based on real world experiences using a variety of digital games, Chapter XVI presents a guide for teachers on how to use games-based learning in the classroom. Beginning with a theoretical overview of the change in learning styles and the growing digital divide, the author discusses the impact that games have had on young people. The chapter also provides a practical guide for teachers wishing to integrate games into their classrooms, beginning with an overview of the changing role of the teacher, moving onto preparation guidelines, before finally discussing assessment and practical implementations.

Section IV. Gender and Disabilities

There is no doubt that computer games are extremely engaging and incorporate features that have an extremely compelling, even addictive quality. It is these highly engaging features of computer games that have attracted the interests of educationalists. However, there are many issues that may prevent computer games becoming a primary tool in education. In the fourth and final part of the book we examine two such issues: gender and disabilities. Understanding the relationship between gender and computer games is extremely important for creating computer games that will function as effective educational tools. While traditional computer games are more popular with males than females, females have a more careful and committed approach to learning and may be more willing to try out new methods of learning including computer games. These opposing influences make it difficult to predict how gender will impact on the acceptance of games for learning. In Chapter XVII, Boyle and Connolly explore whether gender has an effect in games-based learning and suggest that developing educational computer games that will appeal to both males and females adds an additional level of complexity to an already complicated process. In Chapter XVIII, Saridaki, Gouscos, and Meimaris examine the issues around the application of games-based learning for students with intellectual disability. The chapter investigates the common grounds between methodologies for Special Education Needs/Intellectual Disability pedagogy on the one hand and games-based learning on the other, as well as to explore the potential of using digital games for such students. The usage of digital games in the learning experience of students with intellectual disability is discussed, the ways in which commercial and educational games support various special needs methodologies and theories regarding intellectual disability pedagogy are examined and findings from the education literature as well as experimental observations and case studies are presented in order to investigate how and to what extent learning-purposed as well as entertainment-purposed games are able to constitute a powerful educational medium for special needs education and its inclusive objectives.

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Section I

Introduction

Chapter I

Introduction to Games–Based Learning

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ABSTRACT

Games-based learning takes advantage of gaming technologies to create a fun, motivating, and interactive virtual learning environment that promotes situated experiential learning. Many researchers now believe that this approach can better motivate present day entertainment-driven learners to more thoroughly engage in learning through meaningful activities defined in the game context as opposed to those offered using more traditional didactic approaches. This chapter describes games-based learning, the related terms and scope, current approaches, embedded pedagogies and challenges for providing high-quality education in the 21st Century.

INTRODUCTION

The 21st Century has witnessed emergent cultures such as ‘blogging’ (Khan & Kellner, 2004), file sharing (Lessig, 2004) and gaming (Pearce,

2006). These digital cultures have significantly changed the ways humans work, communicate, socialise and play and they are also affecting the way younger generations learn. It is crucial that learning is congruent to lifestyle for effec-

tive learning to take place (JISC, 2004). These changes in lifestyle are inevitable and have since introduced additional challenges to teachers in providing high-quality education.

One of the significant changes experienced in the education sector is the change of learners' attitude and their motivation towards learning. Prensky (2005) describes these learners as the 'engage me or enrage me' group that comprises most of the present day learners who believe that education is a waste of time and irrelevant. Such attitudes and motivation towards learning is worrying and is one of the many factors contributing to the decline in applications to science and engineering courses experienced by education establishments worldwide despite the growing requirements for more scientists and engineers worldwide (OECD, 2006; Sjøberg & Schreiner, 2006). Other known challenges include increased diversity of learners and their learning styles, increases in what must be learnt by learners and also the highly constrained resources in education and training (FAS, 2006a).

Many believe that computer games can be used to address the aforementioned issues (FAS, 2006a; Gee, 2003; Prensky, 2001) borrowing success stories from the use of computer games in corporate and military training (Buckley & Anderson, 2006; Jayakanthan, 2002; Nieborg, 2004). The idea of using computer games in learning is not new but has been negatively affected by apocalyptic ideology on the effect of video gaming in the 1980's (Aguilera & Mendiz, 2003; Squire, 2003). Such thoughts can be linked to the early work of Malone (1980) but only recently made popular by Prensky (2001), Gee (2003) and Aldrich (2003). Findings from initial research studies showed that computer games can be used to acquire certain cognitive abilities and improve learners' understanding in topics presented (Aguilera & Mendiz, 2003; BECTa, 2006; Jenkins, Klopfer, Squire, & Tan, 2003). These preliminary results are convincing and have gained tremendous interest from different sectors including government, academia and industry to further explore the benefits of

such opportunities (BECTa, 2006; FAS, 2006a). Many also agree that it is now appropriate to take advantage of gaming technologies to create a new generation of educational technology tools to equip learners of all ages with necessary skills through experiential learning (FAS, 2006a). It is crucial that the education sector is well-informed of the development of such innovative learning approaches and its benefits to offer high-quality education to all types of learner.

This chapter provides an overview of games-based learning by describing computer games, their application in education and training, and related terms used to describe the approach. Educational theory underpinning games-based learning, its approaches, pros, cons and challenges are then discussed before concluding the chapter with a glimpse into the future of games-based learning.

What is Games-Based Learning?

Computer (video) games are interactive software applications created primarily for participatory entertainment purposes (Rollings & Adams, 2003). The terms 'computer games' and 'video games' were formerly referred to as PC-based games and console-based games but are now used interchangeably due to the blurring state of technology. Computer games as software artefacts combine multimedia and other computing technologies such as networking to clever use to enable the game player to experience goal-directed play in a virtual environment. A computer game can be represented by the three primary design schemas defined by Salen and Zimmerman (2003) in their conceptual framework as;

- *Rules*, which formally represent the 'mechanics' or operational constraints within the game construct, which in turn governs the level of interactivity within the game.

- *Play*, which represents the experiential aspect of the game and communicated to the game player through activities that are distinctively categorised by Crawford (2003) as interactivity, challenge and conflict.
- *Culture*, refers to the beliefs and norms represented in the game world, which is often portrayed to game-players through artificial characters, objects and settings via aural and visual representation of the game world, and through storytelling.

In summary, *rules* and *culture* define the technical and intrinsic representation of some virtual “playground” to support the activity of *play*. This conceptual framework will serve as the basis to distinguish between educational games and computer games in the next section.

The focus of computer games in entertainment has always been the activity of play, which is governed by the set of formal rules defined within some cultural context. Koster (2004) defines play as a brain exercising activity that attempts to master the ability to recognize patterns in various contexts. From a pedagogical standpoint the activity of play that game-players experience is technically a loop of doing and reflecting in a motivating context that enables them to learn to master their art. Indirectly, game-players learn by doing and such an approach helps in retaining information effectively as opposed to just receiving information in a passive manner (Roussou, 2004). Such belief is centred on ‘activity theory’, which assumes that consciousness and activities are inseparable (Leont’ev, 1977). More aspects of pedagogy in games-based learning will be discussed in *Pedagogies.in.Games-based.learning* section later in this chapter.

In general, games-based learning refers to the innovative learning approach derived from the use of computer games that possess educational value or different kinds of software applications that use games for learning and education purposes

such as learning support, teaching enhancement, assessment and evaluation of learners. The term ‘games-based learning’ can also refer to the use of non-digital games such as card games (Baker, Navarro, & Hoek, 2005) and casino chips (Cook & Hazelwood, 2002) as activity to engage and hold learners in focus by encouraging learners to participate during the lesson through game-play. More specific terms that refer to the use of computer games in learning and education include ‘digital game-based learning’, which was coined by Prensky (2001), and ‘games-based eLearning’ by Connolly and Stansfield (2007).

In games-based learning environments learners are presented with learning material in the form of narrative and storytelling and they learn through game-playing and studying the properties and behaviour of in-game components, the relationship between these in-game components and the solving of problems in the defined scenario (Tang, Hanneghan, & El-Rhalibi, 2007). From the learning theory perspective, games-based learning possesses characteristics such as:

- motivating and engaging but not necessary entertaining;
- requires participation from learners;
- has clear learning objectives defined in the game-play and scenarios presented while knowledge can be imparted through storytelling and narrative;
- scenarios defined are reflective and transferable to the real-world experience;
- provides freedom to interact in the game world through a set of defined actions;
- provides clearly defined feedback for every action taken;
- both assessment and lesson can take place during game-play;
- matches learner’s pace and intellectual ability;
- highly scalable so can be used for educating large numbers of learners concurrently.

Distinguishing Educational Games from Computer Games

Computer games for use in games-based learning are generally termed ‘educational games’. Computer games and educational games share many common technical features but differ in their intended use and design of content. Computer games are primarily designed for entertainment purposes while educational games are intended to impart knowledge or skills development although some educational aspects and entertainment aspects exist in both fields. Therefore the real distinction between computer games and educational games can only be further explained through the definition of the design schemas *play*, *rules* and *culture* based on the purpose defined.

Play in the context of computer games has always been perceived as an activity of enjoyment or recreation instead of serious or practical purpose. Contrary to computer games, *play* in the context of educational games should be defined as meaningful learning activities that promote the formation of new concepts and development of cognitive skills. These meaningful learning activities are interactions designed with an aim to educate learners through the principle of cause and effect. *Rules* and *culture* have to accommodate the direction of play defined for either purpose; entertainment or learning, or both. In fact, many well-designed computer games are indeed educational although they are lacking in the integration of knowledge and training in skills that are considered educational.

Rules that govern game-play in educational games are coupled with measureable learning objectives that are assessable via interactivity. Although computer games have similar measurable objectives, game objectives are designed to steer game-play towards entertaining play and may not be applicable in reality. Grand Theft Auto (www.grandtheftauto.com), a controversial but a very successful computer game where game-player takes on the role of criminal in a big city and par-

ticipates in occasional criminal activities such as occasionally taxi driving, fire-fighting, pimping, street racing and other regular crime features such as bank robbery and assassination is an example of rules of game-play that contradicts with the norm in the society. These rules can also be in the form of distinct challenges that place demands on the learner to solve a variety of problems cognitively and possibly requiring hand-eye coordination. These challenges also exist in computer games but may be presented in a fictitious context that is irrelevant to any real-world context and may lack accuracy in representation. Mechanistic rules underlying game-play for educational games can range from simplistic to extremely complex representation (for example on a par with a true simulator) depending on the subject matter that has resemblance of reality contrary to computer games that require a playable version of mechanistic rules.

The details of *culture* in educational games depend somewhat on the subject matter and the designed learning objectives. Ideally educational games should exhibit belief and norms from some real-world scenarios to facilitate knowledge transfer from the game world to reality. However most educational games have the world set in a fantasy environment as it may increase the intrinsic motivation of learners according to Malone & Lepper (1987). In such context belief and norms should be defined according to the learning objectives and reflect some degree of truthfulness and relation to the real-world to sustain the educational values that distinguish educational games from computer games. Story and narratives are often used to set the scene and immerse game-players into the game world both in computer games and educational games from various perspectives. The difference, however, lies in the defined events (game-play sessions) driven by the story whether such events are meaningful activities that would help game-players to understand the subject or a playground merely for eliciting fun. In fact it is more natural to use dialogue as a method of

storytelling and information dissemination to the game-player via artificial characters instead of narrative. Other forms of content beside narrative, such as the visual element, need not be ultra-realistic although it is desirable (but costly) to include such a requirement in educational games. Visual elements in the form of avatars and objects are sufficient for the purpose of learning. Table 1 below summarises the main differences between computer games and educational games in relation to play, rules and culture.

Some examples of educational games are *Food.Force* and *Hot.Shot.Business*. *Food.Force*¹ is an educational game published by the United Nations World Food Programme (WFP) to educate children between the ages of 8 – 13 about the fight against world hunger. Set in a fictitious island called Sheylan in the Indian Ocean players are taken through six different missions with specific learning objectives; (1) *Air.Surveillance* - The causes of hunger and malnutrition; (2) *Energy.Pacs* - Nutrition and the cost of feeding the hungry; (3) *Airdrop* - WFP's emergency response; (4) *Locate.and.Dispatch* - Global food procurement; (5) *The.Food.Run* - Land-based logistics; and (6) *Future.Farming* - Long-term food aid projects.

Simple game-play is introduced in each mission, for example, in the *Energy.Pacs* mission game-players are required to purchase food items such as rice, beans, vegetable oil, sugar and iodised salt with the budget of USD0.30 per person per meal within 2 minutes.

Disney's *Hot.Shot.Business*² is a business simulation game designed for children between the ages of 9-12 to help them learn the required skills to become a successful business owner (Everett, 2003). The educational game is designed collaboratively with the Ewing Marion Kauffman Foundation, which funds education and entrepreneurship, to support its corporate curriculum. In *Hot.Shot.Business* game-players can choose to own various types of business such as a candy factory, pet spa, landscaping service, comic shop, skateboard factory, magic shop and travel agent. As the game progresses game-players are required to set-up the business, sell services or products, respond to market needs, price the services and products accordingly, market the services or products and compete with other competitors. Business strategies are then evaluated to reflect the game-players performance.

Table.1..Differences.between.computer.games.and.educational.games.in.purpose,.play,.rules.and.culture

	Computer Games	Educational Games
Purpose	For entertainment purposes. Context presented is mostly fictitious or fantasy based.	For learning and skills development purposes. May be a form of entertainment based on the interpretation of the learner.
Play	Interactions designed primarily for entertainment purposes with directed objectives that can be driven by storytelling. Interactions resemble the real-world interaction in a simplified or abstract approach.	Interaction designed for learning purposes with meaningful responses and measurable outcomes. Knowledge is disseminated through events triggered by specially designed interactions and dialogue.
Rules	Rules are designed to accommodate the activity of play, which are often tuned for playability rather than reflecting the real-world.	Rules are designed for specific learning outcomes that can be used to measure the interactions during "serious play". Rules can be simplified or made complex to support the activity of play.
Culture	Beliefs, norms and world setting presented visually and via narrative often set in an imaginary world that is represented artistically and often exaggerated.	Beliefs, norms and world setting presented visually and via narrative that are related to knowledge domain, reflect truthfulness and have direct and explicit relation to real-world events. Game world maybe set in an imaginary world.

Other examples of educational games designed for learners in middle school, institutions of higher learning and adults include:

- *UNIGAME* – A web-based game that encourages learners in higher education institutions to search for information, discuss topics and arrive at a consensus using a problem solving approach (Pivec & Dziabenko, 2004).
- *CyberCIEGE* – A computer game that teaches information assurance concepts through the simulation of an IT firm where learners take on the role of decision maker to satisfy the needs of virtual users while also protecting valuable information assets from cyber-criminals (Irvine, Thompson, & Allen, 2005).
- *Supercharged!* – A computer game in which learners in middle school can learn about electrostatic properties by navigating through an electrostatic maze controlling the charge of the spaceship through careful placement of charged particles (Squire, Barnett, Grant, & Higginbotham, 2004).

There is currently a larger focus on educational games for children than any other age group. This is mainly due to the early stage of edutainment research that focuses mainly on child education. In addition, many educational games are developed quicker and more cost effectively for young children since they have a lower expectation of the sophistication of the interactive content compared to teenagers and adults. Training simulators are more popular among adults especially in the field of aviation (Telfer, 1993) and medicine (Colt, Crawford, & III, 2001).

Related Terminologies and Scope

In addition to the term ‘games-based learning’ and ‘educational games’ there are other terms available to describe the use of computer games for learning. These include ‘edutainment’, ‘train-

ing simulators’ and most recently ‘serious games’. Each of these terms represents different aspects of games-based learning and is used in different contexts. Therefore it is necessary to have each of these terms explained to promote further understanding of games-based learning.

Edutainment represents the integrative use of various media such as television programmes, video games, films, music, multimedia, websites and computer software to promote learning in a fun and engaging manner. It is a multidisciplinary area of research, which furthers the potential of multimedia learning that often relates to multimedia-based educational software distributed via CD-ROM but in general represents the use of entertainment elements in an educational context (Walldén & Soronen, 2004). There are obvious areas of overlap here with other areas of study such as psychology, pedagogy, interactive graphics, human computer interaction, computing and more. *Sesame.Street.workshop* (Revelle, 2003), *National. Geographic. Channel* and *Discovery. Channel* are some examples of edutainment content delivered using the medium of television (although television is typically a non-interactive platform digital TV does offer some elements of interaction). *Typing.software* and *courseware* are some of the typical examples of computer-based edutainment content available off the shelf. Such computer-based edutainment content is mostly produced for the children’s market with low levels of interactivity due to the low expectation that children have towards the quality of content.

Training. simulators are software systems that involve simulation of real-world experiences intended for development of skills where the challenges presented accurately replicate a real-world scenario. The user is required to solve problems using procedural actions defined through hardware interfaces (Narayanasamy, Wong, Fung, & Rai, 2006). Simulation technology was initially developed for investigation purposes in the field of science and engineering and is used to model the behaviour of some real object, machine or

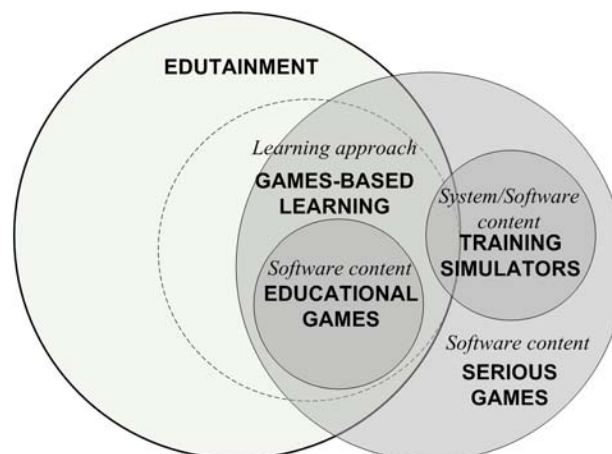
system based on (near) precise mathematical modelling and highly accurate visualisation of the state of the subject over a period of time. Although training simulators share many similarities with computer games they lack elements of game-play that disqualify them from being classified as a game.

Serious.games is a more recent term used to describe computer games with embedded pedagogy (Zyda, 2005). However serious games are not synonymous with educational games and training simulators. The taxonomy of serious games proposed by Sawyer and Smith (2008) expands the scope and purpose of serious games to include games for health, advertisement, training, education, science, research, production and work, in which games technologies are used specifically for improving accessibility of simulations, modelling environments, visualisation, interfaces, delivery of messages, learning and training, and productive activities such as authoring, development or production. Some serious games featured at the Serious Games Initiative website³ demonstrate the diverse and creative application of games technology in training and creating awareness. *Foodforce.* (WFPFoodForce, 2008), *Stone. City.* (Bogost, 2007), *Second. life* (secondlife.com), *America's.Army* (www.ameri-

casarmy.com) and *VR.Therapy.for.Spider.Phobia* (Hoffman, Garcia-Palacios, Carlin, Furness, & Botella-Arbona, 2003) are some notable examples of serious games. Some serious games may not necessarily have game-play elements but can still present educational potential. *Storytelling.Alice*, a programming environment designed to motivate middle school learners (especially girls) to learn computer programming through a storytelling approach, is a good example of serious game for educational purposes. Although there is with very little elements of game-play, it is indeed an example of games-based learning in practice. In *Storytelling.Alice* learners program the animated characters to act in a story they create. Kelleher (2006) reported that learners are willing to spend 42% more time in programming using *Storytelling.Alice* than the predecessor *Alice* (better known as *Generic.Alice*) and devote more extra-curricular time to work on their storytelling program.

Most research in games-based learning and the numerous varieties of software used in this approach are generally categorised as edutainment (as illustrated in Figure 1). Educational games, training simulators and serious games are interactive software content that takes advantage of games technologies for non-entertainment purposes with a different reach in the context

Figure 1..Relationship.between.and.scope.of.edutainment,.games-based.learning,.educational.games,.training.simulators.and.serious.games



of education and training. Education focuses on the development of the mind, while training focuses on the development of specific skill sets (Moore, 1998). These are modes of learning that offer different lessons to learners and can be used in parallel in the context of learning to provide intellectual and skills development. Educational games, training simulators and serious games can be used for games-based learning depending on the appropriateness of the subject content. These terms are referred collectively as games-based learning content in this chapter.

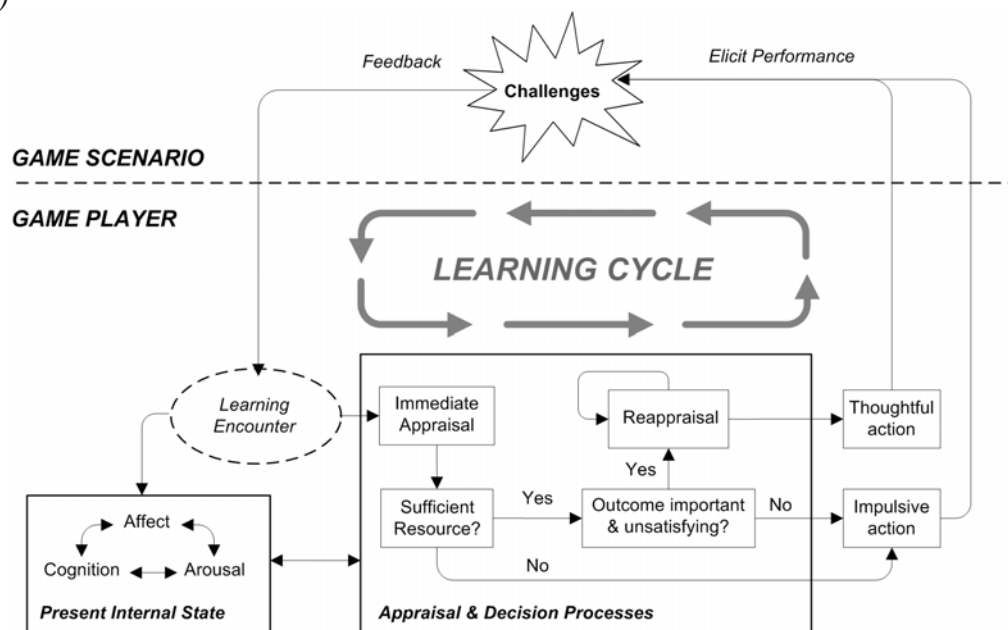
Pedagogies in Games-Based Learning

Games-based learning attracts learners to first learn about the game world and eventually learn about the subject embedded within the game through productive play. From a pedagogy standpoint well-designed learning games have theories of learning such as Gagne's 'Conditions

of Learning theory', Gardner's 'Theory of Multiple Intelligences', Skinner's 'Operant Conditioning theory', Thorndike's 'Laws of Effect' and Maslow's 'Hierarchy of Needs theory' embedded in the design as simple 'recipes' to engage game-players to learn as they play (Becker, 2005; Siang & Rao, 2003; Tang & Hanneghan, 2005).

These theories of learning serve as a basis for a learning model in computer games described by Buckley and Anderson (2006) through their *General Learning Model* (GLM). The GLM provides a means for describing the learning process experienced by learners in the game world. The learning cycle experienced by the game player (or learner in the context of games-based learning) begins with the understanding of environmental cues presented, which are then interpreted to generate a list of short-term goals. Game-players then act according to the selected goal and evaluate the appropriateness of the action taken in relation to the goal selected. Games-based learning also integrates some of the effective and desirable learning approaches used in current

Figure 2..General Learning Model: expanded.causes.and.processes.(adapted from.Buckley.& Anderson. ©2006)



practice. These learning approaches include *active.learning*, *experiential.learning* and *situated.learning*.

Active.learning refers to the use of interesting activities to engage and maintain a learner's focus by encouraging participation during the lesson. Activities introduced as part of active learning should encourage learners to do and question their own actions and should permit them to explore and develop their own understanding of the subject area presented (Bonwell & Eison, 1991). Games-based learning demands the user to participate in the goal-directed play and encourages the learner to practice and experiment with various solutions to the challenges and conflicts presented in a safe, virtual environment. Non-digital games (i.e. those in a non-computer form) are a recommended strategy to facilitate active learning in a classroom setting to encourage participation and foster the spirit of competition among peers (Cook & Hazelwood, 2002; Crichton & Flin, 2001; Hill, Ray, Blair, & Curtis A. Carver, 2003; Radford, 2000). As compared to conventional active learning strategies that take place mostly in a classroom setting, games-based learning can also be used outside of classroom hours individually or even collaboratively in groups via a computer network.

Experiential.learning emphasises the importance of experience in the process of learning. Made popular by Kolb through his 'Learning Cycle theory' it is a useful descriptive model of the adult experiential learning process known to many educators at tertiary level. The model suggests that an adult's learning process is a cycle of four stages better described as *Concrete.Experience*, *Reflective Observation*, *Abstract.Conceptualization* and *Active.Experimentation* (Kolb, 1984). In games-based learning, learners also use an experiential learning approach during game play. Interactivity, governed by the rules that form the play, provides learners the freedom to interact with the game objects in the game world. Responses obtained for each action is a form of knowledge

(causal-effect relationship) gained through interactivity. This is often simply achievable through a single mouse-click or key-press. Repeated use of each action provides greater understanding to learners how such action is useful in a number of situations to shape the learner's experience. The simple control interface (through game pad, keyboard and mouse) and well defined and obvious (or exaggerated) responses in games-based learning contexts makes association of knowledge straightforward and less complicated compared to the real world where it is less easily recognisable. The only drawback of experiential learning is in transferring the knowledge gained in a virtual world to the real world because learners are separated through non-conventional physical objects, such as a game pad or mouse. However innovative hardware interfaces such as Nintendo's WiiMote and Sony's SIXAXIS motion sensing controller are making the gaming experience more physical and tangible and are thus bridging the gap of experience transfer to the real world.

Situated.learning requires learners to be placed in a real, social and/or physical environment that enables learners to experientially learn skills and knowledge of a profession through social and collaborative interaction (Billett, 1996; Brown, Collins, & Duguid, 1989). It was proposed to address the gap between the learning of theory and the application of knowledge (Lave & Wenger, 1991). Games-based learning can virtually situate learners in any (often highly realistic) environment for learning and permit social and collaborative interactions with other learners (via online networking capabilities) and non-player characters (NPCs). Learners have the opportunity to practice their knowledge safely in this environment and review their understanding towards the knowledge constructed instantly through programmed responses. Although games-based learning does not yield the same benefits of traditional situated learning, learners can still learn from the virtual experience offered and are better prepared for the real situation.

Games-Based Learning Approaches

Games-based learning can be used to supplement existing learning approaches or can be integrated into existing curricula as an extension to current e-learning systems. Both approaches have their own merits depending on the needs of adopters, i.e. whether games-based learning will add value to the learning experience or address the wider issues of human resourcing or cost in teaching and training. Selection of the right approach also largely depends on the learners' age group and the intended use of such educational technology. In general the focus of games-based learning content can be either *targeted* or *immersive* (Freitas, 2007). Games-based learning content with a targeted focus is designed to teach very specific concepts in learning, whereas immersive-focused content provides learning experience that offers more than just knowledge.

Early games-based learning projects such as BECTa's Computer Games in Education (CGE) project, the UNIGAME project and MIT's Education Arcade (Games-to-teach Project) use computer games as a supplement to existing teaching practices. Most computer games used in these games-based learning projects are designed as a form of persuasion to raise learners' curiosity and interest, and subsequently transform them to become active learners. For effective learning to take place teachers play a significant role in managing this environment when using the game paradigm (BECTa, 2006). In subject areas such as aviation, corporate finance, medicine and defence, computer games and training simulators are used as a learning platform primarily as a cost effective approach for educating and training adult learners at large. In these scenarios games-based learning is used as a platform mostly for applying concepts to practice, practicing procedures and perfecting the skills within a certain area. Although it may not seem viable for schools to replace existing lesson delivery methods with games-based learn-

ing it does make sense to extend the boundaries of learning to include subject areas that are not covered in schools, for example 'life' skills, personal hygiene and dietary awareness.

Advantages and Disadvantages of Games-Based Learning

Learning with computer games excites and captivates learners to learn about a subject through the use of game-play transforming from the 'dull and painful' learning experience to a fun, motivating and engaging experience. Such embedded attraction, described as the 'motivation of game-play' by Prensky (2002), can empower learners to experience learning with an 'open heart and open mind' blurring the learning-curve associated with a new subject area. Some pedagogic advantages of games-based learning discussed include:

- Encouragement of learners to take a problem solving approach in learning (Khoo & Gentile, 2007).
- Instant feedback to correct misconceptions and promote formation of concepts thus increasing learners' understanding of a subject area (Laughlin, Roper, & Howell, 2007).
- Increased retention of information through learning by game-playing (Roussou, 2004).
- Aid in acquisition and development of cognitive abilities that are not formally taught in education (Gee, 2003).
- Younger learners can learn ICT skills through game-playing that are necessary in the 21st century workforce (BECTa, 2001).
- Fostering collaborative learning among peers (Hamalainen, 2008; Sugimoto, 2007).
- Building learners confidence and helping students with learning impairments such as dyslexia to learn (Aguilera & Mendiz, 2003; Dziorny, 2007).

- Promotes deep learning by arousing learners curiosity on certain subjects (Gee, 2003).
- Transforming entertaining play to productive play and extending learning into gaming (Pearce, 2006).

From a purely financial viewpoint, games-based learning can be a cost effective approach to conduct education and training for domains such as medicine and national security that may involve expensive or dangerous equipment or material that may jeopardise the safety of learners due to mishandling. Games-based learning that demonstrates simulation characteristics can offer a ‘mistake-friendly’ learning environment according to Kriz (2003) and that encourages learners to experiment their solutions in the game world and raise their curiosity on a subject matter. Learners can afford to make mistakes and learn through those mistakes and restart the entire lesson whenever necessary without consequence. From an institutional and organisational viewpoint games-based learning is also a perfect platform to address the increasing need of qualified teachers to educate and train the new generation of learners since computer games are widely accepted and can be easily distributed (for example, using Internet delivery).

Games-based learning also has its disadvantages. Opponents of games-based learning have adopted a somewhat apocalyptic ideology on the effect of computer gaming that purports game-playing as a means to promote aggressive behaviour (Anderson & Bushman, 2001), smoking (Kasper, Welsh, & Chambliss, 1999), obesity (Subrahmanyam, Kraut, Greenfield, & Gross, 2000) and poorer academic performance (Hauge & Gentile, 2003). In recent years, more concrete results on the effects of game-playing has been presented, mostly related to violence and aggression behaviour (Anderson & Bushman, 2001; Anderson et al., 2004; Carnagey & Anderson, 2005). Further findings on the effects of game-playing particularly in studies of violent

computer games reveal that game-players have evidence of numbness towards violence that may suggest a possible transitioning of violent behaviour to reality (Carnagey, Anderson, & Bushman, 2007). Many question the validity of the evidence presented by detractors of computer games based on the studies of media violence (Barker, 2001; Squire, 2002) and instead believe that the unintended effects of game playing are dependent on social and cultural factors (upbringing) of game-players. Also violence in computer games is widely misinterpreted as an agent for aggression as opposed to entertainment, which is what is actually experienced by game-players when they are aware of the consequences of such acts in real life (Dawson, Cragg, Taylor, & Toombs, 2007). In addition, some male students might just exploit such environments as a playground as observed in MIT’s Games-to-teach project (Jenkins, Klopfer, Squire, & Tan, 2003) and BECTa’s Computer Games in Education Project (BECTa, 2001).

Challenges for Games-Based Learning

Positive findings from earlier games-based learning projects are paving the way for more to adopt this learning approach. However there are great challenges ahead that require attention from stakeholders before learners can fully reap the benefits. The adoption of games-based learning is a challenge on its own as it requires teachers to have access to computers with ‘gaming specification’ (usually a high-end machine), technical support, familiarity with the games-based learning content, adequate preparation time, an appropriate audience group and the cost of licenses for games-based learning content (Freitas, 2007).

Initial findings from a related research study also indicate that there is a need to address the source of games-based learning content (Tang & Hanneghan, 2005). Development of games-based

learning content may require a huge budget and such financial barriers have been a major challenge for many teachers who intend to adopt it. Some have tried sourcing such content from commercial-off-the-shelf (or *COTS*) games and this has proved very challenging to get the right content for use in an educational setting. Most *COTS* games available are designed specifically to entertain and some even elicit violence and sexual content, thus rendering them inappropriate (but this does not imply useless) for use in an education context (Tang & Hanneghan, 2005). The other alternative then is to spearhead in-house development of games-based learning content using open source or royalty-free game engines and ‘modding’ (modifying) *COTS* games by utilising a game editor application to create customised game objects and levels. Almost all options available require technical knowledge, which precludes most teachers whose main aim is to solely impart their knowledge rather than become games programmers. It is evident that there are very few tools available to support development of games-based learning content for the non-developer user group.

Designing games-based learning content is another challenge that requires rigorous *design-play-test-evaluate* cycles. The unintended effects of computer gaming may still exist in games-based learning content depending on the intentional use of such a medium and appropriateness of the activities and content presented in that medium (Buckley & Anderson, 2006). Therefore it is crucial that games-based learning content is designed from sound pedagogical theories instead of focusing on entertainment value (Tang & Hanneghan, 2005; Tang, Hanneghan, & El-Rhalibi, 2007).

The duration of the game-play session may also be an issue as lessons are typically scheduled in slots of no more than one hour. Computer games are designed to be highly engaging, therefore an hour of games-based learning may not be enough to satisfy the needs of learners, but more importantly will they be able to learn within this

period of time? Therefore it is justifiable if games-based learning is integrated into the curricular framework to aid learning and cater for different learning styles as proposed by Malone (1980).

The choice of a pedagogical approach has significant impact on learning. Preliminary evaluation of computer games in education reveals the possibility of inhibiting learning as reported in Hailey & Hailey (2003) and Halttunen & Sormunen (2000). As computer games may appeal to some but not all, there is a need to investigate into the appropriateness of using computer games in the design of the curriculum to maximize the positive learning experience.

Future Directions of Games-Based Learning

There is a significant amount of effort promoting the use of computer games in learning both from education, industry and even government. Computer games are now a ubiquitous part of a modern digital life throughout the world and exploiting this platform for use in learning can be of great benefit to all. While other attempts such as e-learning and multimedia learning have in some parts failed to engage learners, computer games are designed to be alluring and extrinsically motivating for game-players. This platform can also help teachers who are constantly challenged by the newer generation of learners and their needs in learning to provide high-quality education.

Although there are different views about games-based learning, there is a general consensus that computer games can be used as a medium for learning based on the positive findings from early games-based learning projects. However, there is a lack of empirical studies to testify to the success of games-based learning at present. More research into the potential and limitations of games-based learning is required to develop a greater understanding on the application of the technique and its impact on society. Aligned with

such vision, the Federation of American Scientist (FAS) (2006b) has identified two focussed research areas; design of games-based learning content and adaptation of simulation to learning environments, that will drive games-based learning forward. For games-based learning to be widely accepted there is a need to address the challenges discussed and more of these will be discussed in greater detail in the remaining chapters of this book.

The adoption rate of games-based learning is currently low in the education sector in contrast to the corporate sector. This is mainly due to constraints of a financial, infrastructure and working practice nature. However acceptance rates are improving year on year. In the UK, close to 60% of teachers want to use computer games in the classroom for educational purposes (Futurelab, 2006) and such statistics will continue to grow with more realising the potential that computer games hold. The availability of programming-free and user-friendly development tools that facilitate teachers in the development of games-based learning content is also highly desirable to encourage adoption by non-games practitioners (Tang, Hanneghan, & El-Rhalibi, 2007). Alternatively the education sector may consider collaboration with industry partners to jointly develop games-based learning applications. This is slowly becoming a viable option through the growth of a serious games industry that has been born out of the commercial entertainment games market as large games studios look to diversify their talent.

REFERENCES

- Aguilera, M. d., & Mendiz, A. (2003). Video games and education: (education in the face of a "parallel school"). *Computers.in.Entertainment.(CIE).*,1, 10-10.
- Aldrich, C. (2003). *Simulations.and.the.Future.of.Learning:.An.Innovative.(and.Perhaps.Revolutionary).Approach.to.e-Learning.* Pfeiffer.
- Anderson, C. A., & Bushman, B. J. (2001). Effects of Violent Video Games On Aggressive Behavior, Aggressive Cognition, Aggressive Affect, Physiological Arousal, And Prosocial Behavior: A Meta-Analytic Review of the Scientific Literature. *Psychological.Science.*,12, 353 - 359.
- Anderson, C. A., Carnagey, N. L., Flanagan, M., Arlin J. Benjamin, J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances.in.Experimental.Social.Psychology.*,36, 199-249.
- Baker, A., Navarro, E. O., & Hoek, A. v. d. (2005). An experimental card game for teaching software engineering processes. *Journal.of.Systems.and.Software.*,75(1-2), 3-16.
- Barker, M. (2001). The Newson Report: a case study in 'common sense'. In *Ill.Effects:.The.Media/Violence.Debate* (2 ed., pp. 27-46). London, New York: Routledge.
- Becker, K. (2005, 16-20 June 2005). *How.Are.Games.Educational? Learning.Theories.Embodied.in.Games.* Paper presented at the DiGRA 2005 - the Digital Games Research Association's 2nd International Conference, Simon Fraser University, Burnaby, BC, Canada.
- BECTa. (2001). Computer Games in Education: Aspects. Retrieved 19 February, 2008, from <http://partners.becta.org.uk/index.php?section=rh&rid=13588>
- BECTa. (2006). Computer Games in Education: Findings Report. Retrieved 19 February, 2008, from <http://partners.becta.org.uk/index.php?section=rh&rid=13595>
- Billett, S. (1996). Situated learning: bridging sociocultural and cognitive theorising. *Learning.and.Instruction.*,6(3), 263-280.
- Bogost, I. (2007). Persuasive Games: How I Stopped Worrying About Gamers And Started Loving People Who Play Games. Retrieved 20 February, 2008, from http://www.gamasutra.com/view/feature/1543/persuasive_games_how_i_stopped_.php

- Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom*. Washington, DC: ASHE-ERIC Higher Education Reports.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.
- Buckley, K. E., & Anderson, C. A. (2006). A Theoretical Model of the Effects and Consequences of Playing Video Games. In P. Vorderer & J. Bryant (Eds.), *Playing Video Games: Motives, Responses, and Consequences* (pp. 363-378). Mahwah, NJ: LEA.
- Carnagey, N. L., & Anderson, C. A. (2005). The Effects of Reward and Punishment in Violent Video Games on Aggressive Affect, Cognition, and Behavior. *Psychological Science Agenda: Science Briefs*, 16, 882-889.
- Carnagey, N. L., Anderson, C. A., & Bushman, B. J. (2007). The effect of video game violence on physiological desensitization to real-life violence. *Journal of Experimental Social Psychology*, 43, 489-496.
- Colt, H. G., Crawford, S. W., & III, O. G. (2001). Virtual Reality Bronchoscopy Simulation*: A Revolution in Procedural Training. *CHEST*, 120(4), 1333-1339.
- Connolly, T. M., & Stansfield, M. (2007). From eLearning to Games-Based eLearning. *International Journal of Information Technology and Management*, 26(2/3/4), 188-208.
- Cook, E. D., & Hazelwood, A. C. (2002). An active learning strategy for the classroom—"who wants to win ... some mini chips ahoy?" *Journal of Accounting Education*, 20(4), 297-306.
- Crawford, C. (2003). *Chris Crawford on Game Design*. New Riders Publishing.
- Crichton, M., & Flin, R. (2001). Training for emergency management: tactical decision games. *Journal of Hazardous Materials*, 88(2-3), 255-266.
- Dawson, C. R., Cragg, A., Taylor, C., & Toombs, B. (2007). *Video Games Research to improve understanding of what players enjoy about video games, and to explain their preferences for particular games*: British Board of Film Classification (BBFC).
- Dziorny, M. (2007). *Digital Game-based Learning and dyslexia in higher education*. Paper presented at the Society for Information Technology and Teacher Education International Conference 2007, San Antonio, Texas, USA.
- Everett, J. (2003). Building a business simulation for kids: the making of Disney's hot shot business *Computers in Entertainment (CIE)*, 1, 18-18.
- FAS. (2006a). Harnessing the power of video games for learning, Summit on Educational Games 2006. Retrieved 3 July, 2008, from <http://fas.org/gamesummit/Resources/Summit%20on%20Educational%20Games.pdf>
- FAS. (2006b). R&D Challenges for Games for Learning. Retrieved 3 July, 2008, from <http://www.fas.org/gamesummit/Resources/RD%20Games.pdf>
- Freitas, S. d. (2007). *Learning in Immersive Worlds: A review of game-based learning*: JISC.
- Futurelab, N. (2006). Close to 60% of UK Teachers Want Computer Games in the Classroom. Retrieved 30 June, 2008, from http://www.futurelab.org.uk/about_us/Press_Release184
- Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. Palgrave Macmillan.
- Hailey, C. E., & Hailey, D. E. (2003). How Genre Choices Effects Learning in Digital Environment. *Journal of Engineering Education*, 92(3), 287-294.
- Halttunen, K., & Sormunen, E. (2000). Learning Information Retrieval through an Educational Game: Is Gaming Sufficient for Learning? *Education for Information*, 18(4), 289-311.

- Hamalainen, R. (2008). Designing and evaluating collaboration in a virtual game environment for vocational learning. *Computers. & Education*, 50(1), 98-109.
- Hauge, M. R., & Gentile, D. A. (2003). *Video Game Addiction Among Adolescents: Associations with Academic Performance and Aggression*. Paper presented at the Society for Research in Child Development Conference, Tampa, Finland.
- Hill, J. M. D., Ray, C. K., Blair, J. R. S., & Curtis A. Carver, J. (2003). Puzzles and games: addressing different learning styles in teaching operating systems concepts. *ACM SIGCSE Bulletin*, 35(1), 182-186.
- Hoffman, H. G., Garcia-Palacios, A., Carlin, C., Furness, T. A. I., & Botella-Arbona, C. (2003). Interfaces that heal: Coupling real and virtual objects to cure spider phobia. *International Journal of Human-Computer Interaction*, 15, 469-486.
- Irvine, C. E., Thompson, M. F., & Allen, K. (2005). CyberCIEGE: Gaming for Information Assurance. *IEEE Security and Privacy*, 3(3), 61-64.
- Jayakanthan, R. (2002). Application of computer games in the field of education. *The Electronic Library*, 20(2), 98-102(105).
- Jenkins, H., Klopfer, E., Squire, K., & Tan, P. (2003, October 2003). Entering The Education Arcade. *Computers in Entertainment (CIE)*, 1, 17-17.
- JISC. (2004). Effective Practice with e-Learning - A good practice guide in designing for learning. Retrieved 5 July, 2008, from http://www.jisc.ac.uk/elearning_pedagogy.html
- Kasper, D., Welsh, S., & Chambliss, C. (1999). Educating Students about the Risks of Excessive Videogame Usage.
- Kelleher, C. (2006). *Motivating Programming: Using storytelling to make computer programming attractive to middle school girls*. Unpublished Technical Report, Carnegie Mellon University.
- Khan, R., & Kellner, D. (2004). New media and internet activism: from the 'Battle of Seattle' to blogging. *New Media & Society*, 6(1), 87-95.
- Khoo, A., & Gentile, D. A. (2007). Problem-based Learning in the World of Digital Games. In O.-S. Tan (Ed.), *Problem-based Learning in eLearning Breakthroughs* (pp. 97-129). Singapore: Thompson Learning.
- Kolb, D. A. (1984). *Experiential Learning*. Englewood Cliffs, NJ: Prentice-Hall.
- Koster, R. (2004). *A Theory of Fun for Game Design*. Paraglyph.
- Kriz, W. C. (2003). Creating Effective Learning Environments and Learning Organizations through Gaming Simulation Design. *Simulation and Gaming*, 34(4), 495-511.
- Laughlin, D., Roper, M., & Howell, K. (2007). NASA eEducation Roadmap: Research Challenges in the Design of Massively Multiplayer Games for Education & Training. Retrieved 10 August, 2008, from http://www.fas.org/programs/ltp/publications/roadmaps/_docs/NASA%20eEducation%20Roadmap.pdf
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Leont'ev, A. N. (1977). *Activity and Consciousness* (N. Schmolze & A. Blunden, Trans.): Progress Publishers.
- Lessig, L. (2004). *Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity*. New York: Penguin.
- Malone, T. W. (1980). *What makes things fun to learn? heuristics for designing instructional computer games*. Paper presented at the Proceedings of the 3rd ACM SIGSMALL symposium and the first SIGPC symposium on Small systems, Palo Alto, California, United States.
- Malone, T. W., & Lepper, M. R. (1987). Making Learning Fun: A Taxonomy of Intrinsic Motiva-

- tions for Learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning and Instruction* (Vol. 3): Lawrence Erlbaum Associates.
- Moore, J. W. (1998). Education versus Training. *Journal of Chemical Education*, 75(2), 135.
- Narayanasamy, V., Wong, K. W., Fung, C. C., & Rai, S. (2006). Distinguishing Games and Simulation Games from Simulators. *Computers in Entertainment (CIE)*, 4, Article No. 9.
- Nieborg, D. B. (2004). *America's Army: More Than a Game*. Paper presented at the Transforming Knowledge into Action through Gaming and Simulation, Munchen: SAGSAGA.
- OECD. (2006). Evolution of Student Interest in Science and Technology Studies - Policy Report, Organisation for Economic Co-operation and Development - Global Science Forum. Retrieved 5 July, 2008, from <http://www.oecd.org/dataoecd/16/30/36645825.pdf>
- Pearce, C. (2006). Productive Play: Game Culture From the Bottom Up. *Games and Culture*, 1(1), 17-24.
- Pivec, M., & Dziabenko, O. (2004). Game-Based Learning in Universities and Lifelong Learning: "UniGame: Social Skills and Knowledge Training" Game Concept. *Journal of Universal Computer Science*, 10(1), 14-26.
- Prensky, M. (2001). *Digital Game-Based Learning*: Paragon House.
- Prensky, M. (2002). The Motivation of Gameplay or the REAL 21st century learning revolution. *On the Horizon*, 10, 1-14.
- Prensky, M. (2005). "Engage me or Enrage me" What today's learners demand. *EDUCAUSE Review*, 40(5), 60-65.
- Radford, A. (2000). Games and learning about form in architecture. *Automation in Construction*, 9(4), 397-384.
- Revelle, G. L. (2003). Educating via entertainment media: the Sesame Street Workshop approach. *Computers in Entertainment*, 1, 16-16.
- Rollings, A., & Adams, E. (2003). *Andrew Rollings and Ernest Adams on Game Design*: New Riders Publishing.
- Roussou, M. (2004). Learning by doing and learning through play: an exploration of interactivity in virtual environments for children. *Computers in Entertainment (CIE)*, 2, 10-10.
- Salen, K., & Zimmerman, E. (2003). *Rules of Play: Game Design Fundamentals*. The MIT Press.
- Sawyer, B., & Smith, P. (2008). Serious Games Taxonomy. Retrieved 26 March, 2008, from <http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf>
- Siang, A. C., & Rao, R. K. (2003). *Theories of Learning: A Computer Game Perspective*. Paper presented at the IEEE Fifth International Symposium on Multimedia Software Engineering, Taipei, Taiwan.
- Sjøberg, S., & Schreiner, C. (2006). How do students perceive science and technology? *Science in School*(1: Spring 2006), 66-69.
- Squire, K. (2002, July 2002). Cultural Framing of Computer/Video Games. *International Journal of Computer Game Research*. Retrieved 18 February, 2008, from <http://www.gamestudies.org/0102/squire/>
- Squire, K. (2003). Video Games in Education. *International Journal of Intelligent Games and Simulation*, 2(1), 49-62.
- Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T. (2004). *Electromagnetism Supercharged! Learning Physics with Digital Simulation Games*. Paper presented at the 6th International Conference on Learning Sciences, Santa Monica, California.
- Subrahmanyam, K., Kraut, R. E., Greenfield, P. M., & Gross, E. F. (2000). The Impact of Home Computer Use on Children's Activities and Development. *The Future of Children*, 10, 123-143.
- Sugimoto, M. (2007, 26 - 28 March). *What can Children Learn through Game-based Learning*.

Systems? Paper presented at the Digital Game and Intelligent Toy Enhanced Learning, Jhongli, Taiwan.

Tang, S., & Hanneghan, M. (2005). *Educational Games. Design: Model. and. Guidelines.* Paper presented at the the 3rd International Game Design and Technology Workshop (GDTW'05), Liverpool, UK.

Tang, S., Hanneghan, M., & El-Rhalibi, A. (2007). *Pedagogy.Elements,Components.and.Structures.for.Serious.Games.Authoring.Environment.* Paper presented at the 5th International Game Design and Technology Workshop (GDTW 2007), Liverpool, UK.

Telfer, R. (1993). *Aviation.Instruction.and.Training.* Aldershot: Ashgate.

Walldén, S., & Soronen, A. (2004). *Edutainment. -. From. Television. and. Computers. to. Digital. Television:* University of Tampere Hypermedia Laboratory.

WFPFoodForce. (2008). Retrieved 20 February, 2008, from <http://www.food-force.com>

Zyda, M. (2005). From Visual Simulation to Virtual Reality to Games. *Computer*, 38, 25-32.

ENDNOTES

- ¹ Food Force is available for free download from www.food-force.com
- ² Hot Shot Business can be played online at www.hotshotbusiness.com
- ³ The Serious Games Initiative website can be found at <http://www.seriousgames.org/>

Chapter II

Learning and Teaching with Computer Games in Higher Education

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ABSTRACT

This chapter examines the rationale for the use of computer games in learning, teaching, and assessment in Higher Education. It considers their pedagogic potential in respect to a number of theories of learning, as well as some of the practical issues associated with using computer games in real teaching situations, both face-to-face and online. The first part of the chapter focuses on the theory underpinning the use of computer game-based learning with HE students, examining motivation and engagement, constructivism, collaborative and problem-based learning. The second part of this chapter considers the practical issues of using computer games in actual teaching contexts and presents twelve principles for the design and evaluation of computer games to support learning.

INTRODUCTION

In recent years there has been increased awareness of the potential of computer games in education, including growing interest in their application in Higher Education. An increasingly diverse student population, with different backgrounds and abilities, has contributed to a rethink about effective ways of teaching and learning, and games-based

learning offers many pedagogic benefits over traditional methods of teaching and learning.

Play is a powerful learning tool, which is essential to the development of both adults and children (Rieber, 1996), promoting engagement in learning and mastery of tasks (Colarusso, 1993). Games are a fundamental part of the human experience and the way in which learning takes place, providing the opportunity to practise and

explore in a safe environment, and providing a forum for learning basic human skills like aiming, timing, hunting, strategy and manipulation of power (Koster, 2005).

There are many examples of innovative ways in which computer gaming has been used to enhance learning and teaching, both with children and adults. Research with school children includes the use of science games (Magnussen, 2005), historical games designed for entertainment (Squire & Barab, 2004), and multi-user gaming environments (Barab et al, 2005). Research in Higher Education includes the use of computer games to support the learning and practice of civil engineering concepts (Ebner & Holzinger, 2007), competitive games to teach programming (Lawrence, 2004), and virtual reality games to teach geography students (Virvou & Katsionis, 2006).

This chapter examines the rationale for the use of computer games in learning, teaching and assessment, with a particular focus on adult learners in Higher Education. It considers their pedagogic potential in respect to theories of learning, and discusses some of the practical issues associated with using computer games in real teaching situations. This chapter is based upon the author's doctoral research into the use of collaborative game-based learning in Higher Education (Whitton, 2007).

The initial section of this chapter examines the pedagogic benefits of computer games for learning, exploring first issues of motivation and secondly examining the potential of games in relation to different theoretical perspectives. The next section of the chapter examines practical issues associated with using computer game-based learning in Higher Education, presenting a number of principles for effective educational game design and discussing implementation issues such as the framing of the games within a learning package, and the assessment of computer game-based learning. Finally, the chapter closes with some concluding remarks on the advantages and disadvantages of computer game-based learning.

Computer Games for Learning

One reason often put forward for using computer games in education is their motivational benefits. This section will argue, however, that the motivational aspects of games are often over-stated and secondary to the pedagogic benefits inherent in the design of certain types of computer game. First, issues associated with the motivational aspects of games are discussed, drawing on a small-scale study into motivations for adults playing games, and secondly, a number of theories of teaching and learning are explored in relation to their applicability to computer game-based learning.

Motivational Aspects of Computer Game-Based Learning

A reason commonly put forward for using game-based learning is that it brings benefits in terms of student motivation for learning. While this may be a more realistic assumption for children, this supposition is less compelling when applied to adult learners. Adult motivation to learn with games is explored here, and evidence presented that the motivational aspects of games should not be a primary reason for their use in Higher Education.

There is an assumption often made in the literature on game-based learning that the majority of people – if not all – find games intrinsically motivating (e.g. Alessi & Trollip, 2001; Prensky, 2001; McFarlane et al, 2002; Oblinger, 2004), and that this is a good reason for using them to teach. In order to investigate how true this assumption is for adult learners, and to explore motivations for using games, a small scale study was undertaken in 2004 to explore these issues. This study also aimed to provide evidence as to whether computer game-based learning would be perceived as an acceptable, if not intrinsically motivational, way to learn by students in Higher Education.

The first part of this study was based upon the phenomenographic methodology, and consisted of a twelve interviews with current and ex-students, to examine their motivations for playing games and their attitudes towards game-based learning in education. The interviews were followed up by the use of a survey questionnaire with 200 undergraduate and postgraduate students, with the intention of examining how representative the opinions expressed in the interviews were in a student population.

The method for data collection and analysis of the initial set of interviews drew on phenomenography, a research approach designed to answer questions about how different people view different aspects of reality. It aims to investigate how people perceive the world and categorise the different conceptions they have about the object of interest (in this case, computer games for learning), and does not try to represent reality, but how reality is perceived by individuals (Marton, 1981). The primary outcomes of phenomenographic research are categorisations of description, which look at the ways in which people perceive the phenomenon. The primary method of data collection is open-ended interviews, which allow discussion of many possible areas and let the interviewees talk about the subject from their own points of reference.

Student perceptions of game playing for learning was considered to be an appropriate topic for the use of phenomenography, but the work described here is not phenomenography in the purest sense because of the small number of participants. However it did embrace the techniques and philosophy of the method, and, as part of a mixed-methods study, it was felt that a relatively small number of participants would be sufficient to draw out themes and opinions without making the amount of interviews unmanageable (the interviews are backed up with a quantitative survey with a larger population).

There were an equal number of male and female participants, half of whom considered themselves

to be 'game players' and half saw themselves as 'non-game players' (i.e. people who play games by choice as a matter of course and those who do not). Each interview lasted between 30 and 90 minutes and was based around core questions but kept as unstructured and open as possible, so the actual questions and lines of discussion varied as different themes and topics were brought up by the different participants. The interview transcripts were analysed iteratively, initially examining them to draw out themes and hypothetical categories of description, then re-analysing to test statements in the interviews against the proposed framework, until a set of categories were arrived at that accounted for the perceptions of all individuals interviewed.

The analysis showed, perhaps unsurprisingly, that the participants who considered themselves to be game players had different motivations for playing games than those who did not. Those who considered themselves to be game players appeared to have one of three primary motivations, although these motivations are not mutually exclusive. The motivations for game players were: playing for intellectual challenge, playing for social interaction, and playing for physical exertion. For those people who did not consider themselves to be game players, there were generally only two circumstances in which they would play games: killing time, and social facilitation, for example an icebreaker game as a way of getting to know people. However, it is worth noting that although there were clear indications of primary motivations with this small sample, these findings would need to be tested against a far larger population before there could be considered valid.

Overall, the feelings of the participants towards game-based learning were positive, even from those individuals who did not consider themselves to be game players. All of those interviewed said that they would be open to the idea of using a game to learn – if it was seen as being the most effective way. Interestingly, only two people out of those interviewed said that using a game to

learn would be intrinsically motivating. Clearly this is a small-scale study on a small group, so the results may be entirely due to chance, but are indicative of the fact that while games may not be motivating for adult learners in themselves, they may still be an acceptable method of learning.

To complement these interviews, a larger scale quantitative survey was carried out to discover how valid these results are in the context of a larger population. The group used for this study were third-year undergraduate, and Masters-level postgraduate, computing students. This group were selected for two reasons: first, the pragmatic reason that this was a student group that could easily be accessed by the researcher; and second, it was hypothesised that computing students would be among those most likely to be motivated to engage with game-based learning. Therefore if it could not be shown that game-based learning was seen as an acceptable or motivational way to learn by this group, there would be little justification for using increased motivation as a rationale for using computer games for teaching in other areas of Higher Education.

A short questionnaire was designed to elicit gaming preferences, motivations and attitudes towards the use of games in education. This questionnaire was pre-tested with a small number of individuals to ensure question clarity and unambiguity, and finally revised before being used for this study. Four classes of students ($n=200$), all of whom were taking a Group Project unit, were asked to complete the questionnaire at the end of a lecture. The majority of those who completed the questionnaire were males aged between the ages of 20 and 29, which is representative of the total population of the programme, and is a group that might be considered to be most likely to engage with games for entertainment (Entertainment Software Association, 2007).

From the survey data, the two predominant motivations for playing computer games were to be able to interact with others and for the mental challenge. This provides some evidence that

motivations for playing games in this group are aligned with the types of games that may be most appropriate for learning in Higher Education (i.e. those that are collaborative and are mentally challenging). It is important to note that it cannot be assumed that even when students are motivated to play computer games, that they will be motivated to play the same types of games that would be appropriate for learning in a specific context, and that there is no guarantee that the games that the students chose to play in their leisure time are those that they might be most motivated to use for learning.

The survey respondents were asked to consider if they would be positively motivated to learn something using a game, whether they would not be motivated either way, or whether they would actually find a game demotivating. Less than two-thirds (63%) of the respondents said that they would find educational games positively motivational, with 28% saying that they would not be influenced either way and 9% responding that they would find games for learning demotivational. While the majority of students said that they would be motivated to learn with games, it is interesting that this number is not higher in a group of predominantly male, largely young, computing students, who might be expected to be particularly motivated to learn with computer games. Further analysis of the data from this questionnaire also found no evidence that people who are motivated to play games in their leisure time will be motivated to play games for learning.

It is clear – and hardly surprising – that the use of computer games for learning is not intrinsically motivational for all students, but the interviews conducted provide some evidence that they can still be seen as an acceptable and appropriate way to learn in Higher Education, if they are perceived by the learner as being an effective way to learn, and not simply used for any perceived motivational benefits.

In terms of the rationale for using computer games, the fact that games are thought to be

motivational is not in itself a sufficient rationale for using a game. This is not to say that computer games should be excluded from Higher Education, only that the sole reason for using them should not be their perceived motivational benefits – the rationale for using games to teach must be that they embody sound educational principles. If a game is perceived as being the most effective way to learn in a particular context, then students will be more likely to be motivated to use it to learn, not simply because it is a game. The ways in which educational principles and theories of teaching can be embodied in games are explored in the following section.

Computer Games and Theories of Learning and Teaching

In this section a number of different theories of learning and teaching will be explored in relation to the potential of computer games as learning environments, again with a particular focus on Higher Education and adult learners. This section highlights the idea of computer games as constructivist learning environments.

One of the key features of computer games is their ability to engender engagement, which is an important factor that contributes to effective learning. Benyon and colleagues (2005) describe engagement as being “concerned with all the qualities of an experience that really pull people in – whether this is a sense of immersion that one feels when reading a good book, or a challenge one feels when playing a good game, or the fascinating unfolding of a radio drama” (Benyon et al, p 61). There are a number of elements that contribute to engagement in virtual environments, including a sense of authenticity and identification with the characters and virtual gaming world, the adaptivity of the environment, a compelling narrative, immersion and flow (Benyon et al, 2005, based on Shedroff, 2001). Flow is the state of optimal experience, which is supposed to bring happiness, and is described as “the state in which people are

so involved in an activity that nothing else seems to matter; the experience itself is so enjoyable that people will do it even at great cost, for the sheer sake of doing it” (Csikszentmihalyi, 1992, p 4). Computer games have the potential to be highly engaging learning environments because they can create compelling narratives within immersive and challenging worlds, with high levels of interaction and feedback.

The way in which the process of learning is viewed by academics has changed significantly over the last century. Until the late 1950s the behaviourist school of thought was predominant, and the mind was seen as a ‘black box’ that could be studied by observing changes in behaviour, where learning could be reinforced by punishments or rewards. In the late 1950s, cognitivism became the dominant way of thinking about how people learn, where the focus is on the mental processes behind behaviour, particularly focusing on cognition, sensory experience, and memory. More recently, the constructivist paradigm has become the prevailing way in which the theory of learning in Higher Education is described (Cooper, 1993).

Bruner (1966) proposed the idea that learning is an active process and that people construct their own insights about a subject by building on past knowledge and experience. He theorised that teaching should stimulate an inclination to learn, specify ways in which to structure knowledge so that learning is most effective, and identify the most effective sequences in which to present the materials to be learned. Many later theories in the constructivist paradigm stem from this work, and in its totality, the constructivist view consists of many theories and perspectives. Savery and Duffy (1995) provide a summary of three fundamental precepts of constructivism: the notion of situated cognition where individuals’ understandings are developed by interactions with their environment in an authentic context; cognitive puzzlement that provides the stimulus for learning; and social collaboration where knowledge evolves

through discussion with others and is a primary mechanism for testing understandings and providing sources of alternative views to challenge the ways in which people think. Certain types of computer games, such as multi-user adventures, simulations and role-playing games, with their rich interactive context, increasingly difficult challenges, and forum for social interaction and collaboration, provide powerful constructivist learning environments.

The constructivist viewpoint hypothesises that people learn by building their own perspectives about the world, by problem-solving and personal discovery. The design of student-centred online learning environments has been greatly influenced by this perspective (e.g. Grabinger et al, 1997; Land & Hannafin, 2000). Wilson (1996) defines a constructivist learning environment as “a place where learners may work together and support each other as they use a variety of tools and information resources in their guided pursuit of learning goals and problem-solving activities” (p5). Constructivist learning environments should allow students to take responsibility for their own learning, including what and how they learn; provide exposure to multiple views; encourage awareness of the learning process; make learning relevant, based on real-life activities; make learning a social, collaborative and interactive; and use multiple modes of representation and rich media (Honebein, 1996).

Computer games can provide the opportunity for learners to explore and navigate immersive virtual worlds using rich media, create authentic contexts for practising skills that can be transferred to the real world, and present a forum and context for problem-solving. Collaboration and discussion with others is central to the constructivist perspective and multi-user games or group game playing in the same physical space are two ways that facilitate this. However, issues of support for student responsibility for planning and structuring learning, and meta-cognition of the learning process are not ones that are usually

considered within computer games, even those designed for education. It is therefore important to take an holistic view of the learning context in which computer games are used, their role in the curriculum, and the activities that precede and follow any game for learning to support reflection, consolidation and application of learning.

Providing a collaborative forum for computer gaming, be that in-game or in the real world, is essential to exploit the full potential of constructivist learning environments, as working collaboratively enables students to work to their strengths, develop critical thinking skills and creativity, validate their ideas, and appreciate a range of individual learning styles, skills, preferences and perspectives (McConnell, 2000; Palloff & Pratt, 2005). Multi-user gaming communities can provide a platform for collaboration and learning with others. Studies of Massively Multi-user Online Role-Playing Games have found evidence of collaborative learning and development of communities of practice (Steinkuehler, 2004) as well as the potential for learning a range of group skills (Ducheneaut & Moore, 2005).

Vygotsky's (1978) work in the field of social constructivism is particularly concerned with collaboration, and he theorised that learning takes place at a social level first and then at an individual level. The theory of Zones of Proximal Development (Vygotsky, 1978) contends that the zone of proximal development is the difference between what an individual can learn working alone, and what he or she can achieve when being supported and guided by an expert. Participating in communities of practice provides a legitimate way of learning from others through apprenticeship and education in the context of the group norms, processes and identity (Lave & Wenger, 1991). One of the significant advantages in the growth and ubiquity of personal networked computers is the potential to develop virtual communities of learners. Collaborative online learning communities involve the “bringing together of students via personal computers linked to the Internet, with a

focus on them working as a ‘learning community’, sharing resources, knowledge, experience and responsibility through reciprocal collaborative learning” (McConnell, 2006, p 11).

The constructivist perspective also supports the idea that learning is best facilitated by allowing students to explore and experience authentic contexts for themselves and to ascertain their own meanings from their experiences. The Experiential Learning Cycle (Kolb, 1984) describes an iterative process of learning in four stages, and emphasises the importance of active learning, with a need for planning, reflection and underpinning by theory. According to this cycle, the student starts by being involved in a learning experience (stage 1); this is followed by personal reflection on the experience (stage 2). The reflection is followed by the application of known theories to the experience (stage 3) and finally the learning is used to inform, modify and plan the next learning activity (stage 4). One of the advantages of computer game-based learning is the ability of the computer to provide the personalised interaction and feedback that is crucial to the experiential learning cycle. Gee (2003) argues that computer games reflect the experiential learning cycle in that students must iteratively examine the virtual gaming world, reflect on the problem presented and form a hypothesis about how the situation might be resolved, take action in the virtual world and see what effect the action has had. While this cycle maps onto learning within the game world, it does not intrinsically provide learners with space for learning about and reflecting on learning, which is an essential part of the learning process, particularly for adults (Knowles, 1998). It is important to recognise that computer game-based learning is necessarily part of a larger learning process and should be considered as integral to the other activities and self-reflection that surround the game and not simply as a stand-alone activity.

Researchers have also highlighted that computer games have the facility to create real-life

problem-solving experiences similar to the model of problem-based learning, which involves small groups of students working with a facilitator to tackle real-life, cross-disciplinary problems where resources are made available to the students but information on how to tackle the problem is not provided. Kiili (2005) suggests that “games provide a meaningful framework for offering problems to students. In fact, a game itself is a big problem that is composed of smaller causally linked problems.” (Kiili, p 17), and in a survey of 25 educational ‘experts’ using game-based learning, de Freitas (2006) found that “broadly the experts interviewed seemed to advocate the use of simulations and games for problem-based learning.” (de Freitas, 2006). Problem-based learning is essentially a collaborative method of learning, and to exploit the full potential of this teaching philosophy in a gaming situation, collaborative or multi-player games would be better suited to provide this than games played individually.

This review of theories of learning and teaching, as they relate to Higher Education, has highlighted some of the similarities between the constructivist perspective and certain types of computer game, in particular simulations, role-play and adventure games. There is a clear pedagogic rationale for the use of games that can provide a situated and authentic environment in which students can work collaboratively to undertake meaningful tasks, solve purposeful problems, and receive appropriate feedback.

Learning with Computer Games in Practice

The third section of this chapter examines the practical issues that arise when using computer games in actual teaching contexts in Higher Education. First, a second study is presented from which a set of principles of effective pedagogic design for computer games were produced, and secondly a range of practical issues are discussed,

such as the fit of the game to the curriculum, the match between learning and gaming outcomes and methods of assessing computer game-based learning.

Principles for Design

When it comes to designing, developing and evaluating computer game-based learning applications for use in teaching adults, it is crucial to recognise what constitutes good design in terms of educational effectiveness, as well as good game and interaction design. This sub-section describes a research study that was undertaken to create a set of guidelines that can be used to support the creation and evaluation of educational computer games for use in Higher Education. The study comprised two phases, a review of existing guidelines in related areas and an analysis of popular internet games. These two pieces of work were drawn together to produce two sets of guidelines for the design of effective web-based educational games, one focusing on the learning design the other on the usability of the interface.

In the first phase of the study, existing design guidelines in three areas related to effective educational online game design were reviewed and synthesised. The areas examined were (a) the design of constructivist learning environments, (b) the design and use of educational multimedia, and (c) the design of engaging computer-based activities and games.

Alessi and Trollip (2001) present fourteen principles that, in their view, support the production of knowledge from a constructivist view, while Savery and Duffy (1995) present eight principles of teaching that derive from constructivism. Hannafin and Land (1997) put forward eleven assumptions about student learning from a constructivist perspective and provide examples of how these can be applied in learning environments. Jonassen (1999) presents a framework for designing constructivist learning environments.

A number of design guidelines for the production of effective multimedia were also examined. Cates (1992) provides fifteen principles for designing more effective multimedia products, while Park and Hannafin (1993) provide twenty. Stemler (1997), Najjar (1998), and Lee and Boling (1999) all describe ways in which a user interface and multimedia elements used can support learning with multimedia. Mayer (2001) brings together his work with that of others in designing effective educational multimedia and presents seven principles that are pertinent to its design and, by extension, the design of educational games that use multiple media.

As well as examining guidelines for the design of constructivist learning environments and educational multimedia, guidelines on the design of engaging computer games were also considered. Jones (1997) suggests a number of features of games that lead to increased engagement: production value, being fit for purpose but not gratuitous; providing a mix of thinking skills and motor skills, immediate feedback coupled with strategy for a greater feeling of accomplishment; research and problem-solving; a safe place to learn from mistakes; and immersion through characters and circumstances that can be related to, and controls that make sense. While many of these factors make intuitive sense in an educational as well as an entertainment context, particularly as regards research and problem-solving, and the provision of an authentic and meaningful context, it is more difficult to argue that the use of games that test motor skills is appropriate for much of the learning that takes place in Higher Education.

Malone (1980) produced a seminal work in designing engaging educational games, and although his work was carried out in the context of children's learning it is still of some relevance here as background. Malone investigated the elements that make computer games engaging and identified features that make games captivating, immersive and enjoyable. The initial analysis

presented three aspects of games that lead to increased engagement: appropriate challenge, a compelling fantasy, and creating curiosity in the environment. Malone and Lepper (1987) extend Malone's original theory to include the additional factor of control, consisting of a large number of options available, logical and consistent control over the environment, and a feeling of power in the game. While Malone's work is useful for gaining a greater understanding of why games can be so engaging, there are a couple of points worth making regarding the value of this work in relation to learning in Higher Education today. First, Malone's research was carried out with children, and although his findings may be replicatable in adults, there is no evidence of this. Some of the factors intuitively make sense when applied to adult engagement (e.g. challenge, curiosity, control) but other factors are perhaps less compelling in an adult context (e.g. fantasy). Secondly, Malone's work took place during the 1970s, a period when computer games were still a novelty, whereas today, games are ubiquitous and people are far more sophisticated in their expectations. Even so, Malone's work is still used regularly as a basis for work on game design and engagement (for example, recent references include Sandford & Williamson, 2005; Dickie et al, 2006; Ebner & Holzinger, 2007) and has been endorsed and applied by numerous other researchers since its inception.

Lepper and Malone (1987) suggest a number of general principles for increasing the engagement with, and therefore effectiveness of, learning. Since their work was carried out with children and is not wholly applicable to adults only the aspects that are considered to be appropriate to adult learning were included in the analysis. Lepper (1998) also highlights a number of design principles for promoting intrinsic motivation for instruction and engagement with learning, while in a more recent study by Becta (2001), several factors are highlighted for increasing and sustaining engagement (again, this last study is in the

context of children and has been applied, where appropriate, to adult learning).

As well as examining guidelines and literature on effective educational design, in order to achieve a better first-hand understanding of the types of popular computer games available and gain insights into the educational potential of different gaming types, an evaluation was carried out of the characteristics of popular web-based computer games. This review aimed to provide an overview of the types of game that were popular and analyse the design and interface characteristics of these games that could potentially contribute to engagement.

Popular commercially-produced computer games are expensive, can be time-consuming to install, and often require several hours of play to simply work through the tutorial, so this study focused on freely-available web-based games because they are generally easy to access, quick to learn, and there are a large number available with a wide variation of genre, interface, design and goals. Since this review aimed to examine some of the most popular free web-based games available at the time (2004), the Channel 4 Games web site (see <http://www.channel4.com/games>) was used as a starting point. This site provides links to many hundreds of games of various genres, which are rated and ranked by the site users.

Over one hundred web-based games were initially examined and sixteen were selected for further evaluation, based on six criteria. Games selected had to be available for free on the web, robust, with no obvious errors and continuously available over a period of time, of a type considered appropriate for educational use (in general, the games selected focused on adventure, role-play, simulations and puzzles), and not designed exclusively for children.

In addition, for a game to be selected for inclusion in this review it had to manifest one or more original or unique characteristics that were considered to be worthy of note in terms of educational value or interface design. Each game was played

by the researcher for a minimum of 20 minutes, after which an analysis was made of the game in terms of areas of educational potential, elements of the game or interface design that contributed (positively or negatively) to player engagement, and ideas from the interface that were seen to be useful or innovative and could be implemented in the game-based applications developed as part of this research.

The review of guidelines in the literature was combined with the games analysis to produce two sets of criteria for effective educational computer game design for adults, the first focusing on the pedagogic design and the second on aspects of the interface design. The first set of guidelines highlights six criteria that can be used to evaluate the educational design of a computer game-based learning application for adult learners. These areas are: the ability of the game to support active learning, the degree to which it is designed to stimulate engagement, the appropriateness of the game for the desired learning outcomes, the degree to which it supports the reflective process, the extent to which it provides an equitable experience for all learners, and the availability of ongoing support throughout the game. These criteria are expanded in Table 1.

As well as this set of guidelines that can be used to support the educational design of computer games, a second set also came of the literature review and game analysis, which focused on the interface design of game-based learning applications. This second set of six criteria can be used to evaluate where the user interface and interaction models support learning. They are: provision of flexible ways for users to interact with the environment, support for the development of a player community, transparent navigation functions, features that support user control of the environment, robustness of design, and appropriate visual design. These criteria are expanded in Table 2.

In all, these twelve principles provide a set of criteria that can be used to support the design and development of bespoke computer games

for learning in Higher Education, as well as the evaluation of existing games. It is worth noting that while these guidelines present ideas for good practice, some of the criteria may impact on each other, be mutually exclusive or be difficult to achieve; the relative importance of each criterion is not considered in this model. Also, as yet, these criteria are relatively untested and further research is required to ensure that they are necessary and sufficient. These criteria should be considered to be an indicator of effective educational design rather than something that must be achieved before a computer game can be considered appropriate for teaching. In practice, there may be many games that are still effective but do not meet all of these criteria. The next sub-section looks at other aspects of the practical implementation of computer games that should be considered.

Practical Issues of Using Computer Games for Teaching

In this sub-section, a range of practical issues that should be considered when using computer games to support learning and teaching in Higher Education will be highlighted and discussed. The issues include the need for an explicit rationale for using computer games, aligning learning outcomes with gaming outcomes, logistical limitations, the need to build in reflection and collaboration and ways of doing so, and implications of assessing games-based learning.

When using games with adult learners it is essential to have a clear educational purpose, that is explicitly communicated to the students, and that they are not simply used because they are considered to be motivational. While computer games may be intrinsically motivating for some learners, this is often not the case, particularly for older students who are likely to be more strategic in how and what they learn and will often aim to carry out their efficient way to do so (Knowles, 1998). For this type of learner, a game used for its own sake is likely to be an unnecessary dis-

Table.1..Criteria.for.the.effective.educational.design.of.game-based.learning.applications,.and.elements.that support fulfilment of each criterion

Criteria	Examples of ways to meet criteria
Supports active learning	Encourage exploration, problem-solving, enquiry. Provide opportunities for collaboration. Provide opportunities to test ideas and gain feedback. Provide opportunities for practice and consolidation. Ensure game goals align with learning goals.
Engenders engagement	Give clear and achievable goals. Create a large world to be explored. Support a high level of interactivity. Supply multiple possible ways to complete the game. Stimulate curiosity and puzzlement. Set challenges at an appropriate level, for example by making them gradually more difficult or customisable. Provide sufficient control over the learning environment.
Appropriateness	Ensure game goals align with curriculum, learning outcomes and assessment. Ensure a game-based approach is appropriate for subject matter and acceptable to students. Match game playing time to time available (including set-up, briefing, de-briefing). Make the game personally relevant to students.
Supports reflection	Provide opportunities for structured reflection. Ensure that there is debriefing on learning and consideration of application to the real world. Highlight the process of learning.
Provides equitable experience	Account for differing prior knowledge of the game type. Allow for customisation of the game. Provide equal opportunities to participate.
Provides ongoing support	Provide an orientation and overview. Allow students to achieve quick initial success with the gradual introduction of complexity. Provide ongoing hints and clues.

traction. However, while many adult learners may not be interested in learning with a game simply because it is a game, there is evidence, presented earlier in this chapter, that they will be happy to use them if they are perceived as an effective way to learn in a particular context. Some learners will be very happy to use games without questioning their educational value, but this cannot be assumed for all.

A second important issue, and one that is often difficult to counter (particularly if using games originally designed for entertainment) is ensuring alignment between the outcomes of the game and the intended learning outcomes from the game. For example, the intended learning outcome of

a multi-user adventure game may be to develop collaborative skills but if the game is designed to be competitive then collaboration is unlikely to happen. If the use of the game does not closely match the learning outcomes and curriculum then the students may be learning something, but it will not be purposeful or relevant in the context of the course of study. Built in to many entertainment games is the goal of learning to play the game itself, exploring the interface and discovering advanced hidden features, which may detract from the desired learning outcomes of the game.

There are also a range of logistical issues to be taken into account in using computer games

Table 2.. Criteria for the effective interface design of game-based learning applications, and elements that support fulfilment of each criterion

Criteria	Examples of ways to meet criteria
Flexible interaction	Make sure that all interaction is purposeful. Ensure that feedback is timely and meaningful. Controls must be logical and consistent. Build in performance indicators. Make a range of interaction methods available.
Support for player community	Provide a facility for players to communicate. Provide community self-regulation functionality. Use avatars or other individual representations.
Transparent navigation	Make navigation tools clear and consistent. Provide alternative methods of navigation. Ensure that help functionality is obvious. Provide an overview of player position in environment.
User control	Make game pace and level adjustable. Provide multiple customisation options. Enable tasks to be undertaken in any sequence. Make instructions obvious and clear. Ensure that all functionality is appropriate and obvious.
Robustness	Make it easy to recover from errors. Ensure the interface is responsive to input. Provide context-sensitive help and hints. Provide the functionality to save and return at a later time.
Appropriate visual design	Make interface simple, uncluttered and aesthetically pleasing. Provide information in accessible chunks. Ensure consistent of components. Ensure that graphics and rich media is purposeful. Make sure that text legible.

in learning; practicalities such as the amount of time available, both to design and develop the game and associated activities and the time available to use in a teaching setting, limited physical or virtual space available (depending on whether a game is played online, face-to-face or a combination of the two) and the resources available (e.g. access to computers with correct specifications). These practical points need to be considered as they will influence how and when computer games can be integrated into courses or programmes of study.

There are also commonly barriers to use in university settings, with games being seen as inappropriate for learning and banned by some IT departments, or with network ports being automatically locked so that certain communications

software or web applications can not be used. Commercial entertainment games and immersive gaming worlds also often require higher specifications of graphics cards or processors than are typical in university machines. University regulations may also affect how games can be integrated into a course, how they can be assessed, and impact on whether the use of computer game-based learning is a supplemental activity, something that is used once or multiple times, or can be included as an activity that fundamental to the whole structure and design of a course.

There are also technological considerations regarding how to obtain or create a required game. In some instances existing commercial games can be used for learning, for example the game to teach history to school students (Squire,

2005), while other examples involve the creation of bespoke applications, such as the action–adventure game developed to teach literacy skills to adults (Kambouri et al, 2006). Using commercial games has the advantage of a high-end product, explicitly designed to be engaging, however they may also be expensive, have complex interfaces and steep learning curves. It can also be difficult to match the outcomes of the curriculum with those of the game so debriefing and reflective activities are particularly important. Many commercial games now come with a creation engine and there is a growing trend towards modifying existing games software for use in education (de Freitas, 2007), which may provide one way to address some of these issues. There are also some commercial games that are specifically designed for learning, but these can be expensive, difficult to customise, and limited numbers of these games exist. An increasingly popular option is the use of massive online worlds for learning, which allow interaction among thousands of players in real-time in virtual spaces, however, many of these worlds lack privacy from other non-student users who can wander into teaching spaces, and because of some of the other activities that take place in what is essentially a public space (e.g. sale of pornography, fighting) may be deemed inappropriate for a learning environment. Much more flexibility in design is afforded by the creation of bespoke games, which enable a designed match of learning outcomes with gaming outcomes for a specific user group, but even the best home-grown software is unlikely to compare to big-budget commercial games.

While computer games certainly have the potential to provide active and experiential learning spaces, they do not necessarily offer students space for reflection and application of their newly acquired knowledge and skills to the real world. Activities such as briefing, debriefing and structured reflection are essential to ensure that specified learning outcomes are mastered; these activities can be structured outside the

game, and in fact it may be highly beneficial to do so as it creates a safe space outside the virtual world. Support for group interaction is also important but as not all gaming environments are collaborative in nature (and, in fact games that require synchronous communication may not suit autonomous adult learners) it is crucial to build in collaborative facilities and activities to the overall learning package. Ways of achieving this include using face-to-face discussion interspersed with periods of individual (or paired) game play, two (or more) individuals playing the same game at the same time (either face-to-face on the same machine or physically distance on different machines but using an online messaging facility), or using asynchronous message boards to support game play and problem solving.

The way in which computer game-based learning is assessed is another key issue. It is essential to ensure that achievement in the gaming environment has a minimal impact (if any) on the ability of the student to achieve in the assessment, so as not to disadvantage students who might be performing less well in the games for reasons that are nothing to do with their level of learning (for example, students who are unfamiliar with gaming interfaces or have problems navigating in a three-dimensional environment). Well-designed assessments can encourage the development and integration of reflective and collaborative activities, for example, considering how progress through the game could have been different in different circumstances, or working with others to produce a reflective report. Whitton & Hynes (2005) describe the use of a combination of a presentation to a board of directors, strategy report and reflective journal to effectively assess a game-based marketing course.

There are many practical difficulties associated with the use of game-based learning in Higher Education, and they have only been touched upon in this section. However, if implemented thoughtfully and used to exploit their pedagogic potential as constructivist learning environments,

games have the potential to be an innovative addition to a lecturer's learning and teaching toolkit, but certainly should not be seen as a panacea to engage a new generation of learners.

CONCLUSION

In all, this chapter has aimed to provide an overview of some of the pedagogic theories that support a rationale for the use of computer games in Higher Education, and to discuss the practicalities of designing effective games for learning and implementing them in real life teaching and learning situations in Higher Education.

When using computer games for learning, as with any innovation in teaching and learning, it is important always to ensure that there is a clear and sound pedagogic justification, which is communicated to the students, and they are not simply being adopted for a perceived motivational effect or because they are seen to be popular. Creating effective educational games is not an easy task and is expensive and time consuming, so it is essential to ensure that the benefits outweigh the challenges.

The novelty effect of using games should also be considered – from both the perspectives of the teacher trying a new teaching method and student taking on a new way of learning. Initial reactions may be influenced by the newness of the methods and may not reflect the long-term acceptability and effectiveness of computer game-based learning.

Despite the disadvantages and practical implementation issues, it is clear that certain types of computer game have the potential to engage people in appropriate and effective learning in Higher Education. If games are designed to embody sound educational principles, and support learning outcomes that are appropriate to the curriculum and assessment, then they can clearly be an appropriate tool for learning. Whether they are the most appropriate and acceptable to learners will

depend upon the particular learning context in which they are used. As de Freitas (2007) says, “the key challenge for effective learning with games is for the learner to be engaged, motivated, supported and interested but also importantly for the learning to be undertaken in relation to clear learning outcomes as well as being made relevant to real-world contexts of practice.” (p 5).

REFERENCES

- Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for Learning*. Boston: Allyn and Bacon.
- Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, 53(1), 86–107.
- Becta. (2001). *Computer Games in Education. Project: Findings Report*. Retrieved July 3, 2008 from <http://partners.becta.org.uk/index.php?section=rh&rid=13595>
- Benyon, D., Turner, P., & Turner, S. (2005). *Designing Interactive Systems*. Harlow: Addison-Wesley.
- Bruner, J. S. (1966). *Toward a Theory of Instruction*. Oxford: Oxford University Press.
- Cates, W. M. (1992). *Fifteen principles for designing more effective instructional hypermedia/multimedia products*. *Educational Technology*, 17(12), 5–11.
- Colarusso, C. A. (1993). Play in adulthood. *Psychoanalytic Study of the Child*, 48, 225–245.
- Cooper, P. A. (1993). Paradigm shifts in designed instruction: from behaviorism to cognitivism to constructivism. *Educational Technology*, 33(5), 12–19.
- Csikszentmihalyi, M. (1992). *Flow: the Psychology of Happiness*. London: Random House.

- de Freitas, S. I. (2006). Using games and simulations for supporting learning. *Learning, Media, and Technology*, 31(4), 343–358.
- de Freitas, S. (2007). *Learning in Immersive Worlds: a Review of Game-based Learning*. JISC.
- Ducheneaut, N., & Moore, R. J. (2005). More than just 'XP': learning social skills in massively multiplayer online games. *Interactive Technology & Smart Education*, 2, 89–100.
- Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: an example from civil engineering. *Computers and Education*, 49(3), 873–890.
- Entertainment Software Association. (2007). *Facts and research: game player data*. Retrieved 3 July, 2008 from <http://www.theesa.com/facts/gamplayer.asp>
- Gee, J. P. (2003). *What Video Games Have to Teach Us About Learning and Literacy*. New York: Palgrave MacMillan.
- Grabinger, S., Dunlap, J., & Duffield, J. (1997). Rich environments for active learning. *ALT-J*, 5(2), 5–17.
- Hannafin, M. J., & Land, S. M. (1997). The foundations and assumptions of technology-enhanced student-centered learning environments. *Instructional Science*, 25, 167–202.
- Honebein, P. C. (1996). Seven goals for the design of constructivist learning environments. In Wilson, B. G. (Ed.) *Constructivist Learning Environments: Case Studies in Instructional Design*. Englewood Cliffs, NJ: Educational Technology Publications.
- Jonassen, D.H. (1999). Designing constructivist learning environments. In Reigeluth, C. M. (Ed.) *Instructional Design Theories and Models: Their Current State of the Art*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Kambouri, M., Thomas, S., & Mellar, H. (2006). Playing the literacy game: a case study in adult education. *Learning, Media, and Technology*, 31(4), 395–410.
- Kiili, K. (2005). Digital game-based learning: towards an experiential gaming model. *The Internet and Higher Education*, 8, 13–24.
- Knowles, M. (1998). *The Adult Learner (5th edition)*. Houston, TX: Butterworth-Heinemann.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. New Jersey, NJ: Prentice Hall.
- Land, S. M., & Hannafin, M. J. (2000). Student-centered learning environments. In D. H. Jonassen & S. M. Land (Eds.), *Theoretical Foundations of Learning Environments*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Lave, J., & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge: University of Cambridge.
- Lawrence, R. (2004). Teaching data structures using competitive games. *IEEE Transactions on Education*, 47(4), 459–466.
- Lee, S. H., & Boling, E. (1999). Screen design guidelines for motivation in interactive multimedia instruction: a survey and framework for designers. *Educational Technology*, 39, 19–26.
- Lepper, M. R. (1988). Motivational considerations in the study of instruction. *Cognition and Instruction*, 5(4), 289–309.
- Lepper, M. R., & Malone, T. W. (1987). Intrinsic motivation and instructional effectiveness in computer-based education. In R. Snow, & M. Farr (Eds.), *Aptitude, Learning, and Instruction, III: Cognitive and Affective Process Analysis*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- McConnell, D. (2006). *E-learning. Groups and Communities*. Milton Keynes: Open University Press.

- Magnussen, R. (2005). Learning games as a platform for simulated science practice. In *Proceedings of the Digital Games Research Association. 2005 Conference*, Vancouver, Canada.
- Malone, T. (1980). *What makes things fun to learn? A study of intrinsically motivating computer games*. Technical Report CIS-7, Xerox Parc.
- Malone, T., & Lepper, M. R. (1987). Making learning fun: a taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr, (Eds.), *Aptitude, Learning and Instruction, III: Cognitive and Affective Process Analysis*. Hillsdale, NJ: Erlbaum.
- Marton, F. (1981). Phenomenography—describing conceptions of the world around us. *Instructional Science*, 10, 177–200.
- Najjar, L. J. (1998). Principles of educational multimedia user interface design. *Human Factors*, 40(2), 311–323.
- Oblinger, D. (2004). The next generation of educational engagement. *Journal of Interactive Media in Education*, 8.
- Palloff, R. M., & Pratt, K. (2005). *Collaborating Online: Learning Together in Community*. San Francisco, CA: Jossey-Bass.
- Park, I., & Hannafin, M. (1993). Empirically-based guidelines for the design of interactive multimedia. *Educational Technology Research and Development*, 41(3), 63–85.
- Rieber, L. (1996). Seriously considering play: designing interactive learning environments based on the blending of microworlds, simulations and games. *Education and Training Resource & Development*, 44, 42–58.
- Sandford, R., & Williamson, B. (2005). *Games and Learning*. Bristol: Nesta Futurelab.
- Savery, J. R., & Duffy, T. M. (1995). Problem-based learning: an instructional model and its constructivist framework. *Educational Technology*, 35, 31–38.
- Squire, K. D. (2005). Changing the game: What happens when videogames enter the classroom? *Innovate*, 1(6).
- Squire, K. & Barab, S. (2004). Replaying history: engaging urban underserved students in learning world history through computer simulation games. In *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.
- Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.
- Stemler, L. K. (1997). Educational characteristics of multimedia: a literature review. *Journal of Educational Multimedia and Hypermedia*, 6(3-4), 339–359.
- Virvou, M., & Katsionis, G. (2008). On the usability and likeability of virtual reality games for education: The case of VR-ENGAGE. *Computers and Education*, 50(1), 154–178.
- Vygotsky, L. (1978). *Mind in Society: The Development of Higher Psychological Functions*. Cambridge: Harvard University Press.
- Whitton, N., & Hynes, N. (2006). Evaluating the effectiveness of an online simulation to teach business skills. *E-Journal of Instructional Science and Technology*, 9(1).
- Whitton, N. (2007). *An Investigation into the Potential of Collaborative Computer Game-Based Learning in Higher Education*. Unpublished doctoral dissertation, Napier University.
- Wilson, B. G. (1996). What is a constructivist learning environment? In B. G. Wilson (Ed.), *Constructivist Learning Environments: Case Studies in Instructional Design*. Englewood Cliffs, NJ: Educational Technology Publications.

Chapter III

Multi-User Virtual Environments for Learning Meet Learning Management

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ABSTRACT

Alongside the growth of interest in Games-Based Learning, there has been a notable explosion of interest in the use of 3D graphical multi-user virtual environments (MUVE) for learning. Platforms such as Second Life® or alternatives (Theresm, Active Worlds, OpenCroquet, and so on) have potential for online tuition in ways quite different from those offered by traditional Web-based Virtual Learning Environments (VLE, a.k.a. Learning Management System or LMS). The Sloodle project is working to integrate Second Life with the Moodle VLE, and to investigate how this might support learning and teaching with the Second Life platform... Second Life can be considered as a 3D client for Moodle learning activities, while a complimentary view is to consider Moodle as a back-end for Second Life learning activities, enabling virtual world learning activities integrated with Web-based class lists and grade books. The authors close by considering future directions and applications.

INTRODUCTION

The educational application of multi-user virtual environments (MUVE) is emerging as a distinct area of research, with considerable cross-over and also some notable distance from the game-based learning mainstream. Within that mainstream, the educational potential of games is often seen primarily through the ability to create simulations or scenarios for role-playing (c.f. Aldrich, 2005 or Gee, 2005).

While commonly built on the same basic technologies as multi-player online games, MUVE are not necessarily games as such – often lacking in the types of rules and systems governing progress and success that are a defining feature of most digital games (Björk & Holopainen, 2004). Platforms such as There, Active Worlds or Second Life are all primarily social worlds, virtual places for people to meet and interact. Interactions may be playful, but the virtual worlds themselves are not games *per.se*, although they may contain any number of games. Two people meeting in Second Life may simply chat, race vehicles, engage in some combat or role-playing oriented game – but without progress in ‘Second Life’ being linked to success in these endeavours in any meaningful way.

In providing the means for user-generated content while removing the pre-determined game elements from virtual worlds it becomes possible to use the environments in a wide range of different ways to support different pedagogical approaches and different curricula (c.f. Livingstone & Kemp, 2007). It is possible to develop detailed simulations or role-play scenarios (similar perhaps to those found in traditional games-based learning), to simply use the 3D world as a space for online discussions within an immersive setting or to use the virtual worlds as constructionist (Papert & Harel, 1991) virtual learning environments – where the students are tasked with creating the content, possibly to teach others about their chosen subject.

Challenges for future educators as these technologies become more commonplace in the classroom (or in some cases, instead of the classroom) will include how to support learners in general purpose 3D learning environments and how to integrate class management and assessments from 3D spaces with other web and intranet based systems for learning support and management. Experience has shown that learning can be hindered in exploratory learning environments, including the likes of Second Life, which do not provide effective guidance to students (Nelson, 2007). Reuse of existing educational materials will also be important, as not all educators can be expected to be skilled developers of 3D educational content.

In the following section we present a brief review of teaching and learning with learning management systems (LMS) and in online multi-user virtual environments (MUVE). From this we look in more detail at the requirements for enhanced support for teaching and learning in MUVES. We will then introduce Sloodle – a system that seeks to provide this support for Second Life through the integration of Moodle, an open source LMS. A detailed case-study is then presented before we close with a discussion on how the ideas presented here may apply to other projects using game-technologies to facilitate learning and to outline future plans for Sloodle.

BACKGROUND

Learning and Teaching with Learning Management Systems

Learning management systems (LMS), also known as Virtual Learning Environments (VLE) are now commonplace across the education sector from Universities down to secondary schools (12-16) and even in the primary sector (5-12). LMS, whether proprietary (Blackboard, WebCT, Desire2Learn, AngelLMS, etc.), open-source

(Moodle, Sakai, Claroline) or developed 'in-house' tend to include a number of common features for facilitating and supporting e-learning – although the precise feature set can and does vary (Cook, 1999, Dougiamas & Taylor, 2003, Kemp & Livingstone, 2006, Yueh & Hsu, 2008):

- Document sharing (e.g. for online distribution of lecture notes)
- Assignment uploading
- Online assessment (for formative and summative assessment, multiple choice quizzes, true/false, and free text)
- Online gradebooks
- Forums for asynchronous discussion
- Chatroom/online classroom for synchronous web-based text-based discussions (Figure 1)
- Integration with institutional registry information systems

Additionally, many LMS also support the development of plug-ins and extensions – allowing additional features to be added by the developers or by third parties. These can include the likes of video conferencing, wikis, or modified forums

for audio discussions using MP3 files (see case study, below).

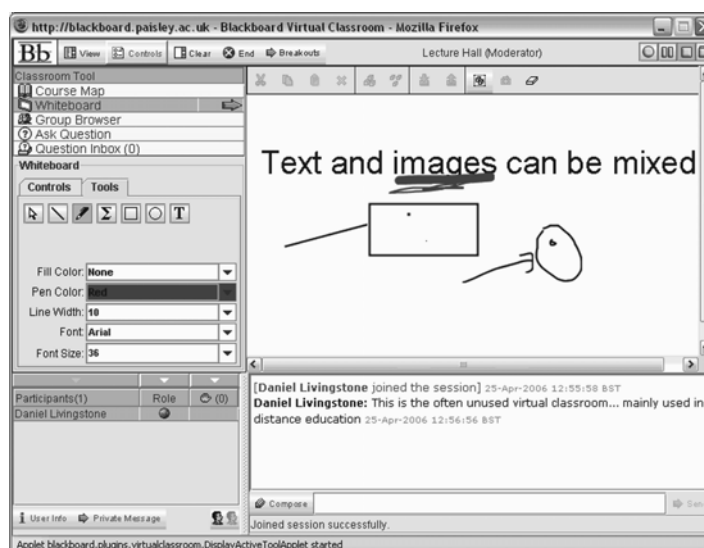
In practice, the actual use of LMS often makes limited use of the more effective co-operative, collaborative and learning technologies. Often LMS are used primarily as simple document repositories to allow online distributed access to course notes, coursework submission and as an electronic gradebook, the findings of Yeuh & Hsu (2008) being fairly typical in this regard. Downing et. al. (2007) present a case-study which demonstrates some of the additional steps required to foster use of an LMS beyond the rather minimal norm.

Thus, while the tools *are there* to support and promote discussion and collaboration, it seems that these are generally the least commonly used tools within a LMS.

Teaching and Learning in Virtual Worlds

Launched in 1995, and still in use today, Active Worlds is an extensible virtual world platform that allows users to create their own worlds (subject to

Figure 1..The Blackboard virtual classroom for synchronous online meetings provides support for text 'chat' and an interactive whiteboard drawing area



purchasing the resources required) and to enable links to other virtual worlds built using the same platform. While the 3D environment is noticeably dated, it is used to underpin two notable pioneering projects using virtual worlds for education – River City (Dede, Nelson, Ketelhut & Bowman, 2004) and Quest Atlantis (Barab, Thomas, Dodge, Carteaux & Tuzun, 2005).

Active Worlds features a fairly traditional looking Windows user-interface, with different elements of content presented in different panes. A central pane shows the 3D world itself, below this is a chat window and to the right a web-browser pane that can be used to view web-pages using the built in web-browser (Figure 2).

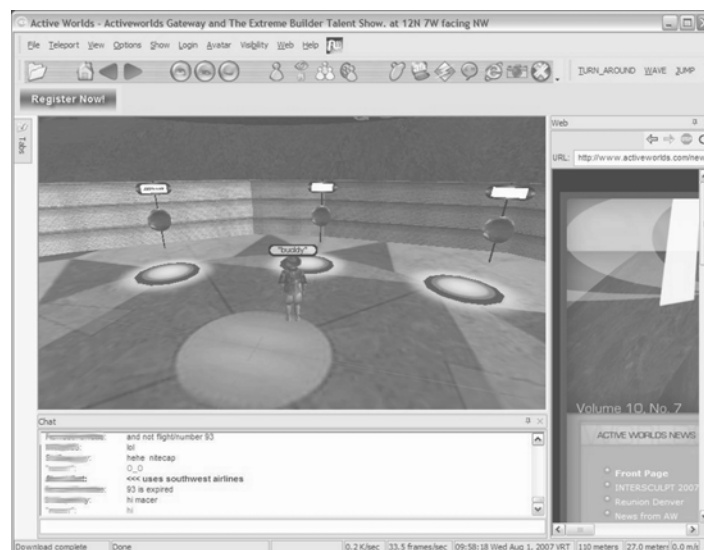
Both River City and Quest Atlantis present visitors with custom-built virtual worlds with immersive scenarios where students work to solve a range of problems. The approach used here is to embed elements of curriculum and problem-based learning tasks into an immersive environment. While for many students, the game-like scenarios promote engagement with the material, in some cases it appears that the game-like nature of the environment may distract from the serious learn-

ing goals, though this might have much to do with issues relating to the acceptance of games as a suitable medium for instruction (Lim, Nonis & Hedberg, 2006).

While the platform itself is open and modifiable, without learning specific content, both of these projects use this openness to create custom environments. Prepared encounters and carefully written narratives are employed to help students achieve particular learning objectives. More generally, it is possible to consider the learning affordances that a platform such as that which Active Worlds provides without reference to instructor generated content (Dickey 2003, Dickey 2005). 3D worlds provide spaces that more effectively support “situated and embodied” (Dickey 2005) learning, effective in presenting opportunities for experiential learning. Communication features (such as text-based chat and instant messaging) support collaborative and social constructivist learning, although limited asynchronous messaging support is an issue here.

But the affordances of the 3D virtual spaces themselves might not be sufficient to promote and support effective curriculum based learn-

Figure 2..Active Worlds uses a familiar Windows user-interface with separate panels for the 3D world, for typed ‘chat’ and for displaying web-pages using the built in browser



ing. The web-browser integrated into the Active Worlds client is used to provide additional support and guidance to students in both River City and Quest Atlantis, with customised web-sites tied in closely to the activities to be undertaken in the 3D space. Nelson (2007) provides further detail of the addition of a tool for reflective-guidance in the River City project, and reports that increased use of the individualized and reflective guidance correlated with gains in test scores. Noting the relatively low uptake and use of the guidance system, Nelson includes in his conclusions a note that “future designers may benefit from more closely integrating the guidance system into the 3-D environment” (Nelson 2007, p.95).

Second Life, publicly released in 2003, is an alternative MUVE. Second Life is graphically much more advanced, with correspondingly higher hardware and networking requirements – but extends to all users the ability to create custom content from avatars to furniture, buildings, vehicles and all manner of scripted and interactive elements (Rymaszewski et. al., 2007). A large and active education community has grown around Second Life, and a range of applications and approaches to using the 3D environment to support learning have emerged. Broadly speaking, these tend to fall into the following categories – though individual classes may involve activities from more than one category:

- **Constructionist.** Students may be charged with creating content to educate others about a topic (Papert & Harel, 1991). While identified by the authors as an example of Experiential Learning, the activities described in Mason & Moutahir (2006) clearly has a notable constructionist component.
- **Facilitating synchronous discussion.** A basic use of the platform is for synchronous discussion for distance or blended learning. A 3D world provides a richer degree of presence than a text only web-based chatroom (Becker & Mark 2002), and so may be more engaging a space to conduct chats.
- **Role-play.** A number of educational and entertainment based role-play sites exist within Second Life. For example, Renaissance Island in Second Life provides a ‘living museum’ where visitors can learn through play and interaction about life, music and culture in Elizabethan England (Bell et. al., 2008). Role-play can also be combined with facilitated discussion – Robbins (2007) outlines how the freedom to change one’s appearance in a virtual world was used to set-up a number of role-play activities (changing gender, body shape or form, etc.) that then fed productively into facilitated debates in a rhetoric class.
- **Visualisation.** The modelling and scripting capabilities allow the creation of static, interactive and automatically updating three-dimensional models representing a range of scientific data. Notable current examples in Second Life include a range of 3D real-time weather models, molecular structures large enough to hold meetings inside them and a giant fly-through model of the insides of the testes with a running commentary. Such models allow students to experience systems from inside, one of the potential benefits of game-based learning identified by Gee (2006).
- **Simulation.** Interactive activities can be built where individual users or groups of users can complete activities that simulate real world tasks, or offer a chance to experience situations otherwise difficult to simulate in a classroom. For example, Virtual Hallucination offers visitors the rare opportunity to experience schizophrenic episodes as reported by schizophrenic sufferers – a chance to learn more about an oft misunderstood illness (Yellowlees & Cook, 2006).
- **Simulated real-world practice.** Shaffer (2006) describes how game-based learning can provide epistemic frames – allowing real-world practices to be developed inside computer supported games. In the multi-user

environment of Second Life it is possible for this practice to extend from being simulated practice to *real.practice*. – albeit within a simulated environment. So, for example, students can learn about conducting field research in an environment with considerably fewer physical risks than those present in the real world (Foster, 2007), practice film-making without the need for cranes to enable difficult shots or time-consuming health & safety assessment processes (Robinson, 2007) or design fashion in an environment where new clothing designs are sought after (Polvinen, 2007).

In contrast to this wide range of examples of the use of Second Life with different subjects and different pedagogical approaches, there is currently a lack of clear empirical evidence regarding the effectiveness of Second Life as a tool for learning. Yellowlees & Cook (2006) surveyed visitors to their virtual installation, finding that over 70% of respondents thought that it improved their understanding of schizophrenic hallucinations. There was, however, no comparative study group with alternative technology to compare against. Weusijana et. al. (2007) use a lab based approach to evaluate whether a virtual world, such as Second Life, can be used to teach adaptive expertise – with evidence from lab based trials indicating that this seems to be the case. This work is currently being extended to include comparisons against a traditional classroom control condition.

Twining (2007) reports on a pilot group of school-children using Teen Second Life as part of an out-of-school programme, and while benefits for individual students are reported, the overall conclusions are merely that Teen Second Life has strong educational potential, but that further study is required. Similarly inconclusive, but indicative of strong potential and interest, have been a series of “snapshot” reports on Higher Education activity with Second Life in the UK, the latest published in May 2008 (Kirriemuir, 2008).

While this does not conclude on the effectiveness of Second Life for learning, the responses listed do highlight some of the positive and negative aspects of using Second Life for teaching – and reveal that there is some considerable amount of ongoing evaluation work.

This list provided earlier is not intended to be exhaustive, but gives some idea of the breadth of form that education can take in Second Life. Given such a wide variety of educational approaches, how can effective support for teachers and learners be provided?

Supporting Learning and Teaching in Second Life

The web-based guidance and support systems found in River City and Quest Atlantis are highly specialised and are developed to work closely with those specific projects. From the listed examples above, it is clear that web-based learning support for Second Life is unlikely to meet the needs of the varied teaching and learning approaches unless it offers a high degree of flexibility – in providing freedom to instructors in choosing which tools suit their needs from a larger set and in providing freedom to use those tools in a way that works well with the preferred teaching style of instructors and preferred learning styles of the students.

A useful first question might be to ask ‘what are the support needs for students taking, and instructors teaching, classes using Second Life?’. One challenge facing educators is the open-ended goal-less nature of Second Life itself. While leveraging this provides a long list of ways in which Second Life *can* be used, it is also a problem for instructors and learners – which can, and does, result in a lot of lost time spent aimlessly wandering around the 3D space unsure of what to do (New Media Consortium, 2007).

Second Life is also used to support different modes of instruction – from being a lab based activity in a face-to-face class taught largely in

a traditional setting to use in a purely distance learning based class or in a ‘blended learning’ setting that uses some mix of both of these.

Existing support for a range of teaching and learning activities exists in the form of a wide range of specialised tools and objects, including:

- **‘Whiteboards’**, for displaying images or slideshows to other users inside the environment. Can be used asynchronously for self-directed learning or as a presentation tool. Other presentation tools include RSS displays, which can be used to present feeds of course related information inside Second Life. Video streams and (with limited functionality) web-pages can also be rendered onto surfaces in the 3D environment.
- **Quiz tools.** Several of these are available. An instructor might scatter a number of quiz objects through a 3D space, each of which contains one or more questions. Setting up quizzes and reviewing results (for formative or summative assessment) may need to be done through Second Life itself.
- **Turn-taking tools.** Discussions are normally free-flowing with typed ‘chats’ in particular prone to interruption. In some settings users may wish to be able to support more formal turn-taking, and some tools exist that track turn taking in discussion. While unable to prevent interruptions, these can remind participants to help enforce this.
- **Chat-loggers.** Settings in the Second Life client can enable the saving of chat and users can also cut-and-paste their chat history into text editors. However, the Second Life terms of service prohibit recording chat without permission and chat-loggers that request this permission before recording chat (which can then be emailed to the owner) are available.
- **Blogging and communications support.** A range of communications tools are available

that integrate with external web-applications. For the most part these are specific to particular applications and uses. These might enable a user’s online status to be seen on their homepage or allow blog-posts to be authored from within Second Life.

- **3D display management.** One useful category of tool, without an obvious analogue, is a 3D content display management tool – often referred to as a ‘Holodeck’ or similar. Named after the Star Trek device, these tools allow the 3D content of an area to be reconfigured or changed entirely with a single click. An educational use of this might be to allow an area to support a range of different role-play scenarios, changing the content to suit any of a large of number of scenarios as and when required.
- **Visitor tracking tools.** A number of companies provide support for user tracking and freeware solutions are also available. These can potentially be used to support attendance registers, although manual transfer of data to the register will be required.

These examples describe just a handful of the various tools available. These have been developed by many different creators, and are rarely integrated with each other to any extent. It is difficult to even provide a single authoritative reference for the range of tools available, but The New Media Consortium organise “Teachers’ Buzz” events that regularly present new tools (<http://www.nmc.org/sl>) and a range of tools have been collected at Ross Perkin’s virtual ICT Library (<http://ictlibrary.googlepages.com/>).

Sloodle: Second Life Meets Moodle

Many of the original concepts for Sloodle were focussed on providing a direct analogue of a Moodle course to be realised in 3D inside Sec-

ond Life (Kemp & Livingstone, 2006). Much as a Moodle course provides a 'home' for a course on the web, a Sloodle classroom would provide the same in Second Life – furnished by a suite of 3D tools and features based on the Moodle course page itself.

However, in recognition of the wide range of ways in which Second Life is used in an educational setting, development has focussed instead on providing a suite of tools that can be used singly or together – some 'owned' by the instructor of a class, some by the students.

The approach of the Sloodle project is then to provide tools that can be used by instructors and students in a manner that suits their own learning and teaching styles and goals. Deciding which tools to implement was initially driven by expert analysis and by focussing on tools which could be created easily. Since then, development has been community led with two feature request surveys helping to shape the ongoing development of tools and new features (Livingstone & Kemp, *in.press*).

Tools currently available and prototyped include:

- **Web-Intercom.** This tool mirrors typed chat between Second Life and a Moodle chat-room, allowing synchronous text-chat between users logged into Moodle and users logged into Second Life. This can be used to improve accessibility to Second Life discussions and also allows chats in Second Life to be recorded in the Moodle chat-room database. Thus the intercom also acts as a chat-logger (see above), but with the added functionality of providing password protected access to the log to students and staff registered on the appropriate course. Avatar chat is recorded with both the user's Moodle and Second Life user names where the avatar is linked to a Moodle account.
- **Registration and enrolment tools.** A number of different tools have been developed

to allow avatar registration and enrolment. Registration links a Second Life avatar to a Moodle user account (requiring the user to login to authenticate the link). Enrolment tools allow avatar interactions in the 3D world to automatically enrol the associated Moodle account onto a particular Moodle course. Registration and enrolment has also been used to support the development of prototype access control tools – such as a door that only opens for avatars enrolled on the corresponding course.

- **Object distribution.** Tools have been created which allow instructors to place collected objects into a distributor inside Second Life. Users can then obtain the items for their own avatars by interacting with the object in Second Life or by choosing objects from a web-based form in Moodle.
- **Blogging tool.** The Moodle LMS provides all users with a personal blog space accessible through their profile (or from a blogging 'block' on a course page). A Second Life 'HUD' toolbar allows users to write reflective blogs from within the 3D environment. Posts are automatically tagged with a link to the virtual location from where the entry was submitted.
- **Avilister.** The Avatar listing tool scans the other avatars near the user and checks whether they are registered on Moodle. The Moodle user names are then listed for the Avilister user to see. This tool is combined with the blogging tool, along with a set of 'classroom gestures' animations in a single toolbar.
- **Choice tool.** The Moodle choice activity provides a single question with a number of answers to choose from – and is often used to support activities such as class votes on a single issue. Sloodle Choice allows users to vote in either Moodle or in Second Life, with a 3D representation of the votes visible in Second Life to complement the graphic viewable on the web.

- **PrimDrop.** Many classes using Second Life ask for students to create 3D content for assessment. The PrimDrop allows students to submit these inside Second Life, checks that permissions are set to allow the instructor to amend the submission, and records the submission details on the web-site.

Some of these tools replicate some features available in other tools that can be found in Second Life. These other third party tools are generally not integrated with each other (or necessarily with anything else) and can thus leave instructors with the challenge of collecting a range of tools from different producers with no clear central repository. Tools are also commonly not free – while costs are generally very low, the total cost may rise if copies are required for students. More significantly, tools are generally not provided with access to the source-code, limiting the ability of future users to customise or adapt the tools.

Future tools will continue to be developed with openness and flexibility as a key feature. We believe that educators working in Second Life have, and will continue to have, different approaches to teaching and learning. Supporting these creates a challenge – one size does not fit all. Thus tools need to be flexible, giving freedom to instructors and students to choose *which* tools to deploy and *how* to deploy them. As instructors work more regularly with virtual worlds, and work with larger classes, we believe that there will be an increased need for integration with web-based and other online applications for a range of class management activities – attendance monitoring, assessment collection, gradebook updating, and

so on. But for student acceptance, vital to the success of Sloodle, tools also need to provide tangible benefits to students themselves.

In a later section we present a case-study highlighting just some of these benefits – before which we have a more detailed look into the architecture of Sloodle.

Sloodle Architecture

From a high-level perspective, a large part of what Sloodle does is to simply act as a means of data exchange between two otherwise independent systems, as illustrated in Figure 3.

The way in which this exchange occurs is entirely dependent on the capabilities of the systems involved. In this case, Moodle operates as several PHP scripts residing on a webserver, with a supporting database. Access to a Moodle website by a user is usually accomplished via an HTTP connection, using a web-browser. On the server, the database is queried, the given web-page is structured by the PHP pre-processor, and it is formatted using HTML. Subsequently, on the client, the pages are rendered for human reading. The transmission of data to Moodle is typically achieved using web-forms – the user enters data into fields, and their web-browser transmits it back to Moodle via HTTP parameters (Cole & Foster, 2005).

The Linden Scripting Language (LSL) allows objects in Second Life to communicate with external systems in several ways. Sloodle primarily uses raw HTTP, although XML-RPC (XML Remote Procedure Calling, which occurs as a formatted layer above HTTP) provides additional elements

Figure.3..Sloodle.as.a.data-exchange.between.Moodle.and.Second.Life



of security and flexibility for certain tasks, such as negotiating secure sessions.

In Second Life, scripts can be added to any object – and individual objects can contain multiple scripts. In practice, a single Second Life server may be supporting several thousand scripts as well as processing user data and physics data for moving objects. With these constraints, LSL presents very limited processing time and memory availability, and consequently imposes limits on the quantity of information that may be handled using its communications functionality. With these limitations, the HTML formatting in Moodle pages that might be received by an LSL script would not only be surplus to requirements – typically the script might require only a small amount of data, not a complete HTML page – but might be more than the script can actually process or filter. The data exchanges must therefore be focussed and structured.

This necessitates the use of additional PHP scripts that directly access the Moodle functions and database, extracting only that data which is necessary, and returning it in a strict format. The LSL scripts in Second Life interact with these scripts, instead of directly with Moodle and have been termed ‘linker scripts’, as illustrated in Figure 4.

With this structure, Sloodle begins to act as an integral part of Moodle – in this case, as a Moodle plug-in ‘activity module’. A similar architecture could be used with other LMS or content management systems, providing that reasonable access to the underlying data can be achieved

– whether through scripts with direct access to a shared database or via an API.

Using the current Sloodle WebIntercom tool as an example, Figure 5 shows the complete data exchange between Second Life and Moodle as it is currently implemented. The exchange occurs in both directions, entirely via Sloodle linker scripts. By establishing portable conventions for the HTTP communication between Second Life and Sloodle, and creating a generic interface for Sloodle communications with the VLE, the same structure can be applied in many platforms.

Case Studies

Two example case studies based at the Korea Advanced Institute of Science and Technology are presented here to illustrate the successful use of Sloodle to support the use of Second Life in English language classes. In contrast, some brief notes from a third class are also presented to illustrate a less successful attempt to integrate Sloodle into a class using Second Life.

Dubai-Korea Virtual Cultural Exchange

Sloodle tools were used to facilitate the Dubai-Korea Virtual Cultural Exchange program in the spring of 2008. Chris Surridge at the Korea Advanced Institute of Science and Technology (KAIST) and Nicole Shammas at Dubai Women’s College (DWC), designed and deployed a seven-week course wherein students from both sides would experience a motivated, meaningful com-

Figure 4..Sloodle.scripts.residing.on.a.Moodle.server.act.to.provide.focussed.structured.data.exchanges.between.Second.Life.and.Moodle

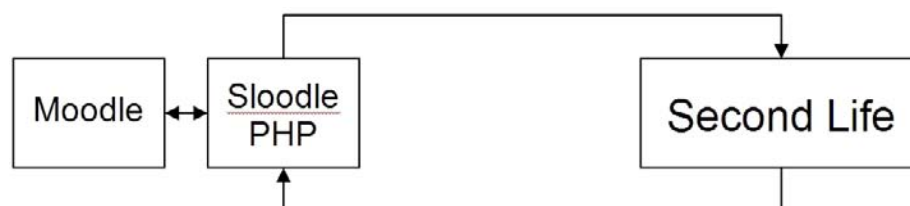
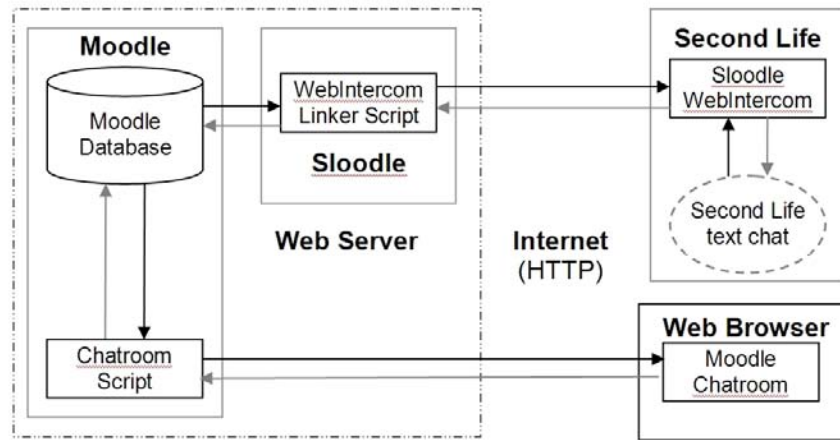


Figure.5..Data.exchange.for.the.Sloodle.WebIntercom..Users.can.participate.in.text-based. 'chats' from. either.Second.Life.or.the.web-based.Moodle.chatroom.



munity of practice. The students involved at both institutions were learning English as a second language – and English was to be the language used in all exchange activities.

Students were taking the class to improve their English skills and the cultural exchange (including meeting in Second Life) provided a high-level of engagement and motivation. Aware of the challenges facing new users in Second Life, a key goal from the outset was to prepare students for communicative interaction in the Second Life environment. Specifically, the program was designed to equip the participating students with the skills required to communicate at a distance with their partner school. The technological tools being used included a Moodle VLE, an audio recording web application, a video conferencing client, video recording and editing tools, as well as Second Life and Sloodle. All of these mechanisms were presented and interacted with under supervision in an internet-ready PC lab. Ultimately, it was hoped that the students would begin making spontaneous contact with their partner school using any or all of the available tools.

Prior to being introduced via Second Life, the students were first prepared for contact through a Moodle audio-forum exercise. The students on each side were divided into teams, with each team

composing, recording and posting relevant questions for their partner team to answer. The result was a rapid, asynchronous voice conversation that stretched over several weeks.

This laid the groundwork for meaningful, personalized interactions, as the students were tasked to not only ask relevant questions, but to respond with answers that were personal and genuine. In addition, the pronunciation differences between the sides also required the development of tools for repairing and maintaining communication. These skills of planned interaction, topic selection, response consideration and communication maintenance were intentionally built into the interaction to prepare for a more fruitful interaction once the students reached Second Life.

The next stage in the interaction involved an exercise whereby students on each side collected small representative objects for 'culture capsules'. The capsules were then sent to the partner school. A video web conference was used to broadcast the opening of the capsules in a live environment. After several weeks of voice interaction, the students were finally able to see and hear each other. As the objects were taken from the culture capsules, the students asked and answered questions about the contents and their relevance.

This interaction solidified the personal nature of the program and provided a gift-giving exercise that created trust and friendship between the sides. These elements, in turn, increased the relevance of future interactions and provided common bonds as well as fresh questions between the sides. This would be an enormous benefit once the students connected in Second Life.

A final step was an ongoing video exchange between the teams on each side. Students were tasked to explain some aspect of their campus life via a short video clip. The videos served to provide the students with creative licence to describe their lives on their own terms using the technology of digital video cameras and editing software. In addition, their success with the videos increased their self confidence regarding using this form of technology. The videos were unsupervised and were left completely up to the students. This independence would also be a useful quality once they met in Second Life.

The first in-world meeting in Second Life employed several of the core Sloodle tools: the Access Checker, the Object Distributor, and the Web Intercom. The Access Checker was set up on the DWC virtual campus in Second Life, and students were instructed to register their avatars to connect their Second Life accounts with their Moodle accounts. Given the simplicity of this task – one merely guides the avatar through a semi-transparent ring while logged in to Moodle – along with the students' exposure to various forms of technology earlier in the program, the results were predictably positive.

The authorization process also meant that students could access the Sloodle Object Distributor on the VLE. The distributor was stocked with free clothing, appearance modifications and accessories. Through the distributor, participants were able to quickly and efficiently distribute objects to themselves and to others, thus reducing the time usually required for finding such things on their own.

The students were then directed to one of several Web Intercom cubes to log their chat. This process is also very simple – one touches a cube and is asked for permission to log the chat. One accepts and the chat logged to the Moodle database.

The students engaged in topical, if boisterous, interactions in Second Life, and were able to review their chat content subsequently by simply logging into Moodle, visiting the chat and clicking on “View past chat sessions.” This was particularly helpful as many of the students were able to review their chat messages and see where communication succeeded or broke down. It also provided solid review material for further interactions.

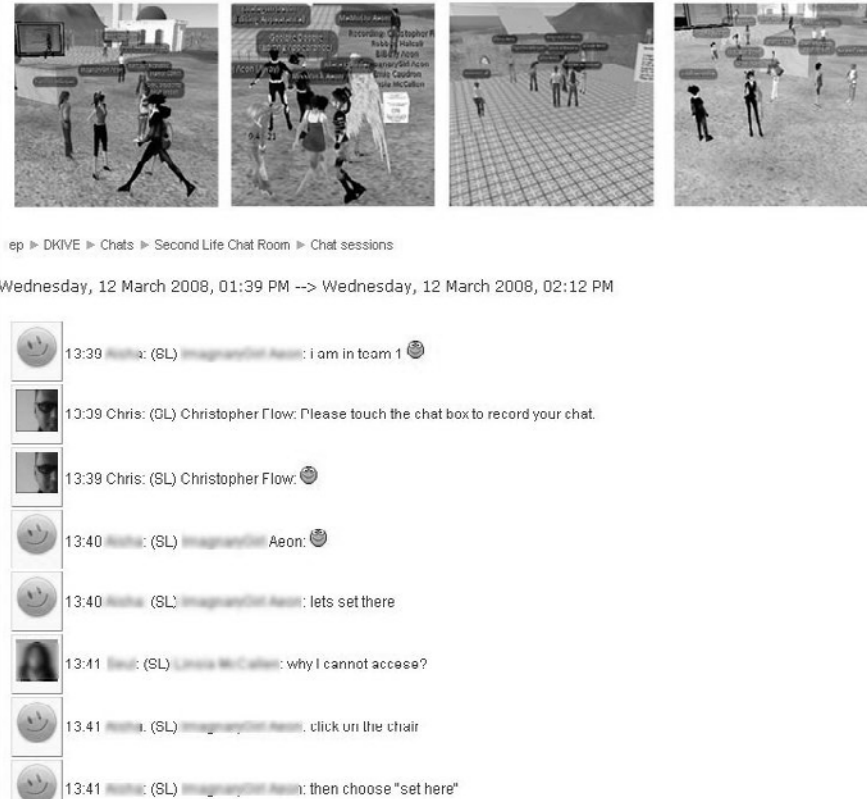
Two additional in-world meetings were planned and attended by the schools with positive results. The students were easily able to locate and activate the Web Intercoms as well as the Object Distributor.

Through this staged program, the students were gradually prepared to use the Sloodle tools to engage in meaningful and motivated communication in Second Life. The tools worked as they were designed to, and the students used their communication repair and maintenance tools to ensure that the intended interactions took place. Motivation and meaningfulness played an enormous role in the effectiveness of these tools in the English language exchange.

Learning English While Learning Second Life

In a separate but related program, students at KAIST were introduced to Second Life and Sloodle via rich-media tutorials. Early tutorials guided students via audio, images and captions, through the process of registering for a Second Life account as well as the basics in avatar management. Successive tutorials or ‘Missions’ as they were called in the program, tasked the students

Figure 6. Virtual exchange students from Dubai and Korea meet for the first time in Second Life (top), their discussions being logged to a Moodle chat-room allowing later review and reflection



to perform actions in Second Life that required the use of blogging and photography skills.

For this program, the Sloodle Access Checker, Object Distributor and Toolbar were used to accomplish the missions. Students were required to pass through the Access Checker in order to authenticate their avatars. This authentication was required to access the Object Distributor, through which they would send themselves the Sloodle Toolbar. The toolbar would then enable them to send written data to their blogs in Moodle.

In Mission 1, students were required to teleport to a location and pass through the Access Checker. They were then informed about the process for authenticating their avatars. This first step was basic, but was an English-medium exercise that required listening, reading and reasoning skills to accomplish correctly. The mission status of the

task distracted the participants' attention away from the language-based layer of the program and toward the task.

In Mission 2, students were required to photograph their avatars, edit and post the photographs in a forum, along with brief written descriptions. Students were then tasked to read the forum posts of their classmates and rate them for quality and interest. This step again required listening and instruction-following skills, as well as the skills required to manipulate the Second Life camera, the Second Life viewport image capture, and an online photo editing program. These skills would, in turn, be required for future missions.

In Mission 3, students chose a location of their choice from the Second Life search function, visited a locale, photographed the locale and, using the Toolbar' Blogging HUD, wrote a

brief blog describing the locale. They were then instructed to edit and add their photo to their blog in Moodle. The entire process allowed them to express some degree of free choice in their mission, while working with the Sloodle tools on a productive and relevant task in English.

The overall results from these early missions was that the students learned progressive and relevant skills in an English medium, while contributing personal information, via Sloodle tools, to the shared community of practice supported by the VLE.

Collaborative Virtual Environments

Sloodle was also used to support a class at the University of the West of Scotland studying Collaborative Virtual Environments. Students were primarily drawn from Computer Games Technology (a software engineering based course), multimedia and animation courses. The assessed activities in this class were based round reflective blogs (using any blogging software or service chosen by the student) and a group project that had to combine a web-site and 3D content in Second Life to promote an aspect of regional life.

The Moodle VLE was used throughout the course and the forum in particular was heavily used by the students to support and co-ordinate the group projects and meetings. The majority of students chose to maintain their blogs on Blogger.com, though some used other hosts or used their existing hosted web-server accounts to create a blog as part of their own web domain. The Sloodle tools themselves were introduced about half way through the course – after the students had familiarized themselves with Second Life and had already written a number of reflective blog entries.

By the end of the class opinions and feelings towards Second Life were mixed – ranging from statements indicating that this had been the favorite class of the year for some students to the opposite extreme. However, one thing all

students had in common was very limited use of the Sloodle tools. Only one student made any significant use of the blogging feature, and other tools had much more limited use. In hindsight, some of the causes of this are obvious – in particular, the use of external blogs removes motivation for keeping a second blog on Moodle – with or without Sloodle to allow entries to be drafted in Second Life.

Summary Evaluation

For the classes held at KAIST, whether embedded in a larger program as the focus of the project, as in the Dubai Korea Virtual Cultural Exchange, or as tools facilitating the use of a virtual environment for task-based learning, the Sloodle tools proved invaluable. By virtue of their ability to track and log interactions from one community of practice to another, for each class the Sloodle tools created one larger, unified community.

Students were willing to use the different tools provided by Sloodle and to make repeat use of the tools without significant guidance or prompting. Students were introduced to the tools at the same time as they undertook their first practicals in Second Life and did not question their value. In a survey of student satisfaction and of how well the class had supported their learning, the overall assessment for the three classes scored 4.5 out of a possible five (where five is the best possible score). Against averages of 4.1 for the college and 4.0 for the institution as a whole, the classes were clearly well received and appreciated.

While several students at the University of the West of Scotland indicated that more documentation, exercises or demonstration time would have encouraged more use of the Sloodle tools, a small majority indicated that they would only use the tools if assessed on it. The students did see significant benefits of using a VLE alongside Second Life, though the benefits of integration had not been proven for this class.

Together, these different results indicate the importance of building authentic learning activities that genuinely benefit from using the tools – with clear differences between the classes held at the different institutions.

Future Research Directions

Beyond the immediate need to investigate data already gathered (surveys, discussions and individual video interviews with students) to add depth to the evaluation, there are a number of ways in which our research work is to be extended.

Over the coming months we will be supporting educators using Sloodle and collecting data from the educators and (where possible) their students. This is necessary to better understand whether the intended benefits are being realized, as well as to gain feedback to help with the continued development of the tools. This is also an important step forward, as to date most of the evaluation efforts have been focused on determining what features the educators think would be of use in their classes – we recognize that there is a need for feedback from students themselves on what works or does not work. We also hope to be able to collect data from educators comparing their classes in Second Life with Sloodle against other classes – either from previous or concurrent deliveries of the same course.

More innovative are our continuing efforts to prototype novel web-to-Second Life interfaces and features. This work, more exploratory in nature, allows us to consider new metaphors for how students and educators might interact in a blended 3D and web-based communicative environment. For example, we can ask how a discussion forum might be visualized in three dimensions – and how this richer visualization might be exploited to add an additional layer of understanding. The extensive collection of existing activities and modules that already exist for Moodle, combined with the relative ease of adding new activities

and modules, means that there remain many web-based activities for which there is no current three dimensional analog.

CONCLUSION

In this chapter we have seen that an open ended and user modifiable virtual world such as Second Life is flexible enough to support a wide range of types of educational activity. We also saw that teaching and learning in virtual worlds can benefit from web-based support, whether for learning support (such as the guidance system in River City) or more administrative in nature.

We then presented an overview of how Sloodle seeks to make the functionality required for support available to teachers and learners. Rather than attempt to provide an authoritative set of prescriptive tools the focus of the Sloodle project has been on providing a flexible set of tools for educators to select from and adapt as they see fit.

We then described some examples from practice which showed how two instructors did just that – selecting a subset of the available tools and prepared them for class use. While the evaluation is currently limited, we believe that the KAIST case-study provides an example of good-practice in the use of virtual worlds for language instruction. Here Second Life helped provide additional engagement and motivation. For the exchange program, Second Life was a key part of the class, but it was only one of a range of activities within the cultural exchange. Students were able to meet, play and chat virtually – Moodle and Sloodle both playing a significant and required part in supporting the interactions and reflections. With careful thought and suitable preparation before classes, Sloodle provided tools that were ready for the students to use as soon as they entered the virtual world.

However, these exemplars of how classes may be prepared and delivered using Second Life do not begin to cover the range of possible approaches to

learning and teaching in Second Life—potentially requiring functionality not currently provided for by Sloodle, or requiring tools be integrated into classes in a different way.

For now work on developing Sloodle continues hand-in-hand with working with the virtual community of educators using and exploring Second Life, who retain a vital role in helping shape Sloodle.

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REFERENCES

Aldrich, C. (2005). *Learning by Doing: The Complete Guide to Computer-Based Simulations*. San Francisco: Pfeiffer Wiley.

Barab, S. A., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, 53(1).

Becker, B., & Mark, G. (2002). Social Conventions in Computer-mediated Communication: A Comparison of Three Online Shared Virtual Environments. In R. Schroeder (Ed.), *The Social Life of Avatars* (pp. 19-39): Springer-Verlag.

Bell, L., Lindbloom, M.-C., Peters, T., & Pope, K. (2008). Virtual Libraries and Education in Virtual Worlds: Twenty-First Century Library Services. *Policy Futures in Education*, 6(1), 49-58.

Björk, S., & Holopainen, J. (2004). *Patterns in Game Design*: Charles River Media.

Cole, J., & Foster, H. (2005). *Using Moodle: Teaching with the Popular Open Source Course Management System*: O'Reilly.

Cook, J. (1999). *Virtual Learning Environments: Making the Web easy to use for teachers and learners*: LTSS, University of Bristol.

Dede, C., Nelson, B., Ketelhut, D. J., & Bowman, C. (2004). Design-based Research Strategies for Studying Situated Learning in a Multi-User Virtual Environment. Paper presented in *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.

Dickey, M. D. (2003). Teaching in 3D: Pedagogical Affordances and Constraints of 3D Virtual Worlds for Synchronous Distance Learning. *Distance Education*, 24(1), 105-121.

Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology*, 36(3), 439-451.

Dougiamas, M., & Taylor, P. C. (2003). Moodle: Using Learning Communities to Create an Open Source Course Management System. *EDMEDIA 2003 Conference*, Honolulu, Hawaii.

Downing, K. J., Lam, T-F., Kwong, T., Downing, W-K., & Chan, S-W. (2007). Creating interaction in online learning: a case study. *ALT-J, Research in Learning Technology*, 15(3), 201-216.

Foster, A. L. (2007). Professor Avatar. *The Chronicle of Higher Education* (September 21).

Gee, J. P. (2005). What would a state of the art instructional video game look like? *Innovate: Journal of online education*, 1(6).

Gee, J. P. (2006, August). Are Video Games Good for Learning? *Curriculum Corportation. 13th National Conference*, Adelaide, Australia.

- Kemp, J., & Livingstone, D. (2006). Putting A Second Life "Metaverse" Skin On Learning Management Systems. In D. Livingstone & J. Kemp (Eds.), *Second.Life.Education.Workshop.at.SLCC*. San Francisco.
- Kirriemuir, J. (2008). *Aspring2008."snapshot"of.UK.Higher.and.Further.Education.Developments.in.Second.Life*. Bath: Eduserv Foundation.
- Lim, C. P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multi-user virtual environment: engaging students in Science lessons. *British.Journal.of.Educational.Technology*, 37(2), 211-231.
- Livingstone, D., & Kemp, J. (Eds.) (2007). *Proceedings. of. the. Second. Life. Education. Workshop.at.SLCC*, Chicago, August 25th-26th. San Francisco.
- Livingstone, D., & Kemp, J. (in press). Integrating Web-Based and 3D Learning Environments: Second Life Meets Moodle. *Upgrade:The.European.Journal.for.the.Informatics.Professional*.
- Mason, H., & Moutahir, M. (2006). Multidisciplinary Experiential Education in Second Life: A Global Approach. Paper presented in the Proceedings of the Second Life Education Workshop at SLCC, San Francisco.
- Nelson, B. (2007). Exploring the Use of Individualized, Reflective Guidance In an Educational Multi-User Virtual Environment. *Journal.of.Science.Education.and.Technology*, 16(1), 83-97.
- New Media Consortium. (2007). *NMC.2007.Educators.in.Second.Life.Survey.Results.Summary: New.Media.Consortium*. Retrieved January 12, 2008, from <http://www.nmc.org/pdf/2007-sl-survey-summary.pdf>
- Papert, S., & Harel, I. (1991). *Constructionism*. Ablex Publishing.
- Polvinen, E. (2007). Educational Simulations In Second Life For Fashion Technology Students. In D. Livingstone & J. Kemp (Eds.), *Proceedings.of.the.Second.Life.Education.Workshop.at.SLCC*, Chicago, August 25th-26th, San Francisco.
- Robbins, S. (2007, 20th-21st November). *MUVES.and.Web.2.0: Using.Second.Life.to.Create.Real.World.Learning*. Paper presented at the JISC CETIS Conference 2007, Birmingham.
- Robinson, A. (2007, March). *Integrating.Second.Life.into.Design.for.Digital.Media*. Paper presented at Massively Multi-Learner, University of Paisley.
- Rymaszewski, M., Au, W. J., Wallace, M., Winters, C., Ondrejka, C., & Batsone-Cunningham, B. (2007). *Second Life: The Official Guide*. New Jersey: John Wiley & Sons.
- Shaffer, D. W. (2006). Epistemic Frames for Epistemic Games. *Computers. & Education*, 46(3), 223-234.
- Twining, P. (2007). *The.schome-NAGTY.Teen.Second.Life.Pilot.Final.Report* (No. KN9851). Milton-Keynes: The Open University.
- Weusijana, B. K. A., Svihla, V., Gawel, D., & Bransford, J. D. (2007). Learning about Adaptive Expertise in a Multi-User Virtual Environment. In D. Livingstone & J. Kemp (Eds.), *Proceedings.of.the.Second.Life.Education.Workshop.at.SLCC*. Chicago, August 25th-26th, San Francisco.
- Yellowlees, P. M., & Cook, J. N. (2006). Education About Hallucinations Using an Internet Virtual Reality System: A Qualitative Survey. *Academic.Psychiatry*, 30, 534-539.
- Yueh, H.-P., & Hsu, S. (2008). Designing a Learning Management System to Support Instruction. *Communications.of.the.ACM*, 58(4), 59-63.

Chapter IV

Observation as a Requisite for Game-Based Learning Environments

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ABSTRACT

In this chapter, the authors propose a Game-Based LMS called the pedagogical dungeon equipped with cooperation abilities for particular activities. The main purpose of this chapter is to explain how to keep awareness of the on-going activities while remaining involved in the game itself. The difficulty is to provide the teacher with this awareness in an immersive way, making the teacher more involved in the game when s/he obtains feedback on the activity. The chapter is split into three sections. The authors propose a first section that deals with the description of our view of learning games illustrated through the pedagogical dungeon. They briefly describe the generation of a dungeon from activity preparation and the links between pedagogical concepts and their representation in the dungeon. The second section concentrates on the observation features needed in these environments in order to obtain interesting facts on what is going on. The authors need to collect traces of the collaborative activity during the enactment phase. They describe the trace life cycle and explain how facts constituting awareness can be calculated from the traces. The third part deals with the restitution of this awareness to the teacher. The problem here is to find an appropriate way to represent awareness both of students' knowledge and behavior. This awareness must be perceived through appropriate graphical representations to preserve.

the. “immersion”.property,.implying.that.these.representations.must.be.directly.present.in.the.game..The.pedagogical.dungeon.has.been.experimented.during.several.practical.works.with.real.classrooms.at.the.University.of.Savoie.and.the.Graduate.Business.School.of.Chambery,.France..This.experimental.approach.illustrates.the.different.aspects.of.the.work,.concerning.the.learning.game.itself,.the.observation.features,.and.the.restitution.of.the.awareness.to.the.teacher.

INTRODUCTION

Nowadays, Learning Management Systems (LMS) offer functionalities that are recognized as being valuable from different points of view. For instance, students can learn at their own speed. These environments also allow the teacher to evaluate specific activities in a uniform way. However, although these environments enable powerful features, they also incur two major kinds of criticism. The first one deals with the non-attractiveness of such environments for the students, as very often students tend to consider them as unexciting. The second one relates to the lack of awareness (see (Greenberg, Gutwin, & Cockburn, 1996) for a definition of awareness) from the teacher's point of view as shown by (Kian-Sam & Chee-Kiat, 2002): s/he no longer has the usual and helpful student's feedback (eye contact, general attitude). As reported in (Hijon & Carlos, 2006), where the authors compare the built-in student tracking functionality of various CMS tools, this functionality is far from satisfactory. The regulation of the activity is thus much more difficult.

Concerning the first point, agreeing with Vygotski's school of thought and activity theory, we consider that the social dimension is crucial for the cognitive processes involved in the learning activity. Consequently, the question was how to enhance the social dimension in such environments.

Observing the emergence and success of online multiplayer games with our students – the so-called “digital natives”-[Summit on educational Games, October 2006 (<http://www.fas.org/gamesummit/>)], more generally in the world (Rosenbloom, 2004) and even in education (Purdy, 2007), (Scott, 2007), it was decided to use one as a support for our course. This led us to apply the metaphor of exploring a virtual world, a dungeon, where each student collects knowledge related to a learning activity. It is our view that the way to acquire knowledge during a learning session is similar to the exploration of a dungeon. This approach reveals advantages such as a recreation-type process, a large usability of the tool or its adaptation to the student's speed. Such game-based learning environments can thus be proposed as a way of implementing learning sessions, in which teachers can prepare and follow a pedagogical scenario (see (Kinshuk, & Patel, 1996) for a definition of a pedagogical scenario).

Concerning the second point; for usability purposes, it is essential that Computer-Based Education offer the possibility of monitoring the activity performed by the students and of obtaining information or feedback about it. For example, being aware of the learning progression of each student is an important goal for the teacher. Here, we explain how we can avoid the loss of perception for the teacher in these environments.

In this chapter, we propose a Game-Based LMS called the pedagogical dungeon equipped with cooperation abilities for particular activities (see (Dillenbourg, Baker, Blaye, & O'Malley, 1996) for a list of cooperation abilities). The main purpose of this chapter is to explain how to keep awareness of the on-going activities while remaining involved in the game itself. The difficulty is to provide the teacher with this awareness in an

immersive way, making the teacher more involved in the game when s/he obtains feedback on the activity. The chapter is split into three parts. We propose a first part that deals with the description of our view of learning games illustrated through the pedagogical dungeon. We briefly describe the generation of a dungeon from activity preparation and the links between pedagogical concepts and their representation in the dungeon. The second part concentrates on the observation features needed in these environments in order to obtain interesting facts on what is going on. We need to collect traces of the collaborative activity during the enactment phase. We describe the trace life cycle and explain how facts constituting awareness can be calculated from the traces. The third part deals with the restitution of this awareness to the teacher. The problem here is to find an appropriate way to represent awareness both of students' knowledge and behaviour. As stated previously, this awareness must be perceived through appropriate graphical representations to preserve the "immersion" property, implying that these representations must be directly present in the game.

Description of the Educational Platform: the Pedagogical Dungeon

In this part, we describe our game-based platform. We first address the links between an educational activity and this game. Then, we demonstrate how the different participants interact with this game. Although the concepts presented in this part are not key research issues, we prefer to explain them to the readers in order to make easier the comprehension of our approach presented later and linked to the observation and awareness in the collaborative activity.

Links Between a Learning Session and the Objects of the Dungeon

We have chosen to derive a set of principles from a formal theory of Human Work Activities called Activity Theory (see (Dunne, 1996) for a definition of Activity Theory) issued from (Vygotski, 1934) proposals. In this theory, the social dimension is crucial for the cognitive processes involved in the learning activity. A learning activity consists of one or more (sub) activities linked and ordered to achieve a given pedagogical goal. Actors (students or teachers) can perform these (sub) activities when their associated conditions (or prerequisites) are satisfied. They carry out these activities in collaborative spaces called arenas, through social interactions or through personal actions. An activity is mediated by tools (such as communication tools or evaluation tools) and uses artefacts (defined in (Dunne, 1996)).

To enhance this social dimension, we have chosen to put the students together in a common virtual environment during the entire learning process. In order to link the game world to the learning one and according to (Hainley & Henderson, 2006), we propose in this section to link the objects used in our game-based framework with the concepts that we usually find in a learning system. Table 1 summarizes these links.

Breakdown of a Learning Session: Rooms and Topology

The learning session (or learning activity) is very often split into different activities. It is the case when the teacher proposes to her/his students a set of exercises linked together in order to reach a pedagogical goal. Each activity has its own local goal, generally a concept to acquire. For a student, performing all the activities ensures that s/he has reached the general goal of the session, i.e. s/he has gained the knowledge associated with the session.

Table.1..Correspondence.between.AT.concepts.and.game-based.LMS.representation.

Classical concept in the activity theory	Corresponding representation in our Game-Based LMS
Arena / Collaborative space	Dungeon for the learning activity Room for a (sub) activity
Link between activities	Corridor
(sub) Activity	Crystals (Exercises)
Condition / Requisite	Room Door
Resources	Knowledge Spheres
Assessment, Validation	Door Key
Communication tool	Chat window
Actors	Avatars (teachers, students)

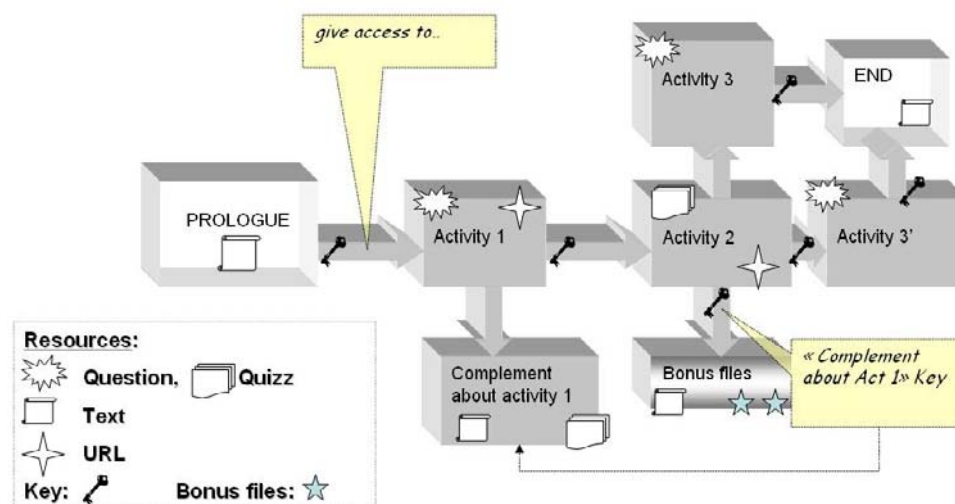
The dungeon represents the place where the learning session takes place. A particular dungeon is dedicated to a particular learning activity, for a particular subject. Each room of the dungeon represents the place where a given (sub) activity can be performed. The dungeon topology represents the overall scenario of the learning session, i.e. the sequencing between activities. There are as many rooms as actual activities, and rooms are linked together through corridors, showing the attainability of an activity from other ones. An

example of a scenario seen as a dungeon topology is presented in Figure 1.

Application to the Dungeon: Use Case 1- Creation of a New Pedagogical Session by the Teacher

The creation of a pedagogical session is not an easy task for the teacher. This activity can be seen as the creation of a scenario, usually written with IMS-LD described in (Koper, Oliver, & Ander-

Figure.1..An.example.of.a.scenario.seen.as.a.dungeon.topology

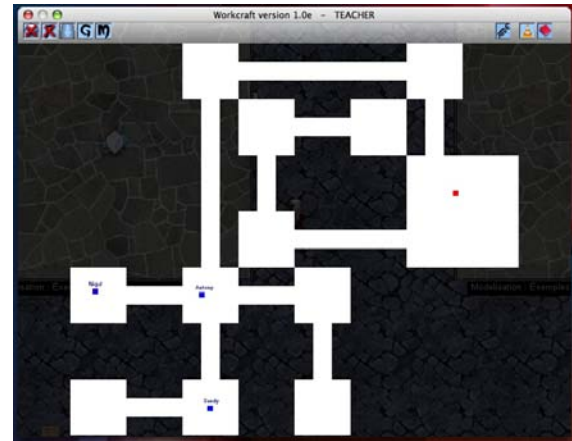


son, 2003) or more flexible languages like LDL proposed by (Ferraris, Martel, & Vignollet, 2007). If the teacher wants to construct a pedagogical session in the dungeon, s/he interacts directly with a session builder. This tool allows the four creation steps of a scenario:

- The definition and type of activities; for instance, an activity can be collaborative.
- The description of the available resources for each activity. Resources could be either local files (content included within the scenario's definition) or links to on-line material. These files usually explain the topic of the activity. The teacher chooses the most appropriate form for these resources: a simple text, videos or even simulation applications, as is the case in (Michelet, Adam, & Luengo, 2007).
- The definition of the validation procedure for each activity. Obtaining a key related to an activity depends on the evaluation of the activity. For each activity, the teacher can choose how to evaluate it. The simplest way to obtain a key is just to read a text. But, most of the time, the student must answer a question or a set of questions. Each of these questions can be a Multiple Choice Question or an open question. In this last case, the teacher will be in charge of validating the answers to that question. We would also point out that questions could be collaborative, in which case the whole team gives the answers. We have developed here a simple way to obtain the keys.
- The definition of the constraints on the activities (organisational and logical temporal links).

According to these constraints, the map of a dungeon is automatically generated and saved. (see (Carron, Marty, & Heraud, 2008) for details). Figure 2 is an example of the result of such a generation.

Figure.2...A.dungeon.map



Enactment of a Learning Session with Students

Actors (students or teachers) can **move** through the dungeon, performing a sequence of sub activities in order to acquire knowledge. Activities can be carried out in a personal or collaborative way: students can access knowledge through resources (documents found inside the game), via help from teachers, or from work with other students. The dungeon can be flexible. For instance, “teleportation portals” can lead to new rooms created dynamically.

Each room is dedicated to an **activity**. One can find **explanatory resources** such as texts, links, and videos. These provide the student with useful information. The student reaches the local goal of the activity if s/he answers a **quiz** successfully. This quiz is thus also located in the room.

As users move through the dungeon, they can meet other students or teachers involved in the same session. When a student is in the same room as another one, it only means that these students are performing the same activity. They can of course access the resources at the same time.

Each room can be accessed through **doors**. These doors are the guardians of the activity. They ensure that the student has the necessary

prerequisites to perform the activity correctly. When users answer a quiz correctly, the associated key is obtained.

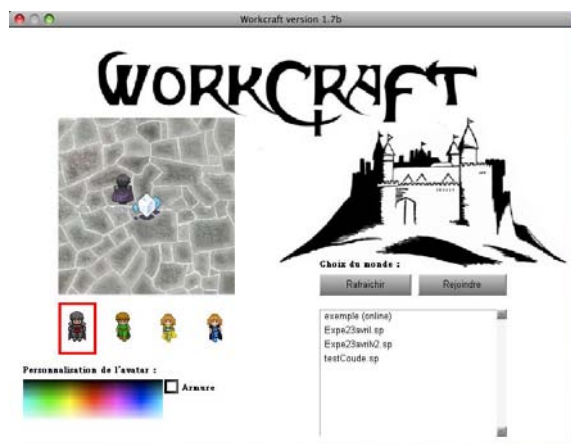
Activities need not necessarily be ordered in the dungeon. However, most of the time, they are well ordered: it is quite rare for a teacher to provide the students with a set of exercises without any order. By ordering the activities, teachers may want either to define an order representing a progressive approach to the general goal of the session (logical order), or simply to force the group to carry out the activities in the same order with the purpose of following the students more easily (temporal order). When users play out a session in the dungeon, this ordering is ensured by the fact that they have to have obtained the key from previous activities before entering a new room.

Application to the Dungeon: Use Case 2 - Embarking on the Quest: Moving, Answering Questions, Obtaining Keys

In our virtual environment, we represent a student by an avatar (see avatar choice in Figure 3) whose characteristics can evolve dynamically over time, as we will see in the third part of the chapter.

Most of the time, a student is present in a virtual room representing an activity. S/he can access several resources related to the activity.

Figure.3..Avatar.choice.window.for.the.student



In Figure 4, two students and the teacher (with the helmet) are present in a room. Touching a sphere/globe item (a resource) opens a text window with explanations or provides a web link, a file, etc. Touching a crystal item proposes an exercise, a test or a quiz. A correct answer to a crystal question generally gives the student a key to open the door and lets her/him continue the quest (see Figure 4).

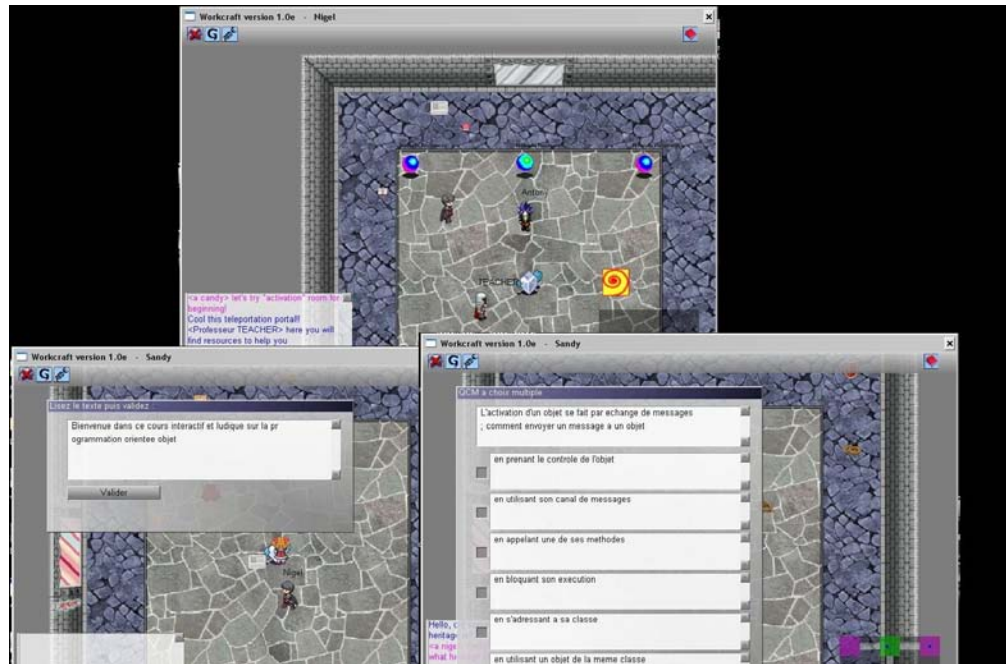
The visualisation is updated in real time and the student may move inside the room and see other avatars move and progress in the dungeon. When a question is related to the concept presented in the room, clues may be found in the resources displayed in the room. The answer can be automatically identified as correct (closed question or key words present). In this case, the result is instantly notified to the student by the system and a door is possibly opened (see Figure 5). But very often, the involvement of the teacher is necessary. S/he corrects the exercise dynamically, can add remarks, and validates the answer or not. Whatever the case, the student is notified via a window (see Figure 5 on the right) containing all the stated information.....

An overall view from above (mini-map) is always supplied for the teachers during the game (Figure 2). This view is dynamic, since one can see all the users involved in this pedagogical session moving through the different rooms. This input provides the teachers with awareness about the on-going activity. The student's view is restricted: s/he can see only the rooms that are accessible to her/him (i.e., the rooms whose keys s/he possesses).

Collaboration in the Dungeon

The teacher may want several activities to be collaborative. In that case, the rooms associated to these activities are **collaborative places**. These places require the students to answer in groups as indicated on the access door to the room. The advantage is to facilitate the exchange of data

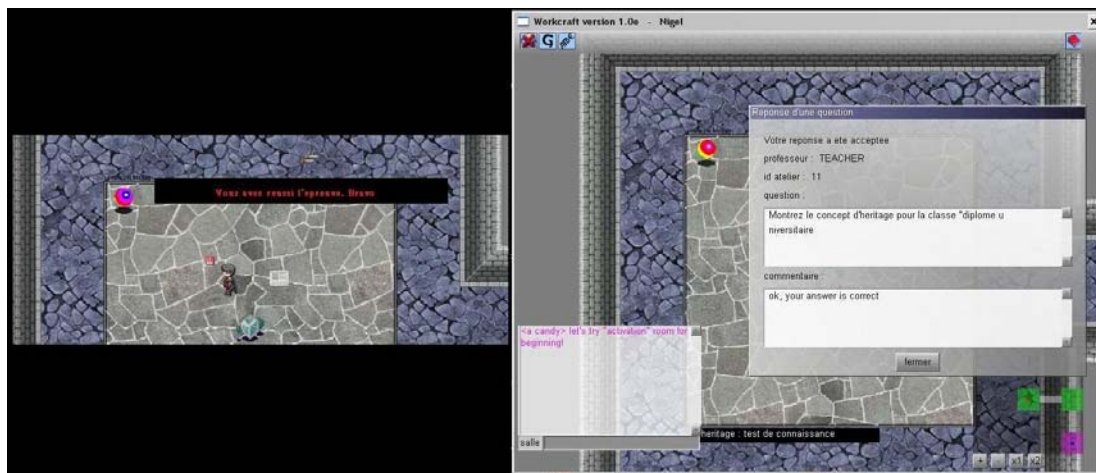
Figure 4..Student.view.of.the.dungeon.and.answering.a.crystal.question



between students, making them asking questions, co-resolving a problem. As in traditional teaching, these collaborative places offer the opportunity to create small groups in order to take advantage of the abilities of the various members of the group, explaining their resolution strategy to each other.

Currently, a chat facility is provided in the dungeon rooms (see the translucent window in Figure 4), but we can of course imagine other collaborative tools available in the collaborative places (shared space, forums, etc.). If the teacher uses collaborative work in a session, s/he must set up teams of students: students belonging to the

Figure 5..Successful.answer.(left).and.teacher.validation.(right).....



same team are supposed to carry out collaborative activities together. The teacher may thus create groups and dispatch students into them.

In collaborative rooms, the quiz is also collaborative. The crystal hiding a group activity has a specific colour and notifies the first student to arrive (see Figure 6). Students in the same team must all be present in the room. They may exchange via the chat tool before answering the question. In the event of a correct answer being given for a collaborative quiz, a collaborative key is provided to all the members of the team.

As in “traditional classrooms”, a student may also collaborate with a teacher, for instance if s/he needs help from her/him.

Experimenting the Dungeon

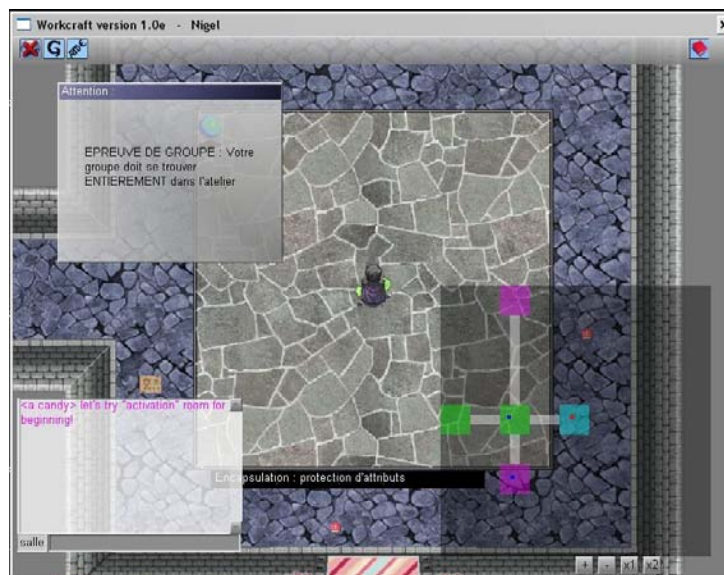
Our research work is always situated between two observations/experiments: one, which serves as a starting point for reasoning, and the other, which serves as a conclusion. From each experiment, new phenomena result which must be observed and so on. Therefore, the pedagogical dungeon has been experimented during several practical works with

real classrooms at the University of Savoie and the Graduate Business School of Chambéry, France. Some of the screenshots shown previously are taken from these experiments carried out with the pedagogical dungeon.

The very first experiment with the pedagogical dungeon aimed to validate the overall approach and to test the system technically. The pedagogical session modelled concerned a computer science lesson about operating systems. Several independent concepts were set out to control an operating system through console commands. The objective of the work was to practice such commands and to verify that the links with theoretical concepts had been acquired. The students were 18 years old and familiar with computer use. The students were working on Linux, and had to find or test some text commands in the console.

During the experiment, about fifteen students and their teacher were present in the classroom. Each student worked on a station equipped with the student client software and the teacher used the teacher client software. The students were allowed to consult part of their lesson or web sites (files or URLs found during the exploration of the

Figure 6..Student's view: “Waiting for a group companion to begin the test”



dungeon). The students were informed that all their actions would be observed through traces. The students were free to refuse this observation but everyone agreed to follow the proposed protocol. They were explicitly allowed to communicate through the chat tool provided with the system. An avatar of the teacher available for students' questions was always present in the dungeon.

As a result, students used the proposed environment without any explanation. Moreover, forms filled in by the students just after the experimentation gave us interesting feedback about the software itself and suggested possible improvements to the interface. However, the main goal of the experiment remains to establish whether such an environment improves the learning process. From the students' point of view, the feedback was very positive: a similar "classical" practical exercise (i.e. without the support of such an application) had been proposed before to the same students. They were much more enthusiastic about the system version: the multiplayer aspect was a great factor of motivation and commitment for the students. An informal competition appeared between users exploring the dungeon. The chat tool was used intensively to communicate about the exercises, boosting the competition and reinforcing the feeling of immersion.

This description of the game gives an idea of how a pedagogical session can take place in the dungeon. The basic rules of the game are well established but, as stated previously, the teacher is used to perceiving informal information in a real classroom. S/he often wants to observe specific information or behaviour and providing her/him with the expected feedback on the overall activity is still a research problem. Our approach consists in taking advantage of the traces left by the actors participating in the mediated learning activity to calculate awareness indicators for the pedagogical dungeon. We describe this idea more precisely in the following section.

OBSERVATION

The dictionary defines observation as the act of making and recording a measurement. In traditional teaching, we are always observing and monitoring students; measuring progress, confusion, or students' motivation. In a computer-based learning environment, this rich type of observation is no longer possible. However, another kind of observation, based on the trace left by the student on their computer, is possible. From now on, we will refer to this specific type of observation. The tracing activity is an appropriate means of reflecting in-depth details of the activity and of revealing very accurate hints for the teacher. Unfortunately, traces are objects which are very difficult to manage and understand. We propose first to briefly list the problems connected with traces and expose how to deal with them.

Facts from Experiments

Fact 1: Log Files are Rich but Correspond to Information which is Difficult to Exploit

A first aspect to consider, central to the observation area, is the form of the traces. Many e-learning Platforms or Learning Management Systems are based on Web Servers (Zaïane & Luo, 2001), (Burton & Walther, 2001). These servers easily supply logs (information concerning the connections on this server) stored in specialised files.

Here is, for instance, a line in the SQUID format, extracted from the traces provided by our local e-learning platform used by thousands of users.

193.48.120.76. 22/04/2003. 04:25:31. POST. TCP_MISS/200. http://www.univ-savoie.fr:443/Portail/logged_in.FIRST_PARENT_MISS/www3-ssl2.univ-savoie.fr.text/html

It is obvious that these traces are not directly interpretable. They should be transformed and rewritten, in order to make their understanding possible. For instance,

“Connection.to.the.e-learning.platform.from.the.university”.

Fact 2: Traces Need to be Transformed in an Organised Way

In order to manage this enormous amount of fine-grained information better, we specified a transformation chain allowing the manipulation of traces (Figure 7). The main purpose is to reach a good level of granularity, allowing a better comprehension of the user behaviour (Loghin, Carron, & Marty, 2005).

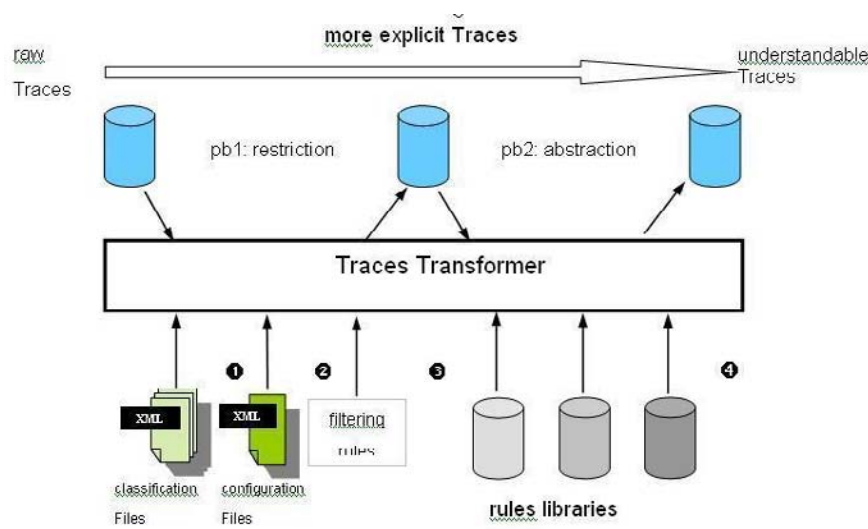
This chain proposes several functionalities to manipulate the traces: filtering in order to reduce the huge quantity of logs, aggregation in order to change the level of granularity (abstraction) of the traces, transformation into a uniform format in order to take into account several log formats

(SQUID, APACHE, I2S), or storage in a database and use of a Database Management System through SQL requests.

Fact 3: Traces Contain Hidden Information; Searching them can be an Interesting Avenue of Research

The approach presented above is valid, since the analyst knows exactly what s/he is searching for and if s/he is able to express it through the proposed interface. From usage of the tool, we can say that there is a need for other approaches, especially when the analyst or the teacher does not know precisely what s/he would like to observe. This is the case, for instance, when the analyst tries to discover new types of usage. In that situation, we are faced with a new issue, one in which the information included in the traces contains hidden behaviour patterns which are to be revealed. Tools implementing “sequence mining” algorithms, and providing significant patterns, must be powerful enough to explore very large data sets (e.g., 1 GB per week for approximately 15,000 people using our e-learning platform).

Figure 7..Transformation.chain.for.manipulation.of.traces



Fact 4: In Order to Understand the activity better, as well as the Links with Predefined Learning Scenarios, Multiple Sources for Traces should be Considered

As mentioned in the introduction, a certain amount of research linked to pedagogical platforms concerns the formalisation of educational scenarios (Koper et al., 2003). The teacher frequently foresees a sequence of activities to be performed during the learning session. This sequence, also called a scenario, guides the session, and it becomes crucial to compare the learners' activities and the predefined scenario (France, Heraud, Marty, & Carron, 2005). This comparison allows one to provide the teacher with awareness of the ongoing activities, and to improve the scenario itself (Marty, Heraud, Carron, & France, 2004).

This is not an easy task, since the users can use simultaneously tools that are not integrated in the educational platform (forums, web sites, chat rooms). We do not want to restrict our understanding to the tasks included in the predicted scenario. We want to widen the sphere of observation, so that other activities performed by a student are effectively traced. Even if these activities are outside the scope of the predicted scenario, they may have helped him/her to complete the exercise or lesson. We thus need to collect traces from different sources. It is therefore interesting, from a general point of view, to be able to take into account more than one source of data. Such an approach allows the deduction, from the multi-source traces, of unforeseen behaviour, as demonstrated in (Marty, Heraud, Carron, & France, 2007).

Fact 5: Visualisation Improves the Teacher's Awareness

Detecting potential problems as soon as possible is a crucial issue. In order to alert the teacher to the fact that the collaborative activity is not progressing as expected, we need to compare the traces

representing the actual activities with the ones mentioned in the predefined scenario and to try to establish links between them. It is essential for the teacher to have a view of what is going on, in order to be able to react to given situations. New observation goals can also appear during the session. For instance, it can be useful to observe the status of the students during the first part of the session and to synchronise them before starting the second part of the session, making sure that everyone has acquired the required concepts.

This adaptive observation, needing high flexibility from the system, can be implemented through agents. A set of "pedagogical observation agents", set up on the students' computers, inspects certain user actions (the ones that are on focus for the observer) and notifies an awareness agent before invoking a visualisation agent to provide the teacher with the appropriate information. This distributed system is thus able to collect the significant logs directly on the machines through specialised agents (Loghin, Carron, Marty, & Vaida, 2008). The visualization agent interprets the traces sent by the observer agents in order to display them on a dashboard for the teacher, through indicators computed from activity traces.

Architecture of the Observation Software

From the facts pointed out in the previous section, we propose a process, namely the observation lifecycle, suited to taking these points into account. This process has three phases that can be described as follows:

A collecting phase, wherein relevant traces are identified and collected;

A transformation phase (structuring, abstraction) of collected data in order to make the rough traces more explicit and more understandable for the observer (researcher, teacher, or student);

And, a visualisation phase, whereby visualisation techniques will be used in order to reveal the semantics from the traces, make them easier

to understand and enable an analysis from a particular viewpoint. This phase aims at facilitating the interpretation of the on-going activity by a non-specialist.

We base our work on a model elaborated in collaboration with the SILEX Team of the LIRIS laboratory. This model, called Trace-Based System (TBS), defines the different modules associated with the different phases mentioned previously.

Figure 8 illustrates the process which allow the observer to interact with a traced e-learning platform in order to visualise and regulate the activity using the traces. The observer plays the role of a “trace composer”. S/he furnishes both the pedagogical scenario possibly expressed with IMS-LD (Koper et al., 2003), and the description of the experiment by pointing out the analysis needs (Carron, Marty, Heraud, & France, 2006). S/he thus sets up the e-learning platform by adjusting collection and transformation tools. Then, the experiment can be enacted, providing the analysts with usage feedback.

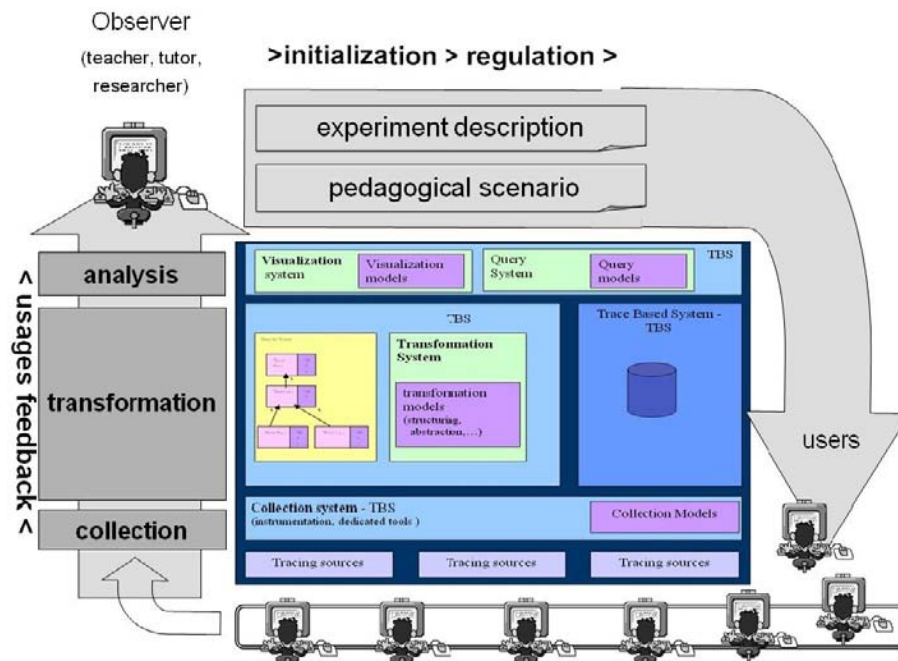
Collection Phase

As demonstrated in Figure 8, the collection phase is prepared before using the TBS and consists in gathering the traces generated in the e-learning platform. Trace collection is a complex computer science problem, due to the large volume of rough traces that it is possible to collect. This collection can be carried out through instrumented software according to the trace composer’s intentions (Talbot & Courtin, 2008) or through files generated by the operating system, or through dedicated spy software, such as key loggers. Another problem related to trace collection is the heterogeneity of rough traces, which requires studying a way to model them (Iksal & Choquet, 2005).

Transformation Phase

The transformation phase is performed inside the TBS. The trace being an object in itself, the notion of Trace-Based System has emerged over

Figure 8..Process for a TBS model.



the last few years, in order to allow and facilitate the exploitation and the interpretation of traces (Laflaquiere, Settouti, Prie, & Mille, 2006). The functionalities of such systems therefore concern trace manipulation. From the rough traces, a TBS offers a set of operations among these objects: filtering, joining or abstracting them. When the results of these operations are still traces, they remain inside the TBS and they can possibly be used for other manipulations. A TBS also offers services allowing trace organisation, such as storage or historical mechanisms. Research questions related to this phase meet trace cleaning (Cooley, Mobasher, & Strivastava, 1999), trace aggregation according to temporal (Marquardt, Becker, & Ruiz, 2004), semantic or syntactic constraints (Tanasa & Trousse, 2004), trace rewriting or modelling (Champin, Prié, & Mille, 2004).

Trace Visualisation

The visualisation phase consists in making requests among traces and in visualising traces. These visualisation tools are part of the interface between the TBS and the trace composer. We have decided to situate the visualisation and the request system outside the TBS, since these tools do not fit the definition of trace manipulation as given in (Laflaquiere et al., 2006). Indeed, visualisation techniques produce results that are not traces. Visualisation consists in elaborating a graphical representation, adapted to the analyst's objective, from traces contained in the TBS. This representation can take many forms, such as a temporal 2D visualisation of a trace (France, Heraud, Marty, & Carron, 2006), or of several traces (Mazza & Dimitrova, 2005), or a spatial 3D visualisation (Cugini & Scholtz, 1999). The visualisation system relies greatly on the analyst's objective. For instance, the visualisation system must be able to provide the analyst with a real time visualisation of the enactment of the users' activities, and particularly to detect and show the users in difficulty. The system must also provide

him/her with information about activities causing problems for these users. Finally, a visualisation of individualised paths showing the path of activities for each user must allow the analyst to make an intermediate assessment of the users' progression.

In this part, we have described the trace life cycle and explained how facts can be calculated from the traces left by the actors. These facts can be presented to the user in order to make him/her aware of what is going on.

Experimenting the Observation

A second experiment with the pedagogical dungeon aimed to validate the observation tools. The pedagogical session modelled concerned a lesson about operating systems. Concerning the teacher, we noted that the use of such a tool may be somewhat disturbing: the way of following the learning progression has entirely changed and s/he may sometimes be overloaded by the number of questions from students waiting. The teacher also complained about the cognitive overload generated by the system: too much information was displayed concerning the different events occurring in the dungeon. Although it was possible to filter the traces in order to display only those related to particular events, this required some additional time from the teacher, who was already overloaded. This remark raises the question of an adaptable control board containing suitable indicators, enabled or not according to the context.

Thus, the most interesting point is that the pedagogical session has to be well prepared and to be specifically adapted to such environments. As stated previously, for the teacher, the experiments revealed a great difficulty in reading and validating at the same time: a lot of student propositions are generated from open questions. The whole session has thus to be well designed in order to protect the teacher from such an overload: s/he must also have time to observe the pedagogical activities and to react dynamically.

This awareness must be perceived through appropriate graphical representations to preserve the “immersion” property, implying that these representations must be directly present in the game. The following part deals with the restitution of this awareness to the teacher and students.

Immersive Concepts for Observing a Learning Game

It is well known that a great part of the success of a game is due to the immersion of the player into its environment. One of our first experimentations (Carron, Marty, Heraud, & France, 2007) showed that it is crucial for a learning game to pay attention to the immersion factor too.

In this part, we will present concepts or artefacts added to enhance learning and to reinforce the feeling of immersion. We first propose to gain awareness concerning the students’ skills and behaviour by introducing new visual representations into the game. We then want to go further by allowing a meta-cognition process to take place via the game. In order to be efficient, the reflexive analysis of the student of his/her own trace must

also be made in the same context. We propose a way to carry out this post-experiment activity in an immersive way, too.

Representing Skills through Equipment

We propose to display the skills via visible equipment (pieces of armour, clothes, weapons: a sword, magic wands, a shield) shown directly on the avatar representation inside the game. Each student begins a dungeon without any piece of armour. Each important exercise assessment lets him/her win an item: for example a sword, a hat (diadem for the girls or helmet for the boys). At the beginning, students start almost naked (see Fig 9).

This way of representing a skill presents a dual interest:

First, the student is proud to see his/her avatar evolving and this motivates him/her to obtain new items by exploring new parts of the dungeon. Moreover, another motivating factor for the student is to show his/her skills to other students. The latter are immediately impressed by this new appearance and try to get the same items as soon

Figure.9..Representing.skills.through.equipment.



as possible. As a side effect, it generally pushes the students to communicate and cooperate in order to progress.

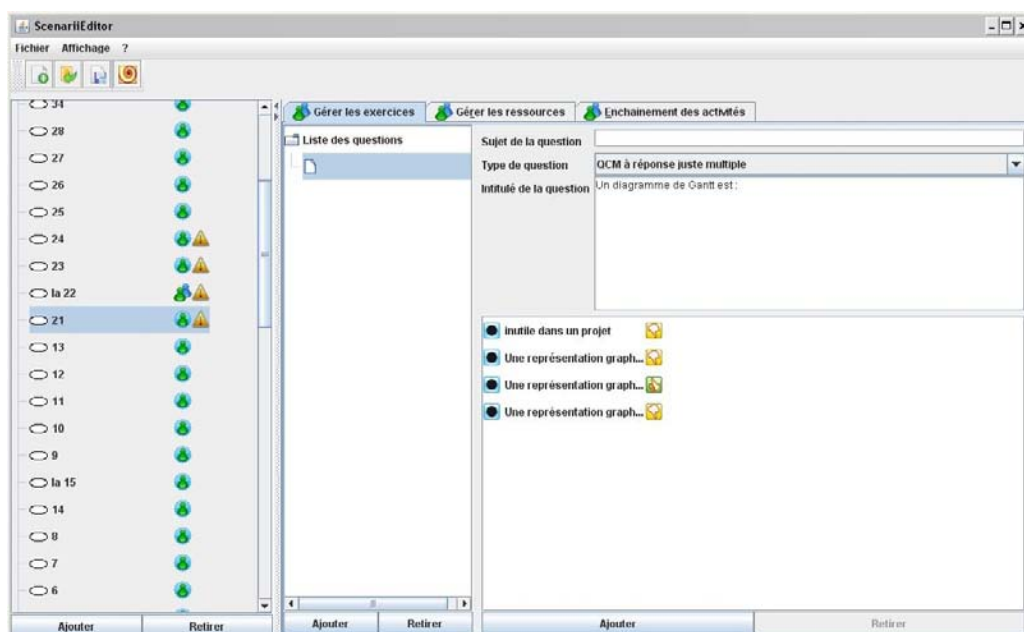
Second, this representation is also very useful for the teacher seeking information about the progression of each student in the dungeon (learning session). He/she is thus instantly aware of the progression of each student without needing to activate or launch a specific visualization tool. Crucial pedagogical information is directly displayed within the game. Currently, the teacher may choose to allocate seven different rewards to specific activities of the pedagogical scenario: these are considered as main or fundamental activities and will let the students obtain, in the event of success, a piece of equipment revealing a particular skill. The attribution of items to specific activities is done when designing the pedagogical scenario. The task editor (Figure 10) allows one to address the allocation of awards to activities (identification through a “risk icon”). We can observe in Figure 10 that both solo and cooperative activities may be marked as key activities (unique player or multiplayer item in Figure 10).

In fact, depending on the topology of the dungeon and the path followed by the students, some students may appear amusingly in the dungeon with just a helmet or almost naked with a sword.

More seriously, we have considered here that a skill is something persistent, similar to a diploma, and has also to be reified into a concrete visible object worn by the avatar. The teacher and students are able to see the skills of everybody in the current dungeon. Naturally, the teacher is always fully dressed (see the top avatar in Figure 11).

Seven items are currently available. The last one is a pair of wings that is obtained when all the exercises in the dungeon have been successfully completed by a student. Such students are naturally identified by the others as the “best players” (most competent in the domain) and then possibly allowed to help the others: they may receive a new “tutor” role in order to help the teacher. We have planned to offer them new skills associated with this role (e.g. a teleportation skill) in order to enhance their cooperation abilities.

Figure 10..Allocating rewards to particular activities of a pedagogical scenario.



The students' skills are represented by equipment. Some students exhibit specific types of behaviour during a session such as brilliant, cooperative, laborious, talkative, rigorous, lax, which are important from a pedagogical point of view. In the following paragraph, we propose a way of representing such behaviour.

Representing Behaviour through Auras

Behaviour is the explicit way a student has of being of an actor, revealing properties particular to the way this actor behaves in the dungeon, from a general point of view or from a specific one linked to the pedagogical scenario. Representing specific behaviour may have an impact on other persons present in a room or even in the dungeon. As a matter of fact, we can predict some of these types of behaviour from the work on traces explained in the second part of this chapter. We can also assimilate this to a distinctive atmosphere or quality that seems to surround or be generated by a person. We have chosen to represent such behaviour with an aura around the avatar. In Figure 11, two auras are represented. Some snow is falling on the two girls revealing that they are in difficulty and a spiral is turning around the boy

meaning that he is talkative. Naturally, the auras are absolutely not linked to the skills.

Different auras have been defined. They can be identified through their different forms (circle, snow, pulsation and spiral) or through their colour (any colour is possible).

The advantages of such a representation are numerous:

First, an aura may represent temporary behaviour and thus may be activated or deactivated when specific conditions are achieved. For example, a student in difficulty generally gives several wrong answers to the same exercise.

Second, a person may exhibit several behaviour patterns at the same time. In this case, the different auras alternate.

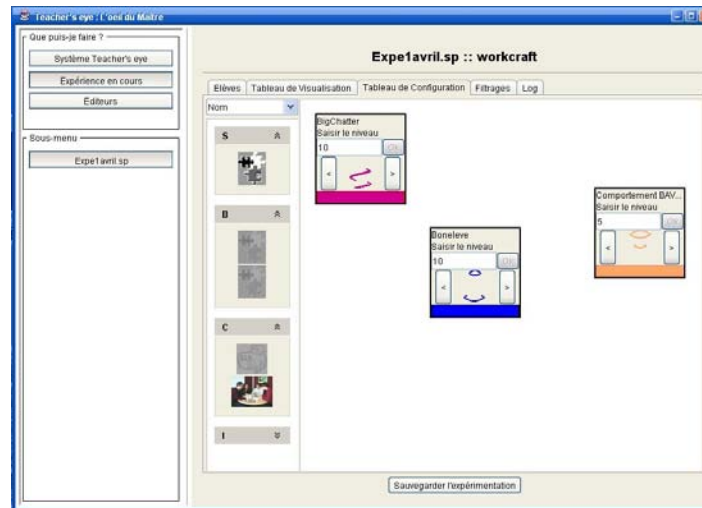
Third, the teacher may decide to define, attribute, activate or deactivate some auras dynamically according to his/her pedagogical needs or wishes. The level of triggering may also be adjusted at any time (see Figure 12 for the configuration tool).

We can note that in this case, the teacher has to use an external tool to define new behaviour patterns, decreasing his/her immersion factor (for a short time) but the results of these settings are directly visible through the avatars in the game.

Figure 11..Representing particular behaviour via auras



Figure 12. Configuring 3 auras to detect 3 particular types of behaviour



An Immersive Means for Reflexive Analysis: Ghosts

In order to allow a meta-cognition process (Paris & Winograd, 1990) via the game, and the reflexive analysis of the student concerning his/her own trace, we propose to carry out this post-experiment activity in the same context. This process can only be performed seriously if the access to many items is possible: look at correct and wrong answers, perceive past hesitations, time spent on specific activities, knowledge of which resources have been consulted. Meta-cognition can thus be

facilitated through replaying the whole session. For this purpose, we have chosen to save all the actions of an avatar in order to be able to replay them later: this is replayed as a ghost player (see Figure 13).

The teacher is able to see a posteriori all the ghosts saved during the session. Although it is possible, the teacher do not replay the session with all the ghosts at the same time but s/he generally selects only a few specific ghosts. As seen in Figure 13, special items are displayed on the ghost when they are obtained and the ghosts blink green for correct answers and red for wrong ones.

Figure 13..Replaying a session with ghosts



Currently, only the teacher may decide to confront the students with their ghosts. Future work will address the possibility of confronting several ghosts, allowing the associated students to exchange information with each other on their ways of carrying out a particular task.

Experimenting Immersion

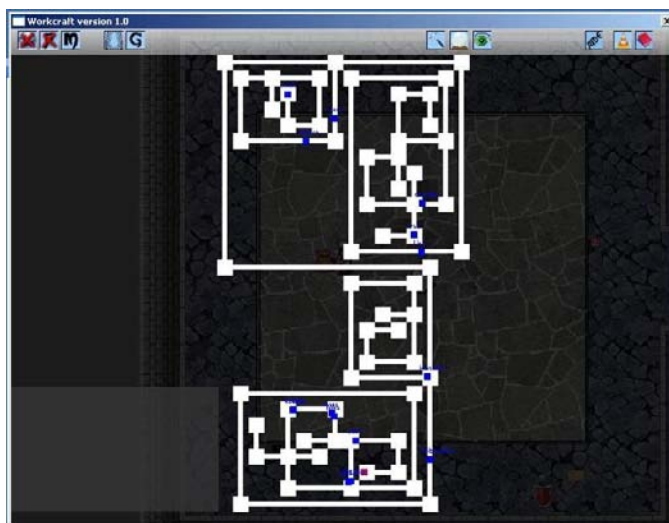
The screenshots shown in this chapter are taken from a real experiment carried out with the pedagogical dungeon based on a project management course assessment. In this third experiment, the whole dungeon was composed of 60 rooms (see the topology with students dispatched in Figure 14). During the experiment, two groups of fifteen students with their teacher were present successively in the classroom.

These students used the pedagogical dungeon for approximately one hour and were very enthusiastic about this kind of assessment. Some possible improvements to the interface were suggested and we observed a great motivation for obtaining items. To detect talkative students and those in difficulty, the teacher activated observation tools in the way stated previously. The students were

not informed of the meaning of the auras but they were very proud to show their avatar with auras to other students. Apparently, the meaning of an aura was not the most important aspect for the students. We observed particular collective behaviour patterns. For instance, some students decided to pursue their quest in pairs, using the chat tool systematically in order to share their experiences.

According to the teacher, the pedagogical aim of the assessment (evaluating the knowledge level about project management) was achieved. Moreover, he was able to use the ghosts in order to examine more precisely what particular students had done. Other observation parts and new immersive factors were there simply for testing purposes. For the moment, this first experiment does not enable us to draw firm conclusions about the value and the interpretation of auras from a pedagogical point of view. New observation indicators applied to other experiments will give us more clues to demonstrating the pedagogical justification of such tools with effective learning enhancement. Nevertheless, the current results encourage us to go on with this research work.

Figure.14..Topology.of.the.dungeon.for.assessing.the.Project.Management.Course



CONCLUSION

As for classical games, we think that the immersion factor is a key point for all the actors (students and teachers). In this chapter, we have proposed some solutions in order to keep the teacher involved in the game by providing him/her with immersive indicators and tools concerning pedagogical objectives.

Through a game-based learning system equipped with observation facilities, the teacher may define observation indicators before and during the game according to his/her pedagogical needs or wishes. The observation system is generic, and we show how to exploit traces left in a game-based LMS in order to obtain relevant information about the pedagogical session.

For appropriation and acceptability reasons, the feedback of information must be adapted and integrated dynamically within the game. The players and the teacher thus remain immersed in the game. These concepts (items, auras) are implemented in the pedagogical dungeon through indicators. Future work will focus on observation indicator classification, and more precisely on the definition of collaborative indicators. The immersion problem is also of great importance when users examine their own traces. Meta-cognition thus implies a ghost re-player. As stated previously, improvements to this player are required in order to provide a more effective tool.

In this kind of environment, personalization is of primary importance. Actors must have a picture of themselves with respect to their current knowledge, and the behaviour they tend to exhibit. This information makes the adaptation of the environment possible for the users. This topic is of course directly connected with research on user modelling. As a matter of fact, these learning games are widely spreading among the educational community. The user model represents this picture, valid at a given time, which will be refined and changed, according to the results obtained from the different uses of the pedagogical tools.

Certain features of the pedagogical dungeon are particularly interesting for feeding this research. Firstly, in the pedagogical dungeon, we can represent the knowledge acquired but we can also keep traces of the way this knowledge has been acquired. To some extent, the ghosts can be considered as part of the user model. Secondly, the dungeon is general enough to be used in diverse areas (e.g. Geography, English). A link between several learning dungeons is therefore possible. This general approach can benefit students and teachers since it can break down the divisions among the topics taught. For instance, the students' skills in communication will be available during a computer science lesson, allowing the teacher to propose adapted activities which are more or less collaborative.

REFERENCES

- Burton, M. C., & Walther, J. B. (2001). A Survey of web log data and their application in use-based design. *In proceedings of the 34th Annual Hawaii International Conference on System Sciences* (pp. 1-10). Maui, Hawaii.
- Carron, T., Marty, J. C., Heraud, J. M., & France, L. (2006). Helping the teacher to reorganize tasks in a collaborative learning activity: An agent-based approach. *In International Conference on Advanced Learning Technologies* (pp. 552-556), Kerkrade, The Netherlands.
- Carron, T., Marty, J. C., Heraud, J. M., & France, L. (2007). Games as Learning Scenarios: are you Serious? *In first European Conference on Games Based Learning*. (pp. 55-64). Paisley, Scotland.
- Carron T., Marty J. C., & Heraud J. M. (2008). Teaching with Game Based Learning Management Systems: Exploring and observing a pedagogical dungeon. *Simulation. & Gaming.*, 39(3), (pp 353-378), Special issue on eGames and adaptive eLearning: A practical approach. DOI: 10.1177/1046878108319580.

- Champin P.A., Prié Y., & Mille A. (2004). Mu-sette: a framework for knowledge capture from experience. In *12ème atelier de raisonnement à partir de cas*, Villetaneuse, France.
- Cooley R., Mobasher B., & Strivastava J. (1999). Data Preparation for Mining World Wide Web Browsing Patterns. In *Knowledge and Information Systems*, 1(1), (pp. 5-32).
- Cugini J., & Scholtz J. (1999). Visvip: 3D visualization of paths through web sites. In *proceedings of the international workshop on web-based information visualization* (pp. 259-263). IEEE Computer Society, Italy.
- Dillenbourg P., Baker M., Blaye A., & O'Malley C. (1996). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), *Learning in Humans and Machine: Towards an interdisciplinary learning science*, (pp. 189-211), Oxford : Elsevier.
- Dunne R. (1996). *Activity theory*. Invited paper presented at Utrecht University, Netherlands, Sep. 1996.
- Ferraris C., Martel C., & Vignollet L. (2007). LDL for collaborative activities. *Handbook of Visual Languages in Instructional Design: Theories and Practices*. Hershey, PA: Idea Group, (in press).
- France L., Heraud J. M., Marty J. C., & Carron T. (2005). Help through visualization to compare learners' activities to recommended learning scenarios. In *5th IEEE International Conference on Advanced Learning Technologies*, (pp. 476-480), Kaohsiung, Taiwan.
- France L., Heraud J. M., Marty J. C., & Carron T. (2006). Monitoring virtual classroom: Visualization techniques to observe student activities in an e-learning system. In *International Conference on Advanced Learning Technologies*, (pp. 716-720), Kerkrade, The Netherlands.
- Greenberg S., Gutwin C., & Cockburn A. (1996). Awareness through fisheye views in relaxed-WYSIWIS groupware. In *proceedings of Graphics Interface*, (pp. 28-38).
- Hainley V., & Henderson J. (2006). Instructional design principles for serious games. *MultiLingual*, 17(8), (pp. 49-52).
- Hijon R., & Carlos R. (2006). E-learning platforms analysis and development of students tracking functionality. In *proceedings of the 18th World Conference on Educational Multimedia, Hypermedia & Telecommunications*, (pp. 2823-2828).
- Iksal, S., & Choquet, C. (2005). An open Architecture for usage analysis in a e-learning context. In *International Conference on Advanced Learning Technologies*, (pp. 177-178). Kaohsiung, Taiwan.
- Kian-Sam, H., & Chee-Kiat, K. (2002). Computer anxiety and attitudes toward computers among rural secondary school teachers: A malaysian perspective. *Journal of Research on Technology in Education*, 35(1), (pp. 27-49).
- Kinshuk, S., & Patel, A. (1996). Intelligent tutoring tools: Redesigning ITSs for adequate knowledge transfer emphasis. In *International Conference on Intelligent and Cognitive Systems*, (pp. 221-226).
- Koper, R., Oliver, B., & Anderson, T. (2003). *IMS Learning Design Information Model, version 1.0*. IMS Global Learning Consortium, Inc.
- Laflaquiere, J., Settouti, L. S., Prie Y., & Mille, A. (2006). Trace-based framework for experience management and engineering. In *10th international conference on knowledge-based intelligent information and engineering systems* (pp. 1171-1178), Bournemouth, UK, Lecture Notes in Computer Science.
- Loghin, G. C., Carron, T., Marty, J. C. (2005), A Method for Enabling a Better Comprehension of User Behaviour. In *Proceedings of CELDA'05 (Cognition and Exploratory Learning in Digital Age Conference)*, (pp. 349-354).

- Loghin, G. C., Carron, T., Marty, J. C., & Vaida, M. (2008). Observation and adaptation of a learning session based on a multi-agent system : An experiment. *In proceedings of IEEE International Conference on Intelligent Computer Communication and Processing* (to be published). Cluj-Napoca, Romania.
- Marquardt, C. G., Becker, K., & Ruiz, D.D. (2004). A pre-processing tool for web-usage mining in the distance education domain. *In international database engineering and applications symposium* (pp. 78-87). Coimbra, Portugal.
- Marty, J. C., Heraud, J. M., Carron, T., & France, L. (2004). A quality approach for collaborative learning scenarios. *In Learning Technology Newsletter of IEEE Computer Society*, 6(4), (pp. 46-48).
- Marty, J. C., Heraud, J. M., Carron, T., & France, L. (2007). Matching the performed activity on an educational platform with a recommended pedagogical scenario: A multi-source approach. *In Journal of Interactive Learning Research*, 18(2) (pp. 267-283), special issue usage analysis in learning systems: Existing approaches and scientific issues.
- Mazza, R., & Dimitrova, V. (2005). Generation of graphical representations of student tracking data in course management systems. *In 9th IEEE international conference on information visualisation* (pp. 253-258). London. ISBN 0-7695-2397-8.
- Michelet, S., Adam, J. M., & Luengo, V. (2007). Adaptive learning scenarios for detection of misconceptions about electricity and remediation. *In International Journal of Emerging Technologies in Learning*, 2(1), (pp. 195-199).
- Paris, S. G., & Winograd, P. (1990). How meta-cognition can promote academic learning and instruction. In B. F. Jones (Ed.), *Dimensions of thinking and cognitive instruction* pp.15-51). Hillsdale, Lawrence Erlbaum Associates.
- Purdy, J. A. (2007). *Serious games: Getting serious about digital games in learning*. Retrieved on the 16 June 2007 at <http://www.corpu.com/newsletter%5Fwi07/sect2.asp>
- Rosenbloom, A. (2004). Interactive immersion in 3D computer graphics. *Communications of the ACM*, 47(8), (pp. 28-31).
- Scott, G. (2007). *Games get down to business. Simulations growing in popularity as younger workers move up the corporate ranks*. Retrieved on the 16 June 2007 at <http://www.theglobeandmail.com/servlet/story/RTGAM.20070502.wgtgames0502/BNStory/GlobeTQ/home>
- Talbot, S., & Courtin, C. (2008). *Trace analysis in instrumented learning groupware: An experiment in a practical class at the university*. To be published in the 10th IASTED international conference on computers and advanced technology in education.
- Tanasa, D., & Trousse, B. (2004). Advanced data preprocessing for intersites web-usage mining. *In IEEE Intelligent Systems*, 19(2), 59-65.
- Vygotski, L. S. (1934). *Language and Thought*. Gosizdat, Moscow.
- Zaïane, O. R., & Luo, J. (2001). Towards evaluating learners' behaviour in a web-based distance learning environment. *In IEEE international conference on advanced learning technologies* (pp. 357-360), Madison, USA.

Section II

Design Issues

Chapter V

Content Integration in Games–Based Learning Systems

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ABSTRACT

A key challenge to move forward the state of the art in games-based learning systems is to facilitate instructional content creation by the domain experts. Several decades of research on computer aided instruction have demonstrated that the expert has to be deeply involved in the content creation process, and that is why so much effort has been devoted to building authoring tools of all kinds. However, using videogame technology to support computer aided instruction poses some new challenges on expert-friendly authoring tools, related to technical and cost issues. In this chapter the authors present the state of the art in content creation for games-based learning systems, identifying the main challenges to make this technology cost-effective from the content creation point of view.

INTRODUCTION

Content in videogames takes two different forms: multimedia and gameplay. 3D models of scenarios, objects and characters, 2D textures to dress the

models, animations, music and sound effects collectively define the multimedia content of a videogame. Gameplay defines “what the player does”. Gameplay designers build the dynamics of the game world by providing a detailed descrip-

tion of what the player can do and what the game has to do in response. As the size and quality of videogames increase to respond to growing player expectations, game development projects are also growing to involve several hundreds of people working for an average time of three years, where content creation consumes a good bit of the budget.

It is easy to argue that games-based learning provides new opportunities for building engaging and motivating learning environments, although up to now not many empirical studies have been made to demonstrate it. However, if we were to assume that games-based learning outperforms other computer aided learning technologies in certain domains, it is hard to argue that based on those benefits we are going to get a budget increased by several orders of magnitude. In order to be of practical use, videogame technology applied to learning has to become cost-effective compared to state of the art computer aided learning technologies.

Regarding multimedia content creation, the solutions, which the videogame industry is already pursuing, are procedural content creation and end-user content creation. For example, for the game *Spore* Maxis has developed procedural animation methods that allow the developer to build new characters and automatically apply predefined animations on them (Cappel, Green, Curless, Duchamp & Popović, 2002). End-user content creation is becoming more popular in industry, both as a way to promote gamer attachment to the game and to profit from a mass of content creation volunteers.

Instructional content creation for games-based learning is a form of gameplay content creation. The instructional designer must provide a detailed description of what the student can do and what the system has to do in response. With current technology the instructional designer should work in pair with a gameplay designer or become one himself. In this chapter we present the state of the art in content creation for games-based learning

systems, identifying the main challenges to make this technology cost-effective from the content creation point of view.

Content Creation in Video Games

Video game content may be divided roughly in two different groups: assets and behaviours. The term assets usually denotes those elements that go into a game, such as the artwork (textures and 3D models), sound effects, music, and, generally speaking, every object that is presented to the user. On the other hand, the way in which the objects behave constitutes the second kind of content and is sometimes referred to as dynamic content. Both kinds of content are usually handmade, therefore their cost constitutes an important part of the game budget. To compound matters, the situation is getting harder, because of the ever growing hardware capabilities that allow video games to present more and more objects with higher resolutions, and therefore requires more and more people involved in the creation of all this content.

The creation of assets involves artists using tools such as 3D Studio™, Maya™ and Photoshop™ to generate 3D models and textures. Depending on the game, the amount of this content varies from just a few models to several Gigabytes of stored files (Gillen 2005). In order to alleviate the cost, some effort has been made to create algorithms that build part of them procedurally. Procedural content generation was used by early games as the only way to fit vast amounts of data onto the small mediums available at that time. Nowadays the goal is not just to save disk space but also man power and therefore budget. Examples of assets procedurally generated are textures, terrains or trees; recent developments like *Spore* are also exploring dynamically generated animations, and *Diablo III*, *Hellgate: London* or *Borderlands* have random level generation.

On the other side, behaviours constitute the dynamic part of the game, because they define what players can do with the objects in the environment and how they react to their actions. These behaviours are usually created by AI and script programmers..

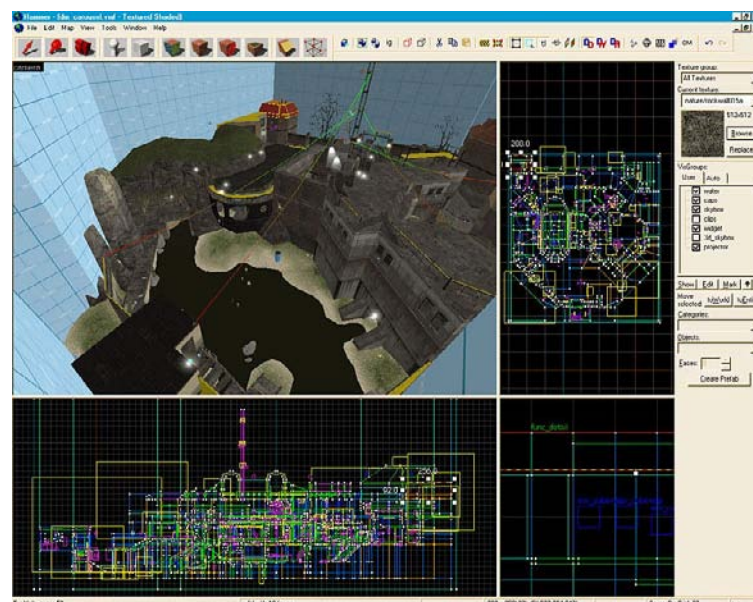
In the middle of the spectrum between static and dynamic content creation, we find the level designers, those people who create levels, challenges or missions. They operate with a specific set of programs known as level editors such as Hammer, UnrealEd or SandBox (see Figure 1) that are usually created by the game studio. With such tools, they can create part of the environment, put the 3D objects created by the artist into it, and link them with concrete behaviours. Level designers may even write high-level code to compound behaviours based on the primitive behaviours created by programmers. Nowadays, the procedural generation of such levels is an open research area. The first-person shooter (FPS) demo .kkrieger¹ contains a complete level procedurally generated, there are procedural city generators and some patents exist in the United States related to

dynamic content generation in role-playing games (Rhyne & Barry, 2006).

Though content is created by game studios, more and more games are shipped together with tools that allow end-users to generate new content and share it. Unfortunately the complexity of the tools makes them too difficult for non expert users, and therefore the user generated content is rare and has usually low quality. A well-known counter example is Counter Strike that began as a user modification of Half-Life and finally became a Valve product.

In our context of key importance is the level designer task. Using their editors they create the environments where the user plays. Those maps contain non-mutable objects (such as terrain or walls), passive mutable objects (doors that can be opened or walls that can be destroyed), and non-player characters (NPCs). Most of the time designers link together the game objects located in the map with concrete behaviours programmed by AI specialists. However, usually AI routines are not general enough for covering every situation that a NPC may find itself immersed in. In

Figure.1..Screenshot of the Valve.Hammer.level.editor.



those cases level designers have to hard code the behaviour creating specific scripts for that situation or using anchor systems (Martel, 2006).

The main goal is to integrate the content dynamically during the execution of the game; the result is:

- **One or more virtual environments:** Using all the generated information, programmers are able to build a virtual environment (both 2D or 3D) where the player interacts. Usually level designers build more than one scenario that are presented to the user in a sequential way. Levels are based on the assets built by artists.
- **Entities that react to the player:** The final goal of a videogame is to provide fun to players using an appropriate difficulty level. Every element in the environment may follow the game rules. All their reactions are the responsibility of logic and AI programmers.

Content Creation in Educational Applications

The first computer assisted instruction (CAI) systems were developed in the USA in the sixties, looking for a way to teach a growing number of people during the Cold War. They were heavily inspired on the behaviourism theories and the programmed instruction (Skinner, 1958). The more representative example of this period was Plato (Programmed Logic for Automated Teaching Operations), widely used in the early 1970s.

In these systems, teaching material is divided into a set of learning objects or instructional units, that are arranged in some kind of hierarchy that specifies prerequisites and other relationships between courses, modules or lessons. Learning objects have specific instructional objectives and are presented separately. They are designed to be studied with no interruption, but should also

be atomic and not too dependant of other ones. Usually, they contain some kind of text with an explanation of some topic, multimedia presentations or even short remedial material for helping students to overcome their misconceptions. These texts and graphics constitute canned material to be presented to the user at the right moment.

Together with the instructional material, learning objects tend to include different forms of tests to assess the student, such as multiple choice or fill-in questions. These simple queries are used by the system to guide its own reactions using pre-created links between the learning objects, each one related with one of the possible user answers. In that way, the instructional units are nodes in a big graph that authors must build with care. The target learning object of each one of those links must be carefully chosen in order to provide meaningful information to the user. For example, a bad response should drive the system to a new learning object where the more likely cause of the error is assumed and a plausible explanation is provided. The content sequence is, therefore, chosen dynamically based on the relationships between course modules and, obviously, the user performance.

Content creation in this kind of system consists of a domain expert cutting the domain knowledge into “atomic pieces” (learning objects) that will be presented individually, and including prefixed questions to test the students. In some sense this process can be compared with the multimedia and level content creation that occurs during the development process of a videogame.

On the other hand, authors must also specify links between the instructional units, providing the next learning object to be presented to the student for each available response in the source canned questions. These links constitute the system reaction to the user actions, and can be, in a loose way, compared with the gameplay or dynamic content creation in a video-game.

In the Plato system, the learning content was written using the Tutor language (Sherwood,

1974) that provided a small amount of alternatives for interactivity and output to the user. Today, due to the relatively simple model, a lot of tools can be used for building them, including general application such as Power Point or Open Office Impress, and specific programs as Macromedia AuthorWare², Tool Book³ or MALTED (Multimedia Authoring for Language Tutors and Educational Development⁴).

Today, this kind of educational software has evolved towards web-based platforms, where hypertext and related technologies are prominent. In this context, learning objects are mapped into web pages, and edges in the content graph are built with links or anchors. The big advantage of this evolution is found on all the existing tools for building hypertext content. The Web also provides a wide range of possibilities with multimedia, acting as a good content representation standard. Also, on-line technologies open the door for distance learning and other collaborative tools, such as forums, wikis or news.

The main strength of this approach for building educational software (using or not using web technologies) is its simplicity. Authors easily understand the underlying model and can start generating content nearly at once. Today, in the Web-based systems area, the existence of SCORM (Advanced Distributed Learning (ADL), 2004), an accepted standard to represent content, allows the independence between the course itself and the software that supports it (known as a Learning Management System). This also promotes sharing

content and avoids maintenance nightmares if the supporting tools become unavailable. On the other hand, due to the generality of the representation, nearly all kinds of domains can be represented, in the same way that books can be written for a wide range of subjects.

Unfortunately, its simplicity is also the main weakness of this model. Domain knowledge representation is poor, consisting on just “canned” multimedia content adapted for presentation to the users but preventing sophisticated automatic computer manipulation. Available interaction is also very simple: students learn reading and thinking more than putting into practice the taught concepts. This makes them suitable for episodic, conceptual or declarative types of knowledge but inappropriate for procedural or problem solving skills (Murray, 1999).

The main reason for this fact is the hard manual work of building all the alternatives and available responses that the system could have to provide. In procedural domains, multiple choice or similar kind of questions are not enough, and the number of alternatives in each step is higher, causing an authoring combinatorial explosion impossible to afford, specially if we want the system to provide specific explanations for each common error.

As an example, Figure 2 shown a small exercise in the Tutor language used in Plato (“TUTOR User’s Memo. Introduction to TUTOR”, 1973). The content author must explicitly add errors and explanations that could be inferred by the system.

Figure.2..TUTOR.code.example

```
unit math
at 205                                ; At the (2, 5) screen position...
write Answer this problem:           ; write this text...
  4 x 3 =
arrow 413                             ; Put the cursor in (4, 13) and wait
answer 12                             ; for the valid response (12).
wrong 7                              ; But if students writes 7,
at 620                                ; at the (6, 20) screen position
write Multiply, do not add            ; write this explanation and repeat.
```

Some improvements to this basic model have been proposed to overcome these difficulties, such as the so called “generative CAI”. Unfortunately, the intrinsic idea does not change, and the system continues codifying decisions about how to teach (Wenger, 1987). The content creators must foresee all the possible student reactions and decide how the system should react. Special care must also be taken to guarantee the coherence between the different canned texts in all the possible student routes through the learning objects.

In an attempt to lighten this manual work, in 1970 Carbonell proposed the idea of using Artificial Intelligence techniques for representing the instructional content (Carbonell, 1970). Instead of pre-creating all the possible paths and texts, the system integrates ways to deduce how the student is performing with her responses and automatically infers the best way to guide the next learning episode. This new kind of system was initially called Intelligent Computer Assisted Instruction, but was later renamed to Intelligent Tutoring Systems (Sleeman & Brown, 1982).

Using more sophisticated content representations allows us to provide the system with general knowledge that would be materialized in real-time, instead of pre-made decisions, and thus bypasses the mentioned combinatorial explosion. In some sense, the raw content becomes a content model. This opens the door to more complex domains that were previously unaffordable. Not only can explanations be automatically created using natural language generation techniques, but also user interactions can be richer because content authors are not forced to specify in advance all the possible users responses. Instead of providing four or five manageable answers in multi choice questions, more open responses can be received and analysed, and the system will deduce the underlying user misconceptions or skills.

Using our previous Plato example, instead of blindly comparing the student response against the answer and wrong command parameters, the system would analyse the response and, using the

domain model, determine the deep causes in order to provide an explanation. This will avoid content authors having to specify the more common errors (such as add instead of multiply, or fail while carrying) throughout every exercise.

Although these ideas could have been used to create educational software similar to those programs built with more classic approaches, researchers were willing to go into more complex domains. This opportunity was therefore seized to afford systems that follow the learning by doing way of teaching, where students spend more of the time solving exercises in an environment with richer interaction. Instead of just visiting learning objects and following links, the system has to decide the next exercise and infer how the student is solving it, providing, ideally, some help when misconceptions are detected.

Early systems consisted of device simulation and equipment training, where the system modelled some kind of apparatus and understood the underlying model (Hollan, Hutchins, & Weitzman, 1984, Kler & Brown, 1984, White, & Frederiksen, 1990). Students had to recognise the different components and identify failing parts, proposing ways to repair them. Using its model, the system not only recreates the device, but also infers the reasons that caused the student actions. Authoring tasks consist of programming the quantitative device simulation and also creating the qualitative simulation with causative or cognitive models that explicitly stores the cause-effect knowledge used in the inference process.

Other domains have similar requirements (Gertner & VanLehn, 2000). In order to avoid content creators having to specify each possible error for an exercise, the system must not only know the valid response but also the more likely human mistakes and their causes. This knowledge has to be suitable for some kind of inference engine that can be fed with the student proposed solution and can provide a value judgement and help when needed.

In addition to the knowledge about exercise resolution and solution comparisons, these systems also need the ability to propose the exercises themselves. This can be accomplished using a hand-made exercise base, created by the content authors in a similar way to the level designers in the videogame area. Another option mimics the procedural content creation, where the system builds exercises “on the fly” depending on the student needs. This second alternative requires a more complex domain model in order to give the system the ability not only to solve, but to invent coherent and valid exercises.

Both aspects (exercise creation and correction) constitute the domain knowledge. Other types of knowledge should also be authored, in order to let the system choose the next exercise to practise (pedagogical knowledge) depending on the student (user model), and to explain and show the correct solutions in an appropriate way (interface knowledge).

Unfortunately, all this material is too dependent on the taught domain and the underlying representational techniques. This makes it very difficult to build universal tools for ITS creation such as those existing for the simpler frame-based applications described earlier. Nevertheless, luckily the ITS field is based on Artificial Intelligence, and has imported its representational techniques and tools. This allows the use of inference engines and creation tools, which should be carefully chosen depending on the concrete domain, requisites and available funds.

Summarising the more important aspects, the fusion of all these kind of knowledge (or content) available in a tutoring system achieves two objectives:

- Provide an environment where the student solves the proposed exercises. These tasks would have more complex scenarios as the user becomes proficient in the domain.
- React to the user actions in two ways. At a micro-level, the system must be able to pro-

vide feedback during the learning episode, while the student is solving an exercise. At a macro-level, the next exercise must be chosen depending on the supposed user knowledge.

Content Integration

Games-based learning systems use videogames (usually in the form of real-time virtual environments) to present educational content. There are many different approaches to integrate this content within the videogame. The easiest one is extrinsic integration that does not allow the user to go on playing the game until he has not successfully answered a question (Kafai, 2001).

More complex scenarios try to smoothly integrate educational content within the game entities. In these cases, explanations, exercises and feedback are part of the very root of a videogame: its design. In a learning-by-doing approach, the general idea is for the virtual environment to present a simulation or metaphorical representation of a real environment where the student practises the concepts he is supposed to learn. The key part of the educational content is not the explanation associated with the concepts but the exercise itself.

Therefore, the concept game level joins with the concept exercise to become a virtual environment where the user may play in order to resolve the task at hand. The environment reacts to the user actions to incorporate explanations and feedback. In this sense, level and exercise generation blur as do the environment response and domain knowledge.

When creating one of these systems, designers and developers run into the difficulties of both areas, videogames and educational applications. From the programmer point of view, they must deal on the one hand with the issues of a real-time virtual environment and on the other hand with the management of exercises, student profile

and feedback. However, the main problem when combining both areas lies in design and content creation.

Regarding content creation we have to combine the knowledge of the domain expert and the level designer to generate the virtual environments that present the exercises. With this approach, the game level itself becomes the exercise and the development team must create a virtual environment per exercise. There are several examples of systems using this scheme, such as Sim Ops Studios⁵, which develops an educational application to train fire-fighters. The application is distributed together with an editor, Core3D, that allows educators to create new scenarios/problems or customise preexisting ones. Users create the virtual environment, placing for example 3D buildings, vehicles, fires and people. The composition of the environment and the properties of the entities define which concepts or procedures the instructor wants to teach.

With this kind of content integration, the independent tasks that we had in pure videogames and pure educational applications (construction of virtual environments and creation of exercises) become a unique task performed by the editor. We have three different ways to do this:

- Force level designers to learn the domain at hand: this approach is in fact used in videogame creation though in a simpler manner. For example, when developing a game based on the Second World War it is common that level designers familiarise themselves with the historical events that took place and may be relevant to the game script (Crawford, 1984). However, usually the domain being taught is too complex to make this approach unfeasible.
- Simplify the editors and tools used for designing the virtual environments and have the domain expert use them: this alternative has also been used in the ITS field but to a different degree. ITS authors need some skill in several areas in addition to expertise in

the subject, such as some level of programming, instructional and graphics design (Murray, 1999). However, although these are not trivial issues, they are much easier than the use of one editor like that shown in Figure 1. Additionally, the domain expert may not be willing to learn how to use such a specific tool far from his area of expertise.

- Have both experts working together on the level editor: this approach would be ideal but, as with the previous one, it is difficult to convince domain experts to work with a tool that has nothing to do with the domain itself. In order to alleviate this problem, the creation may be made in cycles, where the domain expert writes down a specification of the exercise that the level designer tries to express in a game map. After that, the domain experts inspect the result and give some feedback in order to get the virtual environment fit the exercise (Johnson, 2007).

Therefore, all these options are far from ideal. However this is not the only drawback to the approach of having the virtual environment and exercises integrated in just one kind of content. Another one is the cost. Creating a virtual environment per exercise is expensive because it requires placing different entities with the concrete properties that make them behave in the correct way according to the exercise. Somehow the creator of the level is translating an exercise expressed in the language of the domain into a virtual environment that is encoded using the videogame language.

Future Directions: Separation of Concerns in Content Creation

A better scheme is to separate the definition of the exercises from the definition of the actual

level or map where the player executes it. With this approach:

- An exercise defines a situation that has to be executed in the environment, giving an initial state and possible end states along with particular events that should occur and what to do if certain events are identified.
- A map may be used to execute different situations.
- A situation can be represented in a different way depending on the map it is being executed on.

The final aspects of the virtual environment depend on the concrete exercise the user is confronted with. When the pedagogical module selects the next exercise, it also finds out which of the available levels is suitable for the problem, loads it and configures it based on the specific characteristics of the problem.

A simple example of this idea is a driving tutor where the student always drives through the same streets but different events occur depending on the exercise. The exercise would be described by the number of traffic lights, density of pedestrians, if there is heavy traffic, trams, and so on. With this description, the application searches for a virtual environment that fits its needs, for example, if it contains trams. The virtual environment may be seen as a template with hooks that can be replaced by entities that represent objects from the exercise (such as pedestrians or traffic lights).

With this solution we have two main benefits:

- To minimise dependencies between people involved in the creation process, especially between the domain expert and the game designer.
- To minimise dependencies between domain specific knowledge and the rest of the system, so that:

- The same knowledge may be used with different presentation strategies. Given that identifying a successful game play is a crucial point for every games-based application, it is important to minimise the cost of experimenting with different alternatives.
- The same presentation can be used to teach different contents, also reducing development cost by defining different exercises to be defined on the same map.

Another advantage is the reduction of cost in the creation of the videogame. Due to the clear separation between exercises and levels or maps, the quantity of work required by the level designers is significantly reduced because one map may be reused in more than one exercise. This is possible because the procedural configuration of levels depends on the current exercise.

Some initial results along these lines have been recently reported trying to alleviate the authoring effort of narrative content by non-experts. Within the related area of interactive virtual storytelling Si *et.al.* (2007) describe Thespian, an authoring and simulating framework for interactive dramas. In Thespian, each virtual character is controlled by a decision-theoretic goal driven agent, and authors configure virtual characters' goals through specifying story paths. The authoring approach works by simulating potential users' behaviors, generating corresponding story paths, filtering the generated paths to identify those that seem problematic and prompting the author to verify virtual characters' behaviors in them. Thus enabling interactive testing and refinement of an interactive drama.

Within the area of serious game design authoring Nelson & Mateas (2008) intend to let game-design novices to use game-like expression as a way to express content such as opinions and educational material. They propose a game-design assistant that acts in a mixed-initiative fashion,

helping the author understand the content of a design-in-progress, providing suggestions or automating the process where possible, and even offering the possibility for parts of the game to be dynamically generated at runtime in response to player interaction.

Regarding authoring in virtual environments for training Gerbaud *et.al.* (2008) propose an authoring platform to facilitate the development of both new virtual environments and pedagogical information for procedural training. This platform relies on a generic model used to describe reusable behaviors for 3D objects and reusable interactions between those objects, and a scenario language which allows non computer scientists to author various and complex sequences of tasks in a virtual scene.

Unfortunately, procedural configuration is not cost-free. On the one hand, maps and levels must be created to allow reuse and, as in many other areas like software, creating a product with reusability in mind increase its price (Adolph, 1999). On the other hand, creating the routines that allow the configuration of the environment based on the exercise properties requires more effort from developers. The increase of the final price will be worthwhile when the number of exercises exceeds a given threshold.

In conclusion, software architects and designers must find designs that ease the work of the developers, making it possible to reduce the cost of creating systems that are able to configure the virtual environment according to the exercise. We envisage that the use of component-based architectures (West, 2006) will definitely contribute towards this.

REFERENCES

- Adolph, S. (1999). *Whatever happened to reuse?* Software Development Magazine.
- Advanced Distributed Learning (ADL) (Ed.). (2004). *Sharable.content.object.reference.model. (SCORM).2004*, 2nd edition, overview. ADL Co-Laboratory.
- Cappel, S., Green, S., Curless, B., Duchamp, T., & Popović, Z. (2002). *Interactive.Skeleton-Driven. Dynamic.Deformations*. SIGGRAPH.
- Carbonell, J. R. (1970). AI in CAI: An Artificial-Intelligence approach to Computer-Assisted Instruction. *IEEE.Transactions.on.Man-Machine. Systems*,.11(4), 190–202.
- Crawford, C. (1984). *The.art.of.computer.game. design*. McGraw-Hill.
- Gerbaud, S., Mollet, N., Ganier, F., Arnaldi, B., & Tisseau, J. (2008). GVT: A platform to create virtual environments for procedural training. *In. Procs..VR.2008*, (pp. 225-232).
- Gertner, A. S., & VanLehn, K. (2000). Andes: A coached problem solving environment for physics. *Proceedings.of.the.5th.International.Conference. on.Intelligent.Tutoring.Systems*, 1839 of Lecture Notes in Computer Science, (pp. 133-142).
- Gillen, K. (2005). *The first generation of the next. generation.: A. Project. Gotham. Racing. 3. postmortem*. Gamasutra: http://www.gamasutra.com/features/20050906/jenkins_01.shtml. Last viewed August 2008.
- Hollan, J. D., Hutchins, E. L., & Weitzman, L. (1984). STEAMER: An Interactive Inspectable Simulation-Based Training System. *AIMagazine*,. 2, 15-27.
- Johnson, W. L. (2007). Serious use of a serious game for language learning. *In Procs. Artificial Intelligence.in.Education,.,AIED'07*.
- Kafai, Y. B. (2001). The educational potential of electronic games: From games-to-teach to games-to-learn. *In. Playing. by. the. rules.: The. cultural.policy.challenges.of.video.games*. Chicago, EEUU.

- Kleer, J. de, & Brown, J. S. (1984). A physics based on confluences. *Artificial Intelligence*, 24, 7-83.
- Martel, E. (2006). An Analysis of Far Cry Instincts' Anchor System. In S. Ravin (Ed.), *AI Game Programming Wisdom III*. (pp. 555-566) Charles River Media.
- Murray, T. (1999). Authoring intelligent tutoring systems: An analysis of the state of art. *International Journal of Artificial Intelligence in Education*, 10, 98-129.
- Nelson, M. J., & Mateas, M. (2008). An interactive game-design assistant. In *Procs. Intelligent User Interfaces 2008*, (pp. 90-98).
- Rhine V IV, T., & Barry, J. (2006). *Method for dynamic content generation in a role-playing game*. United States Patent 20060148545.
- Sherwood, B. A. (1974). *The TUTOR language. [Computer software manual]*. PLATO Publications, Computer-based Education Research Lab.
- Si, M., Marsella, S., & Pynadath, D. V. (2007). Proactive Authoring for Interactive Drama: An Author's Assistant. In *Procs. IVA. 2007*, (pp. 225-237).
- Sleeman, D. H., & Brown, J. S. (1982). *Intelligent Tutoring Systems*. Academic Press, London.
- Skinner, B. F. (1958). Teaching machines. *Science*, 128, 969-977.
- TUTOR user's memo (1973). *Introduction to TUTOR*. [Computer software manual].
- Wenger, E. (1987). *Artificial intelligence and tutoring systems: computational and cognitive approaches to the communication of knowledge*. Morgan Kaufmann Publishers Inc.
- West, M. (2006, March). Evolve your hierarchy. *Game Developer*, 13(3), 51-54.
- White, B. Y., & Frederiksen, J. R. (1990) Causal model progressions as a foundation for intelligent learning environments. *Artificial Intelligence*, 42(1), 99-157.

ENDNOTES

- ¹ <http://www.theprodukt.com/>
- ² <http://www.macromedia.com/software/authorware/>
- ³ <http://www.toolbox.com/>
- ⁴ <http://www.malted.com/>
- ⁵ <http://www.simopsstudios.com>

Chapter VI

Drawing Circles in the Sand: Integrating Content into Serious Games

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ABSTRACT

One of the most important differentiators between Commercial Games and Serious Games is content; delivered in a way that is successfully integrated with engaging game play and achieves the desired learning outcomes by delivering skills and knowledge effectively to the end-user. This ability to integrate content effectively is the key to producing “killer” Serious Games that deliver demonstrable learning outcomes, business benefits and overall value. However, achieving this nirvana is not a trivial task. Utilising lessons learned and case studies, this chapter provides an overview of why this process can be so challenging, including the differing experiences from the perspective of three stakeholders (game designer, instructional designer/learning psychologist and subject matter expert), how to manage preconceptions and balance their priorities. The case studies will also show how different methodologies, techniques and technology have been applied to help solve this fundamental challenge of delivering a successful serious game. Advice is provided on how to facilitate this process, capture the correct requirements and create a design that meets and exceeds the expectations of all the stakeholders involved, including the client/customer and the end user.

INTRODUCTION

Much interactive material and training has, in the past, consisted of ‘click to turn the page’ applications, where the technology was merely

used as a delivery tool for the content. Recently we are seeing more focus on other more interactive applications for the technology, moving from a delivery platform to products with actual educational significance. The technology can be

used to engage learners and provide experiential opportunities which learners may not have had before. As Kurt Squire explains... “For educators designing games, this shifts the question from one of delivering content to one of designing experience” (Squire, 2006, p20). Serious games are considered to be the new interpretation of what e-learning can offer, but with the benefits of engaging story lines, player rewards and goals, and true interaction.

Serious games also offer instruction beyond traditional means of skill and drill, multiple choice questionnaires and text with fancy graphics; however, the skill sets required to develop them are often out of reach of many instructional designers and subject matter experts. Therefore a partnership is required, forged by the passion of creating something exciting: a learning program that people actually want to complete and come back to again and again in order to practice and improve.

Unfortunately it is not as easy as finding a games designer, subject matter expert and an instructional designer and locking them in a room together, expecting a game design within the week. Communicating with someone that speaks a different language can be very difficult and shouting or speaking slowly is not the answer! The serious games industry is no different. Game designers and instructional designers often speak very different languages and have very different requirements.

Now drawing circles in the sand is a slight exaggeration, but communication between each of the parties involved in serious games design is one of the major challenges faced by the industry going forward; however, it is one that can be solved. Using real examples in the form of case studies, this chapter aims to translate practical experience into lessons learned for the industry when designing and developing serious games with diverse subject content.

So why is it so hard? There is also a misconception by many new to the industry that serious

games will be successful because they use games technology (Gee, 2005). Simply by forcing content into games technology will not produce an effective learning environment. Commercial off the shelf (COTS) games may act as the motivational wrapper, but there is a lot more to achieving real, tangible learning outcomes than that.

Many claims have been made in the past two decades that link real life behaviours to the influence of video games, and often in a negative light. A popular culture reference to the impact video games can have, came from the movie ‘Snakes on a Plane’ which depicted a character able to pilot and land a plane safely due to his skills learned from Microsoft’s Flight Simulator game. This is the ideal, but rather unrealistic goal of serious games.

It could be asked, why a training course could not just be taken to create a simulation or a game that uses all the learning outcomes? The answer is that most learning is seen in black and white and is extremely linear. This is the course, this is the content, and this is what you will learn. Most training material is created focusing on the ‘What’ and not the ‘How’ and this is one of the contributing factors to high drop-out and low retention rates of traditional training and e-learning. In most cases, learning outcomes are only achieved through facilitation and one to one interaction with a skilled teacher or trainer; however, this is often an inefficient, costly and lengthy process, particularly for large numbers of learners. Serious games are more flexible in the way you can interact with them. You can choose whether to follow the story line or explore the environment, sometimes you are able to choose which missions you tackle and you can experiment with how you choose to play. The learner takes a far more active role with a game than in other, more passive forms of learning. Quinn (2005) concludes this nicely: ‘We are not, cannot be, about designing content. A fundamental perspective I want you to take away is that we are designing experiences. If nothing else, start

thinking not about creating content but about designing learner environments and architecting experiences.’

Serious games must also work in the domain of learning theory. ‘The use of instructional theories has been shown to enhance learning, increase motivation and student achievement’ (Gunter, Kenny, Vick, 2006). Gunter, Kenny and Vick aimed to create a unique design rubric specifically conceived for serious games by analysing instructional methodologies and comparing them against current game design ‘best practices’. They conclude instructional strategies must be applied concurrently to the content development in game design, and therefore students would quickly adapt to the process of learning and actually enjoy the conditions under which they learned the concepts. Piaget (1970), and Vygotsky (1978), both leading names in learning psychology, shared the commonality of an interest in the active role a learner must play in the learning process, and Vygotsky (1978) placed an emphasis on the interpersonal aspects of learning, including collaborative group work, where he demonstrated students achieved higher intellectual levels when working in a group, compared to working on their own.

Gagne (1977) highlighted nine “events of instruction” that contributed and facilitated an individual’s learning, each of which can easily be applied within a serious games environment.

They were:

- Gain attention; where the learner’s attention is initially grasped by an exciting story line or animation, for example.
- Set out clear learning outcomes; give the learner a set of instructions or goals that they are aiming to achieve.
- Stimulate recall of prior learning; where the individual has to use prior knowledge to aid them in the current situation.
- Present the content.
- Provide guidance to help the individual; this could take the form of step-by-step instructions, for example.

- Elicit performance; this is achieved through practice and completing tasks.
- Provide feedback; this allows the individual to understand areas that need improvement, and also gives them positive, motivating feedback on areas where the individual excel, or are improving.
- Assess performance; which typically occurs through a post-test evaluation, or debriefing session.
- Enhance retention and transfer; allowing the learner to generalise the information they have learnt and apply it to other situations.

Keller (1987) developed the ARCS model of motivational design as an alternative to Gagne’s events of instruction. Keller proposed four steps, instead of nine, that could be put in place to promote and maintain learning; attention, relevance, confidence and satisfaction. For Keller attention involved both perceptual and inquiry arousal, where inquiry arousal relates to providing questions and problems for the individual, as well as varying the content presented. Relevance referred to achieving goals and matching motives (where the learning style of the user and the users interests are matched as closely as possible), whereas confidence was associated with the learners’ perceived self-control and opportunities for success. Satisfaction looked more at the extrinsic rewards (external rewards) and intrinsic reinforcements (internal reinforcements) an individual could gain from the task. Attention, relevance and confidence all have a dependence on the content.

Understanding Content

To understand how to integrate content, one needs to understand what the content is. Gee (2004) refers to this as ‘a central paradox of all deep learning’. Gee analyses the two sides of the coin by arguing that it will not work to throw the learner into the deep-end due to a lack of knowledge to leverage

the environment effectively and that the domain of knowledge needs to be built up over time and is a complex process that will be beyond a novice. This paradox is a concern to both instructors and advocates of immersion. The key as Gee explains is to use “post-progressive” pedagogies that combine immersion with well-designed instruction; and one area that is exceeding in this mix is the use of Video Games and Simulations.

Just in Time content delivery is easily exploitable within games. Shaffer, Squire, Halverson, & Gee (2005) have created an emerging model of games and propose that they excel by providing learners with situated experiences of activities, whereby they develop new ways of thinking, knowing, and being in ‘Worlds’.

It is understood that content is central to a serious game, but what exactly counts as content? Aldrich (2004) describes 3 categories of content: Linear, Cyclical and Open-ended content. Each category requires a different approach.

Linear content, that of movies, books or television is most familiar to us. It is a recipe that works for entertainment. Most training is also linear: lectures, PowerPoint presentations and most e-learning. Linear content allows most online courses to easily be stored in a Learning Management System (LMS). LMS’s are very often used in large organisations; however they vary immensely from one another. The LMS is the interface between the learning content and the learner, and is the place where the learner’s records of achievement are kept. Serious games have no standard methodology for LMS integration and therefore it is a choice to be made by both the developer and customer or client on how important this issue is. What is certain however is that in order for more flexible, non-linear user-centred content to become the norm, LMS structures must be reconsidered to be relevant in the Web 2.0 world (Derryberry, 2007).

Cyclical content is the same action performed repeatedly, whilst the action or method is perfected. Aldrich defines cyclical content as the

‘DNA of video games’ (p26). For example, a user spends hours perfecting micro movements in order to shave a few seconds off the time left by taking a corner more smoothly.

Open-ended content refers to content where there is no right or wrong answer, and two experiences are rarely the same. Second Life or The Sims are good examples of open-ended content in games.

Each content category is valid in its own right, and can be used independently; however Aldrich argues that for any educational game all 3 should be combined, liberally. The authors would argue that there is a 4th category of content that is well used in games and simulations, which is non-linear, branching content that sits somewhere in the middle between traditional linear content and completely open-ended content. At the end of the day these categories sit on a continuum, rather than as discrete classifications.

Malone (1981) defines two alternative categories of content in games: Intrinsic and Extrinsic. The example mentioned above where the movie character was able to land a plane from playing a simulation in his spare time, is an example of intrinsic content, which is integral to the structure of the game. Achieving success in the game is equal to learning to fly the plane. Extrinsic content, Malone’s second classification, is less tightly linked to the game play, where there is a structure which has flexible content, such as quiz shows and question/answer-based role-playing and adventure games. Again, these categories are not an either/or but a continuum of possible options that compliment different content styles.

Training and e-learning generally use Linear Extrinsic content, whereas games can use a mixture of all the categories defined above. The challenge is combining each category effectively with the existing subject matter to produce an effective serious game. Early choices made in the development cycle will impact the effectiveness of the content and the effectiveness of the game as a learning tool. If the wrong game genre is

chosen for the wrong content, it is likely that a poor learning tool will be produced.

Synergistic Alignment of Game and Content

We know what content is and we know that certain types of game suit particular content types. So what are the rules? Prensky (2001) argues that there is no one way for developing applications and that serious games must be created on a case by case basis. In his description of game-based learning, he calls out principles of instructional design, domain or subject knowledge and game design. However, as mentioned previously the likelihood of success from locking these skill sets in a room together, no matter how long for is minimal. This is a view that is expressed by many serious games experts. One thing is true, however, in that the content must be intertwined with the subject matter within the game and usually with some kind of emotive context. Separated game play from content is merely the carrot on the stick; the reward completely independent of any learning and is not what the authors would consider a serious game.

The balance of content with affective components within serious games is a delicate one and in order for the application to be effective, the right balance must be achieved. Appelman & Goldsworthy (1999) argue that to create the most effective learning environment, the designer must balance the content density against the level of understanding of the content by the user, and continuously adapt this balance throughout the game experience. For example, as the learner's familiarity with the content increases, the presentation can become more abstract and the level of fun or 'affective experiences' required can be reduced. This inverse relationship highlights the reason why simply integrating content into games technology will not work: too much instruction will 'suck the fun' out of the game, but too much fun,

particularly in an abstract or context-less game environment, can make the learning harder to contextualize without extensive reflection or a skilled facilitator.

Methodologies in Practice

In their study to create a new instructional design paradigm, Kürşat and Kaplan (2006) concluded that instructional design requires teamwork consisting of very diverse skills including, field knowledge, proficiency in technology, strategic, holistic and especially creative thinking abilities, project management skills, leadership qualifications, communication skills, responsibility, honesty, empathy, professionalism. High-level programming knowledge and advanced coding skills were also required, although these are highly specialised skills that are often sought from experienced computer scientists and game developers. They also concluded that the quality and qualifications of the team members affect the quality of the instructional system produced.

They emphasised flexibility and a holistic approach to instructional design, where a modular approach would be ideal. At the centre of their ideal instructional design methodology is prototyping and evaluation. They defined their own model for instructional design for game based learning entitled the FIDGE Model which stands for "Fuzzified Instructional Design Development of Game-like Environments" for learning. Within FIDGE there is a dominant focus around context, both in regards to the situation in which the instruction takes place, and the socio-cultural needs of the organisation.

Most serious games companies, such as TPLD, have no, or very limited, credible direct subject knowledge in many domains. Although when moving into a new area we try to immerse ourselves in the subject matter and content, we do not try to learn everything or become experts in a condensed timeframe for a particular project

or product development; rather, we look to engage with appropriate and credible subject matter experts, who become integral to the project.

Here are the key participants typically involved in a successful Serious Game design process at TPLD:

- **Game designers:** Responsible for recommending the most appropriate game genre and game rules/mechanics for achieving the desired learning outcomes, creating any storylines and defining any characters required, as well as designing levels and helping to define the artistic style (although this is often done in collaboration with an experienced artist).
- **Instructional designers/learning psychologists:** Responsible for validating whether the learning outcomes will be achieved by the proposed game design during all stages of development, typically including a number of evaluation studies with target end users (ideally throughout the entire development cycle, through the use of iterative development methodologies, such as Agile), often working in collaboration with the game designer on the pedagogical aspects of the design, as well as ensuring that good learning practices are being adhered to. TPLD utilise a number of serious games essentials to ensure sound pedagogical design. (Routledge and Seeney, 2003)
- **Subject matter experts:** Responsible for defining the desired learning outcomes and the necessary subject content required to deliver these outcomes, often in the form of processes, decision trees, standard templates/exhibits as well as more traditional text-based content or character dialogue, depending on the game genre and content delivery mechanism

We also work hard to ensure that throughout the process the whole development team assigned

to a project is involved to some level with the design, whether in conceptual brainstorming or reviewing a final idea. This ensures that as the application is developed, the team are aware of what they are creating and why, which helps give them a sense of ownership. It also makes it easier for them to know intrinsically what to build, as not everything can always be defined or effectively communicated up front.

In software terms we have moved to AGILE development over the last year and this too encourages involving the whole team with continual reviews and refactoring through iteration. Taking this one step further, with much of our more recent work we try to create opportunities for our developers to see the game actually being used by the target audience, as without this it is often difficult for them to step away from the ‘gamer’ perspective and move to that of, for example, a 45 year old executive or a 14 year old high school student.

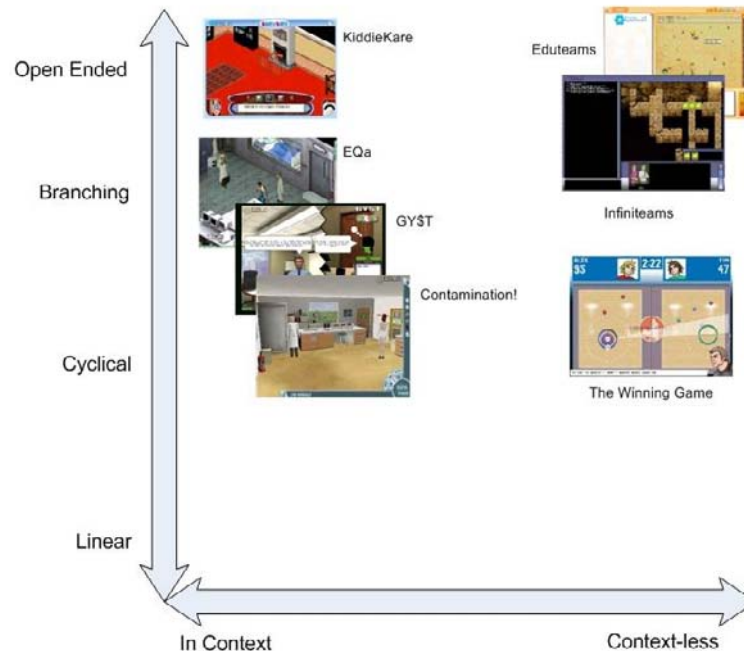
Case Studies

Using a number of case studies and examples, the authors now aim to share their first-hand knowledge and experience to better inform those working on serious games, either at present or in the future. These case studies range from games where the content and the game play are completely seamless, to more context-based simulations where the content and game are less tightly integrated.

eQA

eQA, which stands for Electronic Quality Assurance, was created as a bespoke project for a molecular diagnostics company in the UK. The client came to TPLD with a fairly well-defined design and script, and we were given the task of embedding this content within an immersive 3D environment, primarily in the form of dialogue

Figure 1. Case study classification



interaction between a player avatar and multiple non-player characters (NPCs).

After an initial review of the design, we encouraged the client to consider adding some further elements to the game to provide more engagement for the target users, who were primarily University students. These included a laboratory management aspect, where users must purchase and install lab equipment, after which required diagnostic tests can be performed and some kind of feedback is given to indicate whether the dialogue, tests and other decisions within the scenario are going down the correct or incorrect path. The proposed feedback mechanism consisted of a sick patient in an adjoining room, who was visible through a large window. The patient would gradually become worse or get better depending on the player's choices. In reality this situation would never occur, and the patient would most likely be quarantined in an isolated hospital ward many miles away from the laboratory; however, this instant feedback mechanism provided some much-needed emotional engagement for the player, who

(we hoped) would become genuinely concerned about the well-being of the patient.

The scenario consisted of 4 NPCs for the player to interact with, not always present at any point in time. The script we were given for these characters was initially very dry and technical and didn't enable the player to form any emotional or memorable attachment to the characters. Therefore, another proposed change was to give each character extreme personalities, occasionally going as far as major personality disorders. For example, a megalomaniac boss intent on taking over the world and a paranoid lab technician, who was convinced that everyone was out to get him! This led to some humorous dialogue exchanges that we felt enhanced the game significantly and provided the engagement that was previously lacking.

Unfortunately these dialogue changes were a step too far for the client and many of them were removed late in the project; however, some of the character quirks remained and this did enhance the learning experience. Overall we think it would

be fair to say that this game does not represent our most successful attempt to integrate content into the game play in a seamless way. However, because the game was primarily dialogue-based, with scripted NPC movement and basic interaction with objects, it was relatively simple to create a game editor to allow some of these aspects to be easily customised, and even author entirely new scenarios using the existing game's art assets.

GY\$T

GY\$T, which stands for Get Your Sales Together!, is another example of a primarily dialogue driven game targeted at sales training and development; particularly in a Business-to-Business context. This game was a joint product development with an American-based creative learning company and a leading subject matter expert (SME) in the field of sales training.

Although the subject matter expert had authored a best-selling book and the creative learning company had run many sales training workshops, there was actually very little content present at the start of the design process. Therefore, we held a series of workshops to step through a typical sales engagement process and to identify the desired learning outcomes from the game, as well as listing a number of common “traps” that sales people fall into, which often lead to an unsuccessful conclusion or lost opportunity. This led to a well-defined process consisting of a number of steps to close a sale, including “doing your homework”, “getting in” and “closing the deal” as well as mapping out a decision making process within the target customer's organisational structure.

From a content perspective, this naturally led us to the conclusion that a branching scenario, which consisted of a combination of research and dialogue interaction with the target customer, was the best way to go. Early in the project we decided that because of the importance of getting the language right (including the appropriate level of “Americanisation”), as well as being able to

successfully embed many of the messages from the SME's book, the majority of the content would be authored by the SME directly, using specific tools and templates for the project.

Due to the globally dispersed nature of the team, this led to a clearly defined separation between the game play development and the content creation, with minimal levels of understanding about each other's respective disciplines, despite a number of face to face meetings to try to get things back on track when they started going awry. An experienced game developer was brought in by the content authors to help mitigate this issue, but due to differing ideas and priorities, this solution caused as many problems as it solved from a content perspective (although this individual made a significant contribution to the technical design of the game).

The game was created as a template or shell for the subject matter content and some excellent graphical authoring tools were created for the SME to define scenarios and dialogue with NPC's. A demo scenario with dialogue content designed specifically to show off all aspects of the game's functionality was also created, which included a number of powerful concepts that moved it well beyond the typical multi-guess dialogue systems found in most e-learning simulations and dialogue-based games. A number of guides and tutorials were also created for the SME to learn how to use the tools to create the content they desired.

Unfortunately, the content that was created during the lifetime of the project was generally poor and made very little use of the powerful features provided by the game framework. Although the dialogue was professional and reasonably engaging, many opportunities were missed due to the SME's lack of experience with basic game design principles, such as having an appropriate difficulty curve and introducing new features and complexity slowly over time. A good example was in the up-front research phase that required the user to do background research on

the target customer in the game. This was supposed to consist of some basic information to get the user started in the objective of understanding the customer's needs in order to create an initial communication that included a value proposition to get the company's attention. What actually happened was that over 40 documents needed to be reviewed by the player before they could extract this basic information and move forward in the scenario. Engaging and captivating the audience, within the first 5 minutes, this certainly was not! Unfortunately the end result became yet another not entirely successful attempt to seamlessly integrate gameplay and content.

Our experience with this project and others has led us to seriously question and doubt the approach of getting a subject matter expert with no knowledge of game design principles and best practice to directly author game content without any consultation and collaboration with a suitable intermediary, such as an experienced designer of serious games. However, over the last couple of years we have seen an increasing trend towards this model for content development, particularly with the advent of web 2.0 and its user-generated content model. From our perspective, the only place we believe this approach may work is with younger, game-savvy SMEs (or even school pupils and University students) who can effectively balance the game play and content. With tools requiring little of no technical expertise, we believe that powerful and engaging learning experiences can be created. Designing a serious game also requires a developer to become completely immersed in the relevant subject matter, even when an SME is involved, which in itself is a very effective learning process (many of TPLD's developers are now experts in molecular diagnostics for example!). This is the reason why this type of high-level authoring and customisation tool remains core to TPLD's company strategy in relation to content development.

After two examples where the content has not been particularly well integrated with the

game play we will now go through another four examples where this integration is almost entirely seamless, with the content being delivered directly through the game play as opposed to via dialogue or direct simulation.

Contamination!

This project originated from the same molecular diagnostics company who commissioned the eQA project. Due to their previous experience working with us on the eQA project, they had been approached by a government organisation to create an immersive 3D simulation for teaching quality control processes in laboratories in conjunction with a tutorial book. Traditionally this has been a difficult area to teach, due to the high cost of getting access to laboratory equipment and the consumables required to perform and practice particular tests. Therefore, a 3D simulation that accurately modeled the process and outcomes of these tests was a logical solution.

The initial content consisted of a fairly detailed walkthrough of the desired scenario and a decision tree to show the different points in the process where things could go wrong. Like any simulation, one of the initial questions was whether the game would encourage or force the player to correct a mistake or wait until later in the scenario to see the actual impact of the mistake. We strongly encouraged the latter approach, along with some supporting information to show the player what they had done wrong in order to help them improve next time.

Our initial reaction to the content was that it provided a very useful starting point for the game design, but like the previous eQA project, it was fairly dull, dry and technical, which was not appropriate for the intended student audience. Therefore, we suggested adding an engaging back-story to provide some emotional context to the player. Given the nature of the content and desired learning outcomes we suggested setting the game in a fictional town where there has been

an outbreak of a disease and the player needs to identify the source of contamination by going through the actual process of testing the samples. This concept was met with approval and during a face to face meeting with the subject matter experts we were even able to suggest a further embellishment to the story by making the disease turn everyone in the fictional town into zombies and using this as a direct feedback mechanism in the game! Depending on whether the user is following the correct process (i.e. if mistakes are being made), the zombies will start to attack the lab and more people within the town will be killed. We also decided to give the player regular updates about the current situation via a series of news reports that break up the simulation-based gameplay. Finally, we were able to integrate a couple of engaging mini-games to provide an effective metaphor for some of the diagnostic tests (these would normally be automated and conducted by a machine). The primary reason that these changes were accepted without question was because the subject matter expert was actually a gamer and one of her favourite games happened to be House of the Dead! Another reason was because the SME had seen some of the engagement issues with the eQA project and did not want to fall into the same trap.

Overall, despite some quite dry and very technical content, due to the additional elements that were added to the story and game play this was a very effective example of how to integrate subject matter content with game play to create a powerful learning tool. We have taken many of the lessons learned from this project forward into more recent developments, such as:

- Try to ensure the SME is familiar with games and encourage them to play games and genres that may be relevant to the current project or product development.
- When working in partnership with an SME for more than one project, always be sure to take on board any lessons learned from

previous projects to ensure a more successful outcome next time.

- It is often a good strategy to split the serious game design phase up into a high level design to articulate the overall concept, game play and walkthrough of the game to non-technical subject matter experts and other key project stakeholders.
 - Once this has been agreed and signed off then move into a detailed design phase.
 - Concept demonstrators will often be needed throughout the entire design process to help communicate concepts and ideas that will not be familiar to non-gamers.
 - Is important to define any assessment criteria or metrics within the design, as well as tying any game mechanics and content directly back to the desired learning outcomes, using game genres and an appropriate graphical style for the target audience.

Kiddykare

KiddyKare was created just before the eQA project and, unlike any of the previous examples; this was developed on a speculative basis rather than for a particular client. The concept was to provide an effective marketing tool for suppliers of child safety devices for the home, such as Mothercare. The gameplay consists of a typical house on two levels, with a baby walking and crawling around, being drawn towards areas of danger. The user has an RTS-style view on to the world and can scroll around without any constraints, trying to buy and deploy child safety devices before the baby can injure itself.

Examples include an iron that could fall, an electrical socket the baby could poke its fingers into, a fire that could burn the baby, a set of stairs the baby could fall down and a dog that could get a bit over-zealous while playing with the baby.

Given that the baby was not always in view, the user had a baby monitor that would sound an alarm when the baby was getting close to a hazard, which would prompt rapid deployment of the correct safety device before the baby got hurt. However, due to the humorous nature of some of the injury animations, players often preferred to see the effects of not deploying the safety devices around the home!

Although the game never became a commercial success, we felt it was a perfect example of how to successfully integrate content and gameplay, and took many of the concepts and lessons learned forward into subsequent products and projects.

Winning

The Winning Game was commissioned by the Scottish Institute of Sport Foundation and is based on a concept and theory devised by a leading Israeli-based subject matter expert in Winning and what it takes to become a Winner, called Yehuda Shinar of Winning Enterprises. The concept and an original computer-based simulator, which encapsulated the Winning theory, had been successfully piloted in a number of market sectors by Winning Enterprises, but TPLD was given the task of evaluating its effectiveness in Scottish Education (primarily at high school level). Our initial findings concluded that the concept was extremely valuable and provided significant benefits to school pupils for their general studies, sport and music. However, the user interface needed substantial development in order to create a deployable commercial product.

The Winning Game teaches the user to think correctly under pressure and utilises continual debriefing to improve in all aspects of the game and maximize personal potential. Unusually, the theory and content are very tightly integrated with the gameplay. The Winning principles are codified as a series of rules that are defined as “combinations” within the game engine. These combinations are constantly monitored to assess

whether certain actions are triggered while the game is in a particular state. If a combination is fired, the player is given direct and instant feedback on their actions by an intelligent coach, with results summarised at the end of each game in the form of a detailed assessment report, including graphs to show metrics and improvement over time. Combined with a personal learning plan framework and an opportunity to debrief continually, with the assistance of the coach and a comprehensive replay mode, the game includes all the tools required to become one of the most successful serious games so far.

At the time of writing, we are still finalising the development of the game, so we cannot state definitively that it is a successful integration of content and gameplay; however, all indications from pilot activities so far indicate that this is the case. Perth High School, Scotland, has worked with the game’s designers to help modify its design and assist in determining how the game can be applied within a high school environment. The initial part of the pilot has evaluated the game’s impact on developing a culture of self-improvement and success within the school, both on a personal and an academic performance level. Feedback from the pupil’s has been very positive, with comments such as “The in-game coach does help; it teaches you to be calm, take time and always give encouragement” and “This is the first game I have ever played that has actually taught me anything useful”. (Boyle and Seeney, 2008)

Eduteams/Infintteams

Infiniteams, and its education-oriented cousin, Eduteams, are very good examples of how to effectively integrate content with gameplay. These award-winning products developed by TPLD as boxed products rather than commissioned projects, are targeted at developing team building, communication and leadership skills through a range of collaborative problem solving modules. The modules provide a safe environment

to practice working as part of a team to solve a variety of problems commonly faced in outward bounds-style physical training activities, such as getting across a river using limited resources and effective communication within the team.

These soft skills are becoming increasingly important in today's society, particularly as more organisations move towards having globally dispersed virtual teams. One could argue that the modules within *Infiniteams* and *Eduteams* are literally just collaborative multiplayer games with no visible learning value or subject matter content; however, this would be missing the point entirely. Simply watching a group of young high school pupils or a senior executive management team playing the games, it is easy to see that real learning is actually taking place. Anyone who has experienced the game would also agree that the way a group of individuals approaches the problems and challenges they face, provides a strong correlation with the thought processes involved and actions in the real world.

However, in order to bring this learning to the team's attention, it is often necessary to have a skilled human facilitator on hand to provide support and conduct debriefing exercises with the individuals as each of the modules are completed. Failed attempts, communication breakdowns and underlying problems with the team dynamics can be brought to the forefront of everyone's mind, with the consequences clear to see; along with the evidence of real improvement during subsequent attempts, once the team has talked about and resolved many of these issues, through reflection and debriefing, with the help of the facilitator.

In order for anyone to facilitate a session with *Eduteams* and *Infiniteams* effectively, they need to be given training on how to use the software, how it can fit in with a blended learning approach (particularly if they have existing team-based course material) and how to accurately monitor team and individual behaviour and performance within the game to help stimulate discussion during the subsequent debrief.

This training and the player's learning is further enhanced through the use of social networking and web 2.0 technologies such as blogging, forums and wikis to share experiences and note down personal thoughts and opinions. The use of this technology helps establish communities of best practice by allowing others to learn from how the game has been applied in different ways. This type of surround and community-based support is becoming increasingly important for successful serious games, because it is unrealistic to assume they will operate in isolation in the vast majority of cases.

Both *Winning* and *Eduteams/Infiniteams* have heavily utilised user-centric design approaches throughout the design and development cycle. Early prototypes were tested with large numbers of target end users (these included both teachers/facilitators and pupils/adult learners). This process has continued through subsequent product updates, to ensure that functionality is only added or changed when repeated requests have come directly from end users. We believe that utilising a user-centric design methodology is essential for any successful serious game development. This approach also fits very well with the AGILE development methodology.

Conclusion

“What you want to do is create a game that's built on a set of consistently applied rules that players can then exploit however they want. Communicate those rules to the player in subtle ways. Feedback the results of player choices so they can make intelligent decisions moving forward based on earlier experience. Rather than crafting single-solution puzzles, create rules that describe how objects interact with one another and turn players loose – you want to simulate a world rather than emulate specific experiences”. Warren Spector, creator of *Thief*, as quoted from Aldrich (2004, p. 97).

The rules used within each game should also apply to the content used. The most important rule to communicate is to ensure the medium chosen is appropriate for the content that the developer and/or client wish to get across. Also, ensure that the content is linked to learning goals, which, in turn, are linked to experiences within the game. Remember to gradually build up with content density in the game, as too much too soon can be damaging to the learner and will continue the self-fulfilling prophecy of dull serious games.

The quality of the content is incredibly important. To writers, they say, write what you know. The same is true for game designers...and if you do not know it, find someone who does. Starting with existing content will make the whole process less painful and more efficient.

As can be seen from the discussion and examples mentioned above, content needs to move from text based presentation to be truly interwoven with the game play; the choices and actions the player makes within the game. Only when this is achieved, will true stealth learning be achieved.

Achieving a balance between learning theories such as those of Gagne (1977) and Keller (1987) and engaging experiences as created by games designers will aid developers to be on the right path to creating an effective serious game.

REFERENCES

- Aldrich, C. (2004). *simulations.and.the.future.of.learning*. San Francisco: Pfeiffer.
- Appelman, R. (2007). Serious Game Design: Balancing Cognitive and Affective Engagement. *Digital.Voodoo.Review*. Retrieved 28th April 2008. URL: <http://digitalvoodooreview.com/index.php?option=com_content&task=view&id=24&Itemid=9>
- Appelman, R., & Goldsworthy, R., (1999). *The Juncture.of.Game.&.Instructional.Design*. Can. Fun. be. Learning? Paper presented at the Association for Educational Communications and Technology, Houston, TX.
- Boyle, L., & Seeney, M. (2008). Using Computer Games to Promote Soft Skills in High School – The Winning Game Pilot Study. Unpublished
- Derryberry, A. (2007). *Serious.games:.online.games.for.learning*. I'm Serious.net. Retrieved 28th April 2008. URL: <<http://imserious.typepad.com/imserious>>
- Gagne, R. (1977). *The.Conditions.of.Learning*. New York: Holt
- Gee, J., P. (2004). *Game-Like.Learning:.An.Example.of.situation.Learning.and.Implications.for.Opportunity.to.Learn*. Retrieved 27th February 2008. URL: <<http://www.academiccolab.org/resources/documents/Game-Like%20Learning.rev.pdf>>
- Gee, J. P. (2005). Learning by Design: Good video games as learning machines..*E-Learning*, 2(1), 5-16.
- Gunter, G., Kenny, R., & Vick, E. H., (2006). *A.Case.for.a.Formal.Design.Paradigm.for.Serious.Games*..Retrieved 12th February 2008 URL: <<http://www.units.muohio.edu/codeconference/papers/papers/Gunter%20Kenny%20Vick%20paper.pdf>>
- Henderson, J. (2006). *Serious.Games.by.Serious.Instructional.Designers*. NTSA
- Keller, J. M. (1987). Development and use of the ARCS model of motivational design..*Journal.of.Instructional.Development*, 10(3), 2-10.
- Kürşat, Ç., & Kaplan, G. (2006) *An.Instructional.Design/Development.Model.for.the.Creation.of.Game-like.Learning.Environments:The.FIDGE.Model.in.Affective.and.Emotional.Aspects.of.Human-computer.Interaction:Game-based.and.Innovative.Learning.Approaches:.1.(Future.of.Learning)* IOS Press,US

Prensky, M. (2001). *Digital.Game.Based.learning*. New York: McGraw-Hill

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive.Science*,. (4), 333-369.

Piaget, J. (1970). *Science.of.Education.and.the.Psychology.of.the.Child*. New York: Orion.

Quinn, C. (2005). *Engaging.Learning:.Designing.e-Learning.Simulation.Games*. Pfeiffer: San Francisco

Shaffer, D. W., Squire, K. D., Halverson, R., & Gee J. P. (2005). Video games and the future of learning. *Phi.Delta.Kappan*, 87(2), 104–111.

Squire, K. (2006). From Content to Context: Videogames as Designed Experience. *Educational.Researcher*, 35(8), 19–29

TPLD Ltd (2003) *The.Games.Based.Learning.Essentials* Retrieved 28th February 2008. URL: <<http://tpld.net/main.php?page=1175>>

Vygotsky, L. (1978). *Mind in society: The development of higher psychological processes*. Cambridge: Harvard University Press.

Chapter VII

The DODDEL Model: A Flexible Document–Oriented Model for the Design of Serious Games

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ABSTRACT

This chapter proposes a document-oriented instructional design model to inform the development of serious games. The model has key features in that it promotes a theoretically inclusive approach to learning, a focus on game elements and an emphasis on documentation to provide the rigour necessary to be used as part of a broader project management model. The model defines increasingly granular stages leading to final production documentation for software development. Each design stage contains a series of iterative co-dependent elements. It is proposed that the model can form a base for prescribing and managing activities within an industry context but also as a means to teach the instructional design process for serious games within a higher education setting. A case study of the initial implementation of the model is discussed in order to contextualise it and provide a basis for future enhancement.

INTRODUCTION

Instructional design models are often used to guide the process of designing and developing a range of learning media. They have value in describing the design process; managing the process; prescribing activities within it; communicating

with the clients and other key stakeholders; and finally, teaching and conducting research about the process.

There are a number of well known design models for instructional technology that have been well received and implemented in many settings. Most are influenced by the common

procedural phases of Analyse, Design, Develop, Implement, and Evaluate (ADDIE). They vary in the extent to which they can be described as a design model, project management model, or instructional theory. They also vary in the extent to which they are prescriptive in the nature of the activities involved in design. One of the most common models, developed by Dick and Carey (1990) demonstrates both the strengths and weakness of traditional instructional design models. It provides a structure similar to the generic ADDIE model that identifies the stages inherent in instructional design and emphasises key points such as evaluation and setting objectives. However, the terminology used (such as ‘write performance objectives’ and ‘develop criteria referenced tests’) emphasises the behaviourist nature of the approach and its focus on traditional computer-based training rather than the multiplicity of learning experiences available in games and more contemporary approaches to learning. This level of prescription can restrict the types of products that can be developed, particularly when working within a more open epistemology such as constructivism, which seeks to create environments that facilitate learning rather than promote content acquisition (Jonassen, 1994). Others such as the Layers of Necessity Model proposed by Tessmar and Wedman (1990) accommodate the multiplicity of decisions inherent in the design process but are based on broad principles rather than procedures. This can limit their direct applicability, particularly for novice designers.

This chapter represents an attempt to draw from the best of existing methodologies. The goal is to provide a clear structure to guide the instructional design process, while allowing for the iterative and creative elements of game design and its inherent focus on the end user experience.

A Proposal for a Design Model for Serious Games

There is some precedent when exploring instructional models that may have value in the design of serious games. Ryder (2003) lists a range of models, some of which are quite prescriptive in nature. The vast majority however can be more effectively described as approaches, since he includes reference to fundamental psychological approaches as well as general guidelines which would underpin the design and development process, including Bloom’s Taxonomy of cognitive outcomes and Keller’s ARCS theory of motivation. Many of these have potential to be integrated into a model for serious games design, particularly those that focus on experiential aspects of design such as motivation, flow, and end-user attributes.

These features tend to form the focus of game design models. The MDA model for example (Hunicke, LeBlanc & Zubek, 2004) provides a simple framework for game design based upon three components of:

- Mechanics, describing the components of the game that can be represented as algorithms;
- Dynamics, the interaction of the game based upon user input over time; and
- Aesthetics, describing the intended emotional responses evoked in the player throughout gameplay.

Björk, Lundgren, and Holopainen (2003) provide another model that is deliberately ‘interaction-centric’, using game ‘patterns’ as an approach to articulate the gameplay underpinning design. Such models are inherently game oriented but provide little benefit to the instructional designer, who may be guided primarily by stated learning outcomes rather than an archetypal form of gameplay.

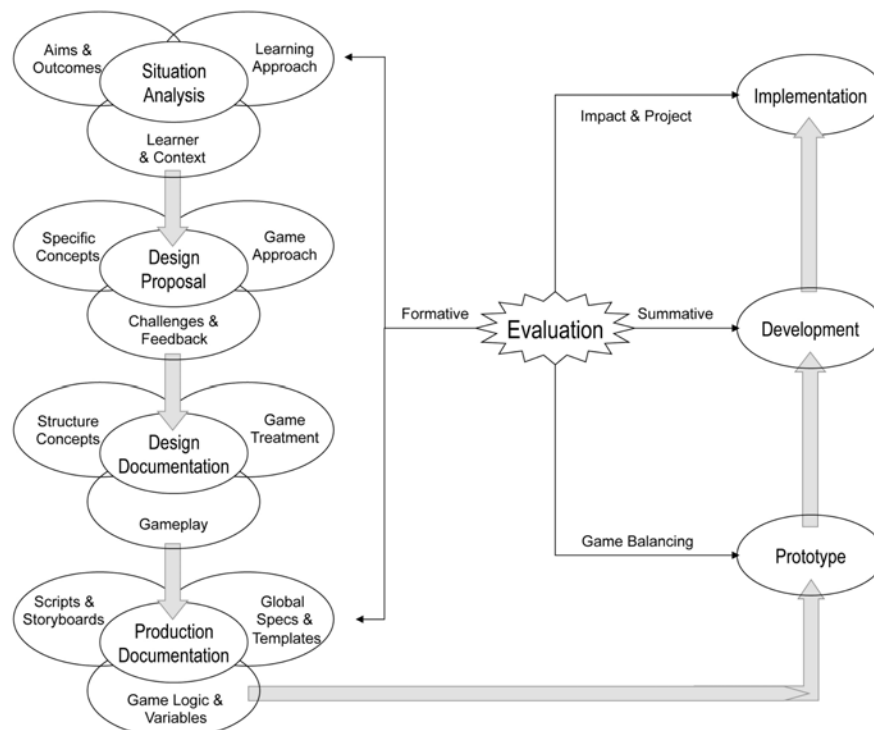
There have been some attempts to integrate instructional design models into the game development process. The Fidge model, for example depicts standard analysis, design and evaluation stages and emphasises their codependence (Akilli & Cagiltay, 2006), however it does not have a strong focus on documentation or provide a level of detail to support novice designers. A more relevant model is one proposed by Kirkley, Tomblin and Kirkley (2005) that underpins an authoring system for the design of mixed reality training. In attempting to reconcile traditional instructional systems approaches used in learning design and ‘waterfall’ phases of game design, the authors provide a tool that breaks the design and development process into a system of interactive wizards.

The model proposed here is less formal but still provides the structure required for novices. Figure 1 demonstrates the approach that has been developed for implementation at Edith

Cowan University in Australia. With a focus on Document-Oriented Design and Development for Experiential Learning, the DODDEL model draws heavily on existing approaches but is unique in that it emphasises games as the instructional medium and a high level of documentation, while attempting to be inclusive enough to include the multiplicity of learning approaches and game styles available to the designer.

The model is deployed in an undergraduate course of Game Design and Culture, where students undertake units in serious games as well as completing team-based industry projects. It has been designed to facilitate teaching and learning about serious game design, while providing a sound basis for communication about the process within teams, and among teachers, clients and developers. As such, it incorporates elements that focus on development issues, though these are not fully articulated here.

Figure 1..The.DODDEL.model.



Overview of the Model

The Situation Analysis and Design Proposal phases of the proposed model roughly correlate with the analysis phase of the ADDIE model. The first explores the potential of a product in the market place and the feasibility of a game for the target audience and within the prescribed learning context. This contributes to the final Design Proposal, which adds to the analysis and provides a more detailed depiction to assist in communicating the goals and overall strategy for the game to key stakeholders. Given the cost inherent in game development it is likely that most projects will be need to be 'green lit' as a result of such a proposal that has been presented in the form of an expression of interest, pitch, or tender.

This is a necessary precursor to the actual design. Within the design phase, Design Documentation and Production Documentation stages represent different levels of aggregation. Design Documentation is typically less formal and detailed than Production Documentation, and this is necessary because of its predominantly internal role in helping designers communicate with each other and clients. Production documentation on the other hand should provide detailed specifications for the final product that can be used by programmers and graphic artists. Should development be outsourced, the signed off production documentation can form a contractual basis for developers. It also has an educational role in that it requires designers to fully articulate final designs and deal with the issues that may result in communicating complex gameplay.

The extent to which designers are involved in the actual production can vary greatly. The Game Design and Culture major at ECU, for example, attracts students with skills and interests in visual design, communication and media theory, but not necessarily strong technical skills. Subject matter experts often have even less skills in product development. This scenario is somewhat similar to traditional instructional design, where design-

ers may come from backgrounds as face-to-face educators or editors of print material. Nevertheless their role is central to the value of the final product.

The centrality of the designer in this process is underpinned by the integration of prototyping into the model. It would be a rare case where a game design goes into full development without a prototyping stage. For every successful game there are many that merely sit on library bookshelves and being able to judge important aspects relating to the affective dimensions of games would be very difficult without real testing at an early stage. One common approach to development is rapid prototyping, which provides an iterative and evolutionary model for development, with evaluation playing an important role in the further refinement of the product.

As can be seen in Figure 1, evaluation is both diagrammatically and conceptually central to the proposed game design model. Formative and summative evaluation are frequently cited as important in project management literature. Game designers need to play role in this particularly in the early stages. In this model, distinction is made between the evaluation of the design itself and game balancing. The former involves the inclusion of key stakeholders in the evaluation of the documentation at every stage as the game design evolves. The latter focuses on the prototype. Developers would be looking at technological aspects of the design such as maintaining adequate frame rate through optimising code, while for designers, game balancing involves moderating the level of challenge to ensure an appropriate sense of flow for the user. This is a process of sweetening the gameplay rather than fundamentally changing the design. It refers to the dynamic balancing that occurs throughout gameplay rather than the static balancing inherent in setting up the transitive and intransitive relationships between gameplay elements. It has been argued that game balancing should occur early, before full development and does not require the graphics to be fully refined

(Oxland, 2004). It is different therefore from summative evaluation, which aims to test the effectiveness of a product once it is completed, and impact evaluation, which identifies the value of the product in real world settings. Ultimately, at the implementation phase, a post-mortem project evaluation can be used to identify the lessons that can be learnt for future projects.

There is a movement in game development towards more ‘agile’ practices. Agile approaches have a focus on people and communication, an ability to respond to change, and prototype development over the more linear methodologies that traditionally drive software development (Keith, 2007). While project management, plans, documentation and milestones are still important elements of the process, particularly for students and novice designers, the levels of iteration within each phase of this model and the role of prototyping and evaluation as an ongoing processes allow for the integration of agility into the approach to design and development.

The Design Stages in Detail

The proposed document-oriented approach can make a strong contribution to quality assurance by providing sign-off points and an audit trail as the design progresses from broad specifications to detailed content. Each stage of the model has document outputs underpinned by three main foci:

- End user experience, which progresses from an analysis of user characteristics, through the mechanisms implemented for challenge and feedback, to a definition of the game logic and variables
- Game treatment, which begins with a fundamental statement of a learning philosophy, through a depiction of the game genre and design, to the final templates and interface.
- Learning outcomes, which increases in detail from a basic statement of aims and outcomes, through the description of underpinning concepts and objectives, leading to the structuring of content and interactivity to the final scripts and storyboards.

Each of the design stages is discussed in terms of these three components and their documented outputs.

Situation Analysis

A Situation Analysis may take the form of an expression of need or problem statement, and may be incorporated into the Design Proposal or act as a basis for a request for tender depending on whether the document is created from a developer or client perspective. Regardless, the analysis should provide a sound basis for the exploration of designs. Such analysis identifies the aims and learning outcomes of the product as well as user attributes and contextual requirements that will all affect the product design in a manner where each of the elements inform each other.

Aims and Outcomes

Aims and outcomes provide the basis for design. The main difference between the two relates to where each is situated. While aims relate to the goals of the organization and development team, outcomes are specific to results of the learning and described in terms of end user attributes. So, an organization may aim to lower student attrition in first year of higher education. The outcome however could be that students are able to manage their course workload and identify appropriate sources of student support. The term outcomes is used because it represents a general shift away from fixed behavioural objectives towards a more inclusive term (King & Evans, 1991). This supports the generation of secondary forms of learning that may not be fully anticipated in

environments that may have social or simulation bases, but may be equally valuable. At this stage, aims and outcomes are represented as broad statements to act as a focus for design and describe a general competence rather than any underpinning skills or knowledge.

Learning Approach

To make the designers' intent transparent, as well as ensuring the proposed product is grounded in existing empirical research, it is important to place design within a theoretical framework. The articulation of a learning approach acts as a philosophical statement and should provide a basis for the learning design. Typical learning approaches may argue for a specific epistemological or psychological orientation such as an objective behaviourist approach or a more cognitive or constructivist approach. They may also incorporate specific theories of learning or intelligence. For example, Gardner's theory of multiple intelligences (Gardner & Hatch, 1989) can provide a basis for ensuring an inclusive approach to the selection of media and activity to accommodate a range of learners. Regardless of the underpinning philosophy, the learning approach should be suited to the aims and outcomes of the product. A product that aims to teach first aid, for example, will be inherently more behaviouristic than one that seeks to assist learners in constructing an appreciation for a certain type of music or literature.

Learner and Context

Any development project must take into account its target audience, and an understanding of the learner and context are crucial to enable design to be targeted towards those needs. This would involve a fairly lengthy discussion that accommodates the attributes of the end users, but also the constraints and affordances of the environment in which the product will be used.

With regard to end user attributes, there have been many attempts to describe individual learning and personality styles and how these impact on the experiences of learners. Within a learning approach that accommodates multiple intelligences, consideration will need to be given to the likely bias of users in terms of their orientation to visual/special, musical, linguistic, kinesthetic approaches and so on. Tools have been developed that try to tease out these attributes (e.g. Museum Libraries Archives Council, 2004). Other approaches include the Myers-Briggs Type Indicator (Briggs Myers, 1980) and Kolb's Learning Style Inventory (Kolb, 1976). While such approaches may be treated with some scepticism regarding their empirical validity (Hunsley, Lee & Wood, 2004) they may still provide a lens through which to consider issues relating to the styles and preferences that end users bring to their experiences.

Beyond accommodating a range of individual differences, a game may also have a focus on a particular group as an audience. Games have a reputation for being primarily oriented towards male users, although there are indications that these differences are less intractable than previously thought (Brand, 2007). Nevertheless, considerable research is being done in this area, for example examining gender differences in neurocognitive propensities and their implications for games (Bonanno, 2005). Other impacting factors may be age and ethnicity. One regularly cited value of serious games is their potential to engage so called Millennial students who have distinct traits such as an intolerance for delay, an IT mindset, a social orientation to learning and a disposition towards multitasking (Oblinger & Oblinger, 2003). Such characteristics have been confirmed by the author's own research (McMahon & Pospisil, 2005). Research has also shown that serious games can be effective with babyboomers and the elderly. Such diversity demands consideration of the nature of product design since 'babyboomers are not interested in

shooting things' (Montet, 2006). At the same time, an increasing focus on games as cultural practice is identifying cultural determinants within countries that impact greatly on the nature of games that are played, particularly in Asian compared to Western cultures (Hjorth, 2006).

At this early stage, some consideration may need to be given to aspects are external to the end user but just as crucial to the design and potential success of a project. Before engaging in any product development it is important to determine whether there is really a need for it. Alternative off the shelf products may diminish the feasibility of the product or there may be other factors that suggest a game may not even be the best approach to the problem. Factors that can be considered include:

- The technology to be used and the installed base within the target audience;
- How the product will be implemented (e.g. as part of a course, to be self-directed, within a classroom etc);
- The overall scope of the product as defined by its outcomes; and
- Proposed development time and availability of resources.

This may result in the inclusion of a detailed project plan and costing, depending on the extent to which this is required (e.g. a broad proposal compared to a response to a request for tender).

The Situation Analysis should integrate the three components of aims/outcomes, learning approach and an analysis of the learners and context of learning. The goal is to provide a cohesive picture of the major determinants that will allow a proposed product to meet the needs of a specific target audience in order to achieve the set outcomes through a particular theory or theories of learning. Once developed, these concepts can form the basis of the Design Proposal.

Design Proposal

The Design Proposal extends on the previous document to propose a general approach to meet the needs identified within the Situation Analysis. At this stage, the solutions are expressed in quite vague terms but will be closely linked to the issues relating to the learning outcomes, game treatment and end user experience. In particular, specific concepts that underpin the broad learning outcome, a description of the type of game that will be implemented and the nature of cause and effect interaction within the game need to be identified.

Specific Concepts

To achieve an outcome, there are usually a number of types of skills and knowledge that need to be developed. These must be identified and mapped to the aims and outcomes of the product. For example, a photography game may have the ultimate aim of making learners better photographers, but a range of underpinning skills may be required within that, such as the ability to operate photographic equipment, understand light and exposure, focus and depth of field, and so on. Therefore an important step in teasing out the aims and outcomes is to specify these subordinate skills. They may be conceptual in nature, such as understanding the impact of a particular colour or they may be quite behavioural such as the ability to select the correct shutter speed to ensure correct exposure. In defining specific concepts or objectives, the author has found it useful to have them articulated as active phrases addressing specific levels of Bloom's Taxonomy (Bloom, 1956). Knowledge based outcomes for example may require learners to *name* the parts of a single lens reflex camera. An analytical outcome might be that they are required to *compare and contrast* two photographs for their quality, while a synthesis outcome may require students to *create*

their own picture using a simulated camera. This list of concepts can then be used later to inform the architecture of the game.

Game Approach

The game approach situates the product in a genre and identifies some basic criteria for its look and feel of the product. It is the experience of the author that genres are well understood by novice designers who have an interest in games. Most would be able to identify the salient characteristics of first and third person shooters, real-time and turn-based strategy games, puzzles, adventure games, platform games and so on. The game approach sets up expectations about the gameplay within the environment and the associated setting and context of the game. These can often be analogous to learning strategies too, and defining an approach to the game can be done effectively by giving consideration to the relevance of traditional e-learning techniques such as those as those identified by Newbey et al. (1999). These include simulations, tutorials, drill & practice, problem solving, discovery learning, discussion and collaborative learning. Such activities underpin a variety of game approaches. For example, quizzes are an ideal mechanism for drill and practice, online role-playing games promote collaborative learning and discussion and so on. Once again, consideration needs to be given to all aspects of design when making decisions about the nature of a game. While quizzes may provide a valuable approach to building knowledge, their lack of authenticity makes them difficult to tie them to applied outcomes. Likewise, online role-playing may be a valuable tool for the social construction of understanding, but in training for fire safety some topics may not be suitable for discussion. Instead learners may be required to apply skills without even necessarily understanding them.

Challenge and Feedback

Ultimately games can be defined by the nature of the challenge and feedback within them. Gameplay can be seen as a balance between the challenge and feedback within a game with the end users' capacity to use the feedback to enhance their skill.

Once again, this section should be integrated with the other aspects of design. A game challenge will be a learning challenge, and the feedback that the user receives will enhance their performance in the game but also their achievement of the learning outcome. Much traditional 'edutainment' can be criticized of failing to meet one or both of these goals. Games are not simply a mechanism for making learning palatable. A rigorous approach to designing challenge and feedback should ensure that activity within the game is goal directed and leads to positive consequences for the learner.

Most game genres are ultimately derived from the nature of the challenge that is inherent in them. Rollings and Adams (2003) describe a range of pure challenges that are archetypal forms of interaction that underpin game approaches:

- Logic and inference challenges;
- Lateral thinking challenges;
- Memory challenges;
- Intelligence-based challenges;
- Knowledge-based challenges;
- Pattern recognition challenges;
- Moral challenges;
- Spatial awareness challenges;
- Co-ordination challenges;
- Reflex/Reaction time challenges; and
- Physical challenges.

It is not an exhaustive list—one may for example think of adding social challenges to the canon, with a view to delineating the challenge inherent in online games where one of the goals may be to create effective teams/squads. By defining the

nature of the challenge, however, one is a step closer to defining the nature of activity in the game. Most importantly it takes the developer to a point where it is possible to define the feedback inherent in the game.

Feedback is crucial to the user's performance in the game and by extension, the ability for the end user to monitor his or her learning. Games have feedback embedded in them through achievements, scores, health, money and other tokens within the game economy. Effective e-learning should be able to harness these forms to provide a naturalistic mechanism for learners to practise their learning and monitor their performance. From the most basic quiz score to the most complex performance criteria within simulations, it is imperative that the learner receives support that is tied directly to the challenge. This section of the Design Proposal provides the opportunity to define the mechanisms to support goal achievement and offer remediation to learners.

Design Documentation

The design phase is in many ways the most complex in that it defines the qualitative aspects of the game. As such, it needs to accommodate formal elements relating to how the game will be manifest, yet support the creativity and dynamic flexibility required for innovative and evolutionary design. The documentation produced within this stage should be able to effectively communicate the design of the game to clients and within the design team. While it may be rougher and less detailed than Production Documentation, it serves an important role in coalescing the various elements into a cohesive description of how the final product will look, feel and behave. It also acts as a transitional form of documentation to the more formal scripts and storyboards. There are a number of forms the documentation may take, but at this stage the design should be able to offer a high level depiction of the game treatment, gameplay and structure of the product.

Structure Concepts

An important means of ensuring learning outcomes are achieved is to structure concepts in a way that maps them across the design of the product. In many cases, but not all, there will be a hierarchy of concepts that need to be covered which will guide the path the user takes through the game. Even if that is not the case, the process of structuring concepts will assist in defining the types of instructional content that may be required and give a sense of the scope of the final game in terms of its playable hours. This could also involve developing a proposed sequence through the concepts. In some cases the learning concepts will cross many or all parts of the final product, in others, they may be dealt with discretely within sections of the product. One obvious approach to creating this structure is to develop an organisational chart. This is particularly useful when the domain that the product seeks to address can be represented within a hierarchical or linear path.

Game Treatment

As well as structuring the underpinning concepts to be addressed in the product, it is also important to define how this basic structure will be treated. The game treatment should give a sense of the look and feel of the product. Within any genre of game there are many decisions to be made about the visual and narrative aspects of the game experience. Within the basic sections that have been identified it is important to consider what the game world will actually look like, what characters inhabit it (both player and non player), the overall story arc and key plot points and events that drive the game. It is something of a truism that games often lack a depth of content, storyline, and emotion (British Screen Advisory Council, 2005). Attention to these aspects in the game treatment can do much to enhance its value as an engaging environment. Character descriptions, plot outlines and concept graphics are important tools for driv-

ing this part of design. The game treatment should also include consideration of the game interface. This may include the look of interface elements such as menus, head-up displays, icons and so on. It is also important to identify mechanisms for the end user to act on the game world. This stage may involve graphical forms of documentation such as sketches of game environments and characters, as well as textual forms such as character profiles and story outlines. These brief working documents encompass the main visual and conceptual aspects of the product.

Gameplay

This is also the point at which the basic forms of challenge and feedback that have been identified are expanded on to describe the gameplay. This crucial aspect of game design addresses how the elements of the game are combined to create a sense of achievability but uncertainty in meeting the game challenge. If a game is too hard it will be frustrating for the end user. Conversely an excessively easy game can be boring. Oxland (2004) identifies a number of elements that contribute to gameplay such as:

- Rules;
- Boundaries;
- Feedback;
- Interface;
- Goals; and
- Challenge.

So, while the overarching challenge of the game may be to apply lateral thinking to solve a problem, the problem may be based around the goal of rescuing a character. User activity in achieving this goal is governed by the rules that are placed on the decisions that can be made and the constraints of the game world in terms of where the player can go at a given point in the storyline and what is available to help solve the problem.

Integrating Structure, Gameplay and Game Treatment

Defining the relationship between the above elements is a necessary but difficult task, rendered even more complex by the fact that none of the elements discussed in this section are mutually exclusive. Interface, for example is part of the game treatment in terms of the look and feel of the product, but also plays a vital role in the user's ability to perform a task within the game world. So while the game treatment may focus on the comprehensibility of the interface, the gameplay will need to specify the types of controls and actions that are possible in the game.

Further analysis may be required to clearly delineate the relationship between the above elements into a cohesive environment. This analysis goes beyond situational issues to look at the critical factors related to the learning as it is both manifest in the game world and applied in the real world. In virtual reality simulations, Stone (2008) highlights the difference between physical and psychological fidelity. The former relates to how accurately the environment mimics the real world while the latter refers to actual level of fidelity required to transfer skills to it. Since psychological fidelity is the ultimate goal of learning, there are obvious implications in terms of the gameplay, game treatment and concepts to address which aspects of the real world actually need to be fully modelled. Stone breaks fidelity down into the following criteria:

- Task fidelity
- Interactive technology fidelity
- Context fidelity
- Hypo- and Hyper- fidelity

Decisions need to be made for example about what physical and cognitive aspects of the task are important, whether the environment requires specific interfaces such as haptic devices or visualisation screens, the background stimuli that may

impact on performance and the extent to which fidelity supports or detracts from the concepts to be learnt. All of these obviously have great impact on the gameplay, treatment and structure of the product.

Also at this stage consideration needs to be given to the motivational and immersive aspects of the design to ensure learner engagement. These can include the development of game flow, where the tension between challenge and skill are optimised but also the affective aspects of the game experience, such as narrative curiosity that is developed through the plot or the sense of care and identification that can be developed for an emotionally deep and complex character or their predicament.

One way of accommodating this is to try to economise in design documentation by creating more holistic forms. The structure maps, concept graphics, and the gameplay document can be integrated into a more complete document that describes each module.

The format that these module descriptors take will vary depending on the nature of the product. They may take the form of a story outline broken down into chapters, or game levels. They may be based around ‘dungeons’ in the game world, or specific scenarios or activities. One way of presenting such a document may be in the form of a table with columns assigned to key design features such as:

- The specific learning outcome(s) or concept(s) being addressed
- Visual media in the form of characters present, descriptions of any instructional or illustrative graphics and so on
- Auditory media - which may include environmental sounds, dialogue or sound effects
- Interaction - which will describe the ways in which the user can manipulate the elements in this particular module of the game.

Ultimately these elements will need to be balanced in a way that manages all of the factors that influence design. A highly realistic simulation may act as a very stimulating environment but ultimately distracting from the concepts to be learnt. In another case, a level of abstraction, while effective in promoting broad conceptual understanding, may limit transfer to real situations.

Production Documentation

The results of Design Documentation may vary, but would include: structure maps; descriptions of gameplay elements; character arcs; concept graphics; and the overall game, broken down into module descriptors. The main difference between Design Documentation and Production Documentation is that the former describes the design, while the latter prescribes the development of the product.

It is a necessary distinction. The main focus of Design Documentation is communication and much detail can be omitted in the earlier stages of design to get across the main ‘ideas’. Unfortunately these types of documentation do not ensure quality in the final product. The purpose of Production Documentation is to be a paper-based analogue of the final game. This ensures that the product is built to specification and accurately reflects the design. Production documentation is fully detailed to the extent that it can contribute to the quality assurance and contractual aspects of the project. For example, once a storyboard has been signed off by the client it is given to the developers to build. At that point there is a clear demarcation of responsibility between the client, developer and designer. Anything not built to the storyboard specifications becomes the developer’s responsibility to fix. Another common scenario is where the client seeks to change the scope of the design. If the storyboard has been signed then these changes can be negotiated beyond the origi-

nal contract scope. The designer's responsibility is to ensure that the production documentation itself accurately reflects the design.

Just as approaches to Design Documentation vary, there are many ways to approach Production Documentation. An in-house development may allow more flexibility and commensurately less detail in documentation than an outsourced project. However, best practice would suggest that the more detail in the documentation the less margin for error between the design and the final product.

Many organizations develop approaches to production documentation that are part of their overall quality management system. Typically, however, the types of documents that are produced draw from multiple disciplines such as interactive media development, film and video and software engineering. Therefore they can include documentation as diverse as:

- Storyboards (textual scripts and/or visual storyboards)
- Flowcharts of specific interactions
- Tables of entities and variables, and media assets

The list is not exhaustive and typically multiple forms of documentation are required at the production stage.

To avoid duplication between documents, it is proposed that a distinction is made between global and specific types of documentation. Global forms of documentation define the game elements that are common throughout the product. A common document would be a set of specifications that would define:

- Colours
- Fonts
- Standard screen dimensions and layouts for specific parts of the product
- Game controls, standard cursors, interaction styles and forms of feedback

- Libraries of elements that may be used in certain parts of the game, e.g. character animations, game variables and their impacts on other variables, media assets used in several parts of the game etc.

Some of these are extensions of the design documentation already provided but in more detail.

The role of the storyboards then is to flesh out the detail within specific parts of the game that differ to or build on the global forms of documentation. For example, the user may be required to interact with a character in an adventure game. The approach to animation and interaction may be defined within the global specifications, but the actual dialogue and the results of the interaction at a specific point in the game will vary. At this point it is useful to embed these in storyboards.

The exact nature of storyboards will depend on the type of game. Two common forms are textual storyboards (scripts) and visual storyboards. The difference is the focus of each. In a virtual house which consists of 5 rooms, little may change between the rooms but the character interaction and dialogue within them. A textually based document which refers to templates in global specifications would therefore be appropriate. In a tutorial-based game which presents unique graphical information on each screen, then it may be more appropriate to foreground the visuals. A common visual storyboard template would include a placeholder for a drawing of the screen as well as sections to write the graphical and audio media and interactions within that screen.

Ultimately there is no single 'magic bullet' to production documentation. Often the best approaches are developed over time and may vary depending on the type of project. It is important however that the documentation represents the final product accurately enough to be developed according to the design specifications.

This is a marked extension of the functionality of design documentation. For example, in defin-

ing the gameplay at a design documentation level of a shooter, the role of weapons, health, shields and so on will be discussed. At the production level, it is not enough to describe these in general terms. The quality of the final gameplay will be dependent on specific factors. For example, exactly how much health is lost when the user is hit with a pistol? Or a phase rifle? Or a rocket launcher? At what distance? To what extent do shields minimise the damage and how many health points are lost? These must be represented algorithmically and in a manner that can be understood by programmers. Designers often use tools like flowcharts or pseudocode to define the logic of a game in enough detail to ensure the final product represents these relationships.

Summary

Example outputs in terms of the documentation required for each stage of the design phases of the DODDEL model is outlined in Table 1. It is neither an exhaustive nor prescriptive list, as the requirements of a particular project may emphasise some forms of documentation over others. Nevertheless, it provides a framework that can be used to guide the serious game design process.

Case Study

The model has been applied to a final year undergraduate unit in Serious Games at Edith Cowan University as part of a new Creative Industries major in Game Design and Culture. The group

Table 1..Example documentation outputs

Stage	Components	Outputs
Situation Analysis	Aims and Outcomes Learner and Context Learning Approach	Aims Outcomes Learning approach End-user attributes Proposed patterns of use Technological affordances and limitations Budgetary issues Existing/competing products
Design Proposal	Specific Concepts Challenges and Feedback Game Approach	Concepts/Objectives Learning strategy Game approach/Genre Nature of challenge Remediation/feedback
Design Documentation	Structure Concepts Gameplay Game Treatment	Game overview Structure/Organisational chart Module descriptors
Production Documentation	Scripts & Storyboards Game Logic & Variables Global Specs & Templates	Visual storyboards Narrative scripts Flowcharts/data flow diagrams Asset lists Variables Pseudocode Global specifications Visual templates Development style guide

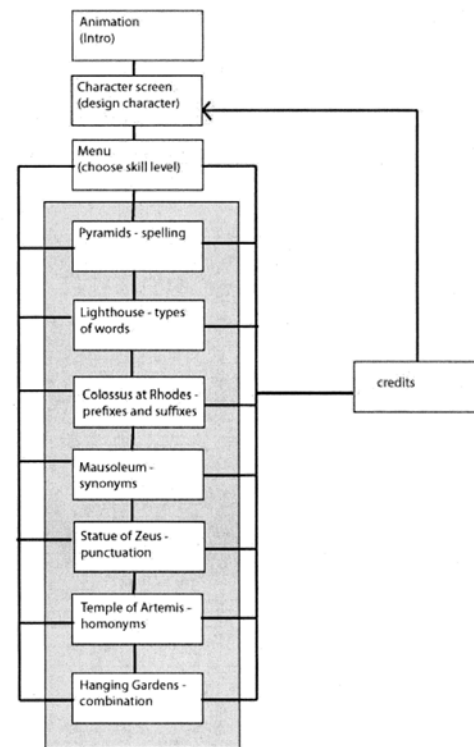
consisted of 10 students. One of the requirements was that the students work in teams of two or three, using the model to document a serious game design of their choice. The following example was submitted by a pair of students who chose to teach spelling within the context of an adventure game, *SpellStory*, set within the context of the seven wonders of the ancient world.

The Situation Analysis provided by the students demonstrated the connectedness of the elements of the model. Stated outcomes that the user would know how to spell a range of words, understand their uses, apply this knowledge to authentic spelling task and use contextually provided historical information to solve problems, pointed to a requirement for a blended cognitive/behavioural approach. Behavioural learning was proposed due to the inert nature of the spelling knowledge required, which in turn suggested an approach that would involve repeated drill and practice to provide rehearsal of the spelling skills and promote automaticity. Some of the more cognitive elements of the project were in the use of knowledge of the seven wonders of the ancient world to solve problems and help progress the story. The students argued an adventure game was most appropriate to the target group of 7-11 year olds with varied difficulty within the spelling tasks to accommodate the diverse literacy levels of this group.

These ideas were carried through a Design Proposal that separated *SpellStory* into the 7 modules (wonders) and tied specific concepts to each. The game was described in terms of being a quest, where the user needs to find 7 keys which promoted mastery learning of the concepts within each individual wonder. The concept of variable degrees of difficulty was more thoroughly explained in this section as well as elements of logic, inference and pattern recognition that would underpin the challenges for the user.

The three main forms of design documentation that were provided in this case included a structure map which essentially broke the game down into

Figure.2..*SpellStory.structure.map*



the seven modules (Figure 2), module descriptors (Table 2) and rough concept graphics (Figure 3). As can be seen, there is a corollary between the structure map and the module descriptors, though the lack of numbering within the structure map does not highlight this connection.

The module descriptors and concept graphics were still quite broad at this stage. Nevertheless they provided a strong working basis from which the team was able to storyboard their design. As with the structure map, the labeling of the concept graphics made it difficult to identify the modules or sections to which they belonged, but still provided a sense of the visual treatment of the characters.

The Production Documentation was handled somewhat differently from several of the other teams' submissions in that, through negotiation with their lecturer, the team members chose to submit a prototype as part of their design. This

Table.2..SpellStory.module.descriptors

Module	Objective	Content	Media	Interaction	Result
0. Menu and setup	1) Choose a skill level 2) Design a character to represent the player	Map showing all the Wonders, options to choose levels and design character	Background music, parchment graphic, character with changeable attributes	Player can click on the attribute lists to get different styles e.g. for hair, skin colour, eyes etc; has to click on the first screen to start game.	Player has a sense of ownership from being able to design their own character, and starts the game.
1. The Great Pyramid of Egypt – (spelling)	1) Navigate through the pyramids to reach the treasure chamber and obtain key 2) Learn spelling through drill and practice exercises.	Spelling games, information about the pyramids	Animated sequences, character voices, background music, hieroglyphics	Player can click correct options with the mouse or enter with keyboard; can choose a path to go through	The player has to get through all the spelling challenges to complete the level; on completion they receive a fact card (as a printable) and a game key.
2. Lighthouse at Alexandria (types of words)	1) Run up the stairs to reach the top of the lighthouse and guide the friendly ships (marked by a certain type of word) to safety. 2) Learn about the types of words by correctly identifying	Tests about types of words (nouns, verbs, adjectives, adverbs); historical facts about the lighthouse	Animated sequences, character voices, background music, Sounds of the sea, images of ships on the sea.	The player had to click on the steps to advance; would have to click on correct options to determine the type of words in the games, click on the ships and the shore to guide them safely to land.	The player has to succeed at the challenges to reach the end of the level and hence should know what the different classifications of words are; the player receives a fact card

Figure.3..SpellStory.rough.concept.graphics



negated the need for fully realised visuals and templates, as these were embedded in the prototype. This decision also highlights the need for flexibility in deciding which forms of documentation to use. Rather than complex interrelated variables

within a simulation, the design was characterised by smaller quizzes and puzzles and underpinned by a narrative. This meant that textual storyboards with an emphasis on the sequences and decisions within the gameplay were the most appropriate

Table.3..SpellStory.textual.storyboards

Number	Visual	Audio (spoken)	Audio (sound effects)	Interactivity/authoring
1.0	Outside of pyramid. Question in front of door with space to type in. Buttons with 'enter' and 'hint'.		Background music – Egyptian theme (global for this module)	Keyboard: Type out the letters (set answer as var 'answer') Mouse over: If 'hint', display hint. Mouse click: if 'answer' equals 'correct', go to 1.1 else if 'answer' does not equal 'correct', go to 1.0.
1.1	Wall with hieroglyphics. Player's character walks in from the left with a wood torch. Companion (Egyptian boy called Ahmed) walks in from the right. Player character shows the artefact from intro sequence. Buttons at top corners of screen: 'Go' and 'Quit' (global)	Ahmed: "Hi! I'm Ahmed... I heard you're looking for something..." Player: "Yeah, I need to find a key for this." Ahmed: "I think you'll have to go to the treasure chamber to find that." Player: "Do you know where that is?" Ahmed: "I've never been there but I've heard about it... someone told me there are a lot of traps and mummies guarding it though..."	Effects – burning torch, footsteps	Mouse click: If 'Go' then go to 1.2 If 'Quit' then go to 0.1 (global)
1.2	Player and Ahmed peering down passageway nervously. Hieroglyphics in background. They come to two panels in the wall representing different paths.	Mouse click: Player: "Are you sure this is the right way?" Ahmed: "I hope so."	Effects – burning torch, footsteps	Mouse click: If on either door, go to 1.3
1.3	Darkness around player and Ahmed. They look around.	Ahmed: "I don't like the sound of that..."	Effects – burning torch, scratching noise, distant thud.	Randomly generated option: If var 'challenge' = mummy, go to 1.3.1

choice for communicating the design at a detailed level. A sample is shown in Table 3.

The logic of the game was primarily articulated through pseudocode within the interactions and authoring column of the storyboards. While it could be argued that there is some detail still missing within these (for example distinction between graphical and textual information within the visual column) their role as a primary production document is evident. This is particularly true when considering the other linked supporting documentation that could be used to clarify them. In this case they took the forms of a guide that

identified global characteristics and documentation style (such as the convention of spoken audio being represented between quotes) as well as discrete forms of content such as question and vocabulary banks.

One of the advantages of the prototype as an instantiation of the design is its immediacy (Figure 4). It provided a direct and accessible proof of concept that, when presented to the class prior to submission, allow students to respond to without their reading of the design being heavily guided by the team itself. It was interesting to note that the quality of feedback from students as they

Figure 4..Spell.story.prototype.screens



reviewed each other's designs was significantly higher for the team that selected to develop a prototype. While this may be something of an ideal – not every student group in this course would have members with such development skills – it reinforces the potential of a prototype, not just as a evolutionary model of the final product, but as a communication tool throughout development.

Findings and Recommendations Following the Initial Implementation

Following submission of their designs for assessment, students were asked to participate in a review of the model with a view to improving it. Data was gathered from an online five point Likert scale survey. Students were required to state the extent of their agreement to ten statements about the model as well as respond to four open ended questions that interrogated students' opinions about the strengths and weaknesses of the model as well as specific elements that were problematic and how the model could be improved. While the cohort of 10 students was not enough to provide statistical validity, this method provided an extra form of data to complement the analysis of the quality of student submissions themselves, discussions about the model in class and peer presentations of design. Further data was sourced in the

form of an informal focus group from a group of students who used the model; not in this serious games unit, but as part of a multimedia project which took the form of a serious game.

The survey indicated a positive perception of the model by the students, with no item returning an average less than 3.5 when result scores were averaged, from 1 being Strongly Disagree to 5 being Strongly Agree. In particular, the survey yielded 100% agreement that the model was clearly explained and performed a useful framework for their game design project. It was also felt that each stage was logically sequenced, that the notion of broad to detailed design within the stages was useful and that it provided an effective framework for novice users. The most neutral responses were to the specific questions about whether the model helped the students apply learning, gameplay and visual design principles. It appeared that the difficulty in grasping some of the concepts themselves impacted on the ease of implementation within the model. Learning design, for example, was new to all of the students, and careful scaffolding was required to help students see the connectedness for example between problem-based learning and simulation games.

The strengths of the model as demonstrated by verbal discussion, responses to the open-ended survey questions and the quality of the submitted designs, were in the disaggregation of the design process into clearly structured stages and elements. Students valued it to provide way

points and milestones within the process as well as to allocate responsibilities and the links to the concepts that were covered within the course.

This structure was also one of the main weaknesses in that it felt overly regimented to some participants. Some students did feel that the elements within each stage overlapped and had difficulty in managing this. A number of students felt that they did not know which order to present discussion about elements within each stage when developing their design. While the connectedness between the elements of each stage was a deliberate feature of the model it could be possible to promote an order where this makes sense. For example, a statement of aims and outcomes may occur logically in some instances before a discussion of situational factors and potential approaches to learning.

Specific parts of the model that students had most difficulty were the Situation Analysis and Design Proposal, which were perceived by some students to be quite similar. One weakness observed in most submissions was a tendency to deal with the situation analysis as a description of the game rather than a study of the characteristics of the environment and aims that would impact on the game. In one case students' description of the target users were framed within their tendency to play certain types of games rather than a depiction of learner characteristics such as numeracy and literacy levels, inherent level of motivation and so on. It was understandable therefore that there was some duplication between that and the game approach. Another area that tended to cause confusion was the distinction between game treatment and gameplay. While this distinction seems quite a natural one to the author, it did cause some confusion for a few students. Those that provided a set of module descriptors seemed better able to identify the connections and distinctions between them as they could be integrated into a single document.

A final concern that was raised was with how the design model was implemented as a teaching

tool. Two students found that there was too much to take in during one semester, and one commented that the model was too complex. Only one student provided a specific comment about how the model could be improved and that was to combine the situation analysis and design proposal or to make them more distinct.

Overall it appeared that the DODDEL model provided an effective framework to help students design games with an educational focus. Most of the issues raised with the model could be addressed with a revised approach to its implementation. One of the reasons why most situation analyses were rather descriptive related to the fact that students could invent their own projects and frame them within an arbitrary choice of target group, nominal budget and available technology. A positive outcome of this was a diversity of designs. For example *SpellStory* took the form of a Flash-based adventure game for primary school children. Another team chose to design a complex ethical game within a military 3D game engine for adults. While both of these designs were legitimate, they were artificial projects. It also meant that contextual factors were quite arbitrary, though it did allow learners to develop their own aims and outcomes rather than work with a received list. Providing a more authentic project and having students conduct a situation analysis as a separate activity at an earlier stage of the project should remove some of the confusion between the Situation Analysis and Design Proposal.

To overcome the complexity of the model, a more succinct summary will be provided with the unit plan in future to complement a more detailed reading. This implementation also had students introduced to the model mid-way through semester. In future it will be introduced at an earlier stage and this will form the basis of the unit structure.

While the model has been developed in line with the literature and is valid in terms of its capacity to provide structure for novices to design

a range of educational games, there is still a great deal of research that may be conducted to enhance it. The model was positively received when presented as a concept at a recent game industry forum. Nevertheless, it lacks expert validity from the industry itself. This can be achieved by having students use the model as they progress through their course into a Games Project unit that has them work with real clients to develop working prototypes. Engaging the clients in the evaluation process should provide a rich dataset from which to further develop it. The growing nature of the course should also provide a greater sample size when conducting future evaluations.

The DODDEL model has been designed to provide flexibility. As technologies and theories of learning develop as well as new markets and audiences for serious games, there will be opportunities to enhance and modify the model. This is particularly true of the developmental stages which currently only exist in their broadest terms. The emergence of a range of rapid application development environments, from 2D game and web-based development tools to increasingly accessible 3D game engines, is undoubtedly going to have further impact on the game development industry and there is great potential for this to be reflected in the model.

CONCLUSION

The DODDEL model has been developed as a heuristic for novice designers to produce documentation that supports the development of innovation and creative games while enabling communication between key stakeholders and leading to the development of quality production documentation. While the actual forms of documentation may vary between organizations, it is believed that the methodology itself is flexible enough to accommodate a range of learning approaches and game types.

The key to the success of the model is in ensuring that the phases create a clear articulation of detail and complexity from rough ideas to final documentation while maintaining an iterative approach to design within each phase of the process. The focus on end user experience, game treatment and learning outcomes should contribute to a cohesive design, where each aspect is informed by the other, leading to a product that is fun, empowering, and leads to durable learning outcomes.

REFERENCES

- Akilli, G. K., & Cagiltay, K. (2006). An Instructional Design/Development Model for the Creation of Game-Like Learning Environments: The FIDGE Model. In M. Pivec (Ed.), *Affective and Emotional Aspects of Human-Computer Interaction—Game-Based and Innovative Learning Approaches*. (pp. 93-112). Amsterdam: IOS Press.
- Björk, S., Lundgren, S., & Holopainen, J. (2003). Game Design Patterns. In M. Copier & J. Raessens (Eds.), *Level Up. - Proceedings of Digital Games Research Conference 2003*. Utrecht, The Netherlands, 4-6 November.
- Bloom, B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. New York: David McKay Co Inc.
- Bonanno, P. (2005). Gender-based Neurocognitive Propensities influencing Gameplay: An Interactions-oriented approach. In M. Burmester, D. Gerhard, & F. Thissen (Eds.), *Proceedings of the 4th. International Symposium for Information Design, 2nd. June. 2005. at. Stuttgart. Media University*. (pp. 59-82).
- Brand, J. (2007). *Interactive. Australia.. Facts. About the Australian Computer and Video Game Industry*. Bond University. Retrieved 12 April, 2007 from [http://ieaa.com.au/doc/ Interactive%20Australia%202007%20web.pdf](http://ieaa.com.au/doc/Interactive%20Australia%202007%20web.pdf)

- Briggs-Myers, I. (1980). *Gifts Differing: Understanding Personality Type*. Davies-Black Publishing.
- British Screen Advisory Council (2005). *The Games Industry: Changing times. – reaching new audiences*. Retrieved 7 April 2007 from <http://www.bsac.uk.com/reports/gameschangingtimes.pdf>.
- Dick, W., & Cary, L. (1990). *The Systematic Design of Instruction, Third Edition*. Harper Collins.
- Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational Researcher*, 18(8), 4-9.
- Hjorth, L. (2006). Playing at being mobile: Gaming and cute culture in South Korea. *Fibreculture Journal*. Issue. 8. Retrieved 30 April, 2007 from http://journal.fibreculture.org/issue8/issue8_hjorth.html
- Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A Formal Approach to Game Design and Game Research. *Proceedings of the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence 2004*. Retrieved 18 March 2008 from <http://www.cs.northwestern.edu/~hunicke/MDA.pdf>
- Hunsley, J., Lee, C. M., & Wood, J. M. (2004). Controversial and questionable assessment techniques. In S. O. Lilienfeld, J. M. Lor & S. J. Lynn (Eds.), *In Science and Pseudoscience in Clinical Psychology* (p. 65). Guilford, ISBN 1-59385-070-0.
- Jonassen, D. (1994). Thinking Technology: Towards a Constructivist Design Model. *Educational Technology*, (April, 1994), (pp. 34-37).
- Keith, C. (2007). SCRUM RISING – Agile development could save your studio. *Game Developer*, 14(2), 22-26.
- King, J. A., & Evans, K. M. (1991). Can we Achieve Outcome-based Education? *Educational Leadership*, 49(2), 73-75.
- Kirkley, S., Tomblin, S., & Kirkley, J. (2005). *Instructional Design Authoring Support for the Development of Serious Games and Mixed Reality Training*. Paper presented at Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), 2005. Retrieved 27 March 2008 from http://www.informationinplace.com/Hot/SeriousGames/Kirkley_Tomblin_Kirkley_Authoring_Game_MR.pdf
- Kolb, D. A. (1976). *The Learning Style Inventory: Technical Manual*. Boston, MA: McBer.
- McMahon, M., & Pospisil, R. (2005). *The Role of Ubiquitous Mobile Technology in Supporting the Needs of Millennial Students*. Paper presented at Educause Australasia 2005: 'The next wave of collaboration'. Auckland, New Zealand, 5-8 April 2005.
- Montet, V. (2006). Games For Seniors Vision. *Australian IT*. 3 October 2006.
- Museums Libraries Archives Council (2004). *Inspiring Learning For All*. Retrieved 30 April, 2007, from <http://www.inspiringlearningforall.gov.uk>.
- Newby, T. J., Stepich, D. A., Lehman, J. D., & Russell, J. D. (1999). *Instructional Technology for Teaching and Learning, 2nd Edition*. Englewood Cliffs, NJ: Prentice Hall.
- Oblinger, D., & Oblinger, J. (2005). *Educating the Net Generation*. Boulder CO: Educause.
- Oxland, K. (2004). *Gameplay and Design*. Essex, UK: Addison Wesley.
- Rollings, A., & Adams, E. (2003). *On Game Design*. USA: New Riders.
- Ryder, M. (2003). *Instructional Design Models*. U of Colorado. Retrieved 10 April 2007, from

http://carbon.cudenver.edu/~mryder/itc_data/id-models.html.

Stone, R. J. (2008). *Human Factors Guidelines for Interactive 3D and Games-Based Training Systems Design*. Birmingham, UK: Human Factors Integration Defence Technology Centre.

Tessmer, M., & Wedman, J.F. (1990). A Layers-of-Necessity Instructional Development Model. *Educational Technology Research & Development*, 38(2), 77-85.

The Sims. [Computer Software] (2000). Redwood City, California, USA: Maxis, Electronic Arts.

Chapter VIII

Games–Based Learning, Destination Feedback and Adaptation: A Case Study of an Educational Planning Simulation

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ABSTRACT

Serious. games. are. suitable. for. learning.. They. are. a. good. environment. for. improving. the. learning. experience.. As. a. key. part. of. this. setting,. feedback. becomes. a. useful. support. for. decision. making. and. can. reinforce. the. learning. process. in. order. to. achieve. certain. objectives.. Destination. feedback. allows. users. to. draw. on. strategies. and. improve. skills.. However,. too. much. feedback. can. make. the. learner. too. dependant. on. external. advice. when. taking. the. next. action,. resulting. in. a. weaker. strategy. and. a. lower. performance.. In. this. chapter. the. authors. introduce. a. conceptual. approach. to. feedback. in. E-Learning. with. serious. games;. how. useful. or. harmful. it. can. be. in. a. learning. process.. They. describe. a. case. study. carried. out. with. a. simulation. of. an. educational. planning. task.. The. authors. studied. the. performance. of. 43. learners. who. had,. or. did. not. have,. visual. destination. feedback. in. a. problem. solving. task.. They. conclude. that. in. this. context,. too. much. assistance. can. be. counterproductive.

INTRODUCTION: An Approach to Adaptation, e-Learning and Games-Based Learning

Serious games have become an important topic in the recent and not so recent history of education. Gaming itself is becoming a key issue in education and has been widely researched in the last 50 years (Caillois, 1958; Huizinga, 1971). In the mid 90's the Internet started to provide new perspectives for serious games. A range of new possibilities arose, such as collaborative worldwide extended multi-player sessions, instant messaging, instant updating of settings and multi-language support. The array of features is still growing, and is not only attractive for *regular* users, but also for learners and teachers (Bruckman, 1993; Prensky, 2001).

Generic games that can be used for learning can cover any kind of non-educational games; for instance, the well-known Sims, SimCity, Flight Simulator, Pac-Man, FIFA, SuperMario Bros, Civilization, Rayman and Diablo II. (Dickey, 2005; Squire & Barab, 2004; Jenkins & Squire, 2003). All of them belong to different categories (*genres*) of games. Following the taxonomy produced by Crawford (1984), which focused on objectives and nature of the game, we find several well-defined categories, such as skill-and-action, combat, maze, sports, paddle, race, strategy or any other kind which is in the list. Goldsmith (1999) also describes another taxonomy: Trick Taking Card, Collectible Card, Exploration, Trading, Auction, Solitaire, Word, etc. Prensky (2001) defines a similar taxonomy based on objectives and nature but follows a different categorization focused on pairs of opposite features (e.g. intrinsic versus extrinsic, reflective versus active, single-player versus multi-player). With a more theoretical perspective drawn before the digital era, we can resort to the first taxonomy on games ever made by Roger Caillois (1958), although it fits only partially with the aim of this text, as it concerns the pre-personal computers

and consoles era, and therefore, also pre-digital games-based learning.

With such a variety of available games and genres it is very easy to find several direct applications and consequences among them, as can also be found in learning. For instance, games allow players to experience, to try, to improve skills, to learn content and to practice strategy (Turkle, 1995; Piaget, 1962; Vigotsky, 1978; Arts, 2005a); they elicit emotional reactions in players, such as wonder, the feeling of power, or even aggression (Squire, 2002); they can also support rather accurate episodes of history (SEGA, 2005), real systems (Microsoft, 2006b), complex popular events (Interactive, 2004) or board games (Microsoft, 2006a), just to mention a few. In addition, with computer networks or network Serious Games on the Internet, they allow players to strengthen their social skills while using virtual communities alongside the games and the facilities of collective and shared games (Bruckman, 1993; Prensky, 2001; Arts, 2005b; Auralog, 2005).

In addition, there are several interactive learning techniques that can be used inside and/or around a game, i.e. learning by doing, learning from mistakes, goal-oriented learning, role playing, constructivist learning, adaptive learning and feedback (Prensky, 2001). Adaptive learning supports adaptivity (the ability to modify eLearning lessons using different parameters and a set of pre-defined rules) and adaptability (the possibility for learners to personalize an eLearning lesson by themselves). These two approaches go from machine-centered (adaptivity) to user-centered (adaptability) and can be used in combination (Burgos, Tattersall & Koper, 2007). Furthermore, we also define adaptation in eLearning as a method to create a learning experience for the student, as well as the tutor, based on the configuration of a set of elements in a specific period aiming to increase the performance of pre-defined criteria (Van Rosmalen, Vogten, Van Es, Van, Poelmans & Koper, 2006) (i.e. educational, user satisfaction-based). Elements to modify/adapt can be based

on content, time, order, assessment, feedback interface and so forth (Burgos, 2008).

The implementation of adaptive learning within a game, along with other techniques, can improve the learning process as well as the user involvement. This involvement provides a *de facto* bi-directional communication flow, where the game stimulates the active role of the user, who in turn gives a feedback that provides some influence to the game itself. Therefore, we can use learning strategies to achieve some well-defined benefits to guide the user.

Background: Feedback and Serious Games

What is Feedback?

Mason and Bruning (1999) define *feedback* as “any message generated in response to the learner’s action”. There is an interactive flow between the learner and the system (Evans, Kersh & Kontianen, 2004). This information flow is seen as a series of frequent inputs and not as a single one, because it is a part of the full learning flow (Gherardi, 2006); and it can be based on a number of inputs (i.e. the learner’s performance, the learning history, the learning goals) (Prensky, 2001). Furthermore, it is fully supported by the learner’s interactions, and collects specific data from this user as an input, and, in turn, provides some analysis back to the same user as an output (Weber, 2003; Evans, Kersh, & Kontianen, 2004).

In the context of Human Computer Interaction (HCI), feedback can manifest itself in different ways, although it usually refers to some information presented to the user *after* something is done. This can be an indication that a certain action has been carried out (or been left behind) and it provides some qualitative and/or quantitative feedback about, for example, the user’s performance. Since the widespread introduction of Graphical User Interfaces, it was common to

adhere to guidelines; for instance, Apple started to provide this type of support from 1992 onwards (Computer, 1992). One of the guidelines is to keep users informed about what is actually happening by the provision of an appropriate communication flow between user and application through a bi-directional feedback. A few years after GUI’s and WYSIWIG’s interfaces became common, however, Gentner and Nielsen (1996) wrote an influential article that explored alternative approaches to computer interfaces. One of the issues was to consider bringing some flexibility into the feedback and dialogue provided by the system. They pondered how much feedback should be provided to the user to be most effective. For instance, the computer could initially provide detailed feedback to familiarize the user with operations and increase their self-confidence. Later, the feedback could be scaled back over time and restricted to unusual circumstances when the user requests more feedback and/or the system detects such need.

Types of Feedback

As mentioned above, in computer applications there are numerous ways to provide a user with feedback (e.g. visual, acoustic, or force feedback just to name a few and others will emerge in the future). In addition, feedback can be fully driven by the learner’s activity and data can be collected as input, and after analysis by the system, information can be returned back to the learner as output (Evans *et.al.*, 2004; Weber, 2003).

Generally speaking, there are two main types of feedback (Mory, 1996): instructive (related to knowledge domain) and informative (related to the context where learning happens). While the instructive feedback leans on a corrective intervention on the learning process, the informative is focused on self-regulation. In addition, there are four complementary types of indicators in informative feedback: (1) related to performance, (2) related to process, (3) related to social inter-

actions and (4) related to environmental interactions. Performance feedback is the most common feedback in games-based learning, but not the only one.

Use of Feedback in Games-Based Learning

Significantly, games also provide outcomes and feedback in real-time (Rieber, 1996; Laurillard, 2002), which guide the next actions to be taken and help the user to focus his/her activity and decisions and the evolution of the story. They are attractive for the players but also for the teachers, as they engage and excite the students as well as provide a means of interaction and learning.

Feedback is also a key factor in educational games and simulations, as they constitute another resource while learning. Garries, Ahlers and Driskel (2002) define a cycle in games that involves several loops of repeated judgment, behaviour and feedback and she points out that feedback is a critical component to regulate the learner's motivation. Also, Csikszentmihalyi (1990) stresses the importance of feedback in his classical definition on flow theory. Kernan and Lord (1990) state that specific feedback based on commitment of goals increases the effort, the performance and the motivation of the learner. People are expecting some reaction on their actions and efforts and become disappointed when they do not receive it, resulting in a decrease in their motivation and performance (Beck & Wade, 2004).

Prensky (2001) supports the use of instant feedback to reinforce adaptive learning and games-based learning as a way to provide useful and immediate information to the learner about his performance. Baer (2005) underlines that immediate and contextual feedback improves learning and reduces uncertainty. Kirriemuir (2002) highlights that instant feedback invites and allows for exploration and experimentation, as well as stimulates curiosity. Kiili (2005) and Chen, Wigand, and Nilan (1999) state that games

should provide instant and appropriate feedback in order to improve the performance.

However, not all authors agree on the positive effects of feedback. In their literature review on computer and video games for learning, Mitchell and Savill-Smith (2004) state that one and the same feedback mechanism can be perceived in different ways. They refer to a study by Halttunen and Sormunen (2000) that used an educational game to support learning of information retrieval. After an evaluation, the effectiveness feedback users received from the system were generally seen to promote learning significantly. Feedback concerning the performance of one's own query, the chance to reformulate the query, and to further evaluate the effect of changes on performance were seen as highly motivating and enhancing learning. However, there were also students reporting that their attention were fixed on performance and tried to improve on their results mechanically, without analysis and reflection of their preceding queries and results. Here, the feedback tempted searchers to pay attention to the performance measures achieved, rather than on analysis of the situation and strategy of the search task.

Educational games, and even more in simulations, are usually played in an unpredictable way by the players. This unpredictable behavior can provide some input based on performance on which a final analysis will be given back to the learner, although this feedback can be too complex or not specific enough to make it useful or even easy to understand or to apply (Fowlkes, Dwyer, Oser, & Salas, 1998). In addition, once some feedback is provided, its use by the learner is uncertain, possibly resulting in a reduction of the performance as well (Kluger & DeNisi, 1996).

Destination Feedback and Games-Based Learning

There are other types of feedback, such as *destination feedback* (Computer, 1992). It refers to the issue of when the user drags an item from its

place to a selected target, the application provides some information back that indicates whether the item will match and/or be accepted. Destination feedback depends on the destination's ability to accept the nature of the information contained in the dragged item. This type of feedback informs the user about a range of possible actions to be taken. Furthermore, these possible actions in some ways constrain the free choice of the user, and results in an assisted election. In computer use, there are a number of examples where this principle is being applied, such as software installation wizards, extended help-options, access to restricted areas and greying-out menu-items that are blocked when a specific user should not make use of them. This last setting provides a context-sensitive feedback in the interface. Feedback by *greying-out* of items is one example of what is referred to as externalizing information. The *externalization* of information makes it available on the interface; however, there is no need for recognition but instead for recall, in order to carry out the associated task satisfactorily, and it relieves working memory (Zhang, 1997; Zhang & Norman, 1994). On the other hand, when no visual support is provided, the user has to *internalize* the information himself, and store this information in his memory. Depending on the type of information and task to be carried out, externalization or internalization are more suitable or can hinder the process of finding the right solution (Zhang, 1997).

In the context of games-based learning, the internalization-externalization approach provides guidance or assistance in complex situations. It relieves the working memory of students so that they can devote attention to development of more elaborate strategies. However, we can question the assumptions of the positive effects that this kind of feedback can have. Perhaps learning with a feedback-based interface is more volatile and difficult to transfer to other situations. This situation is not advisable when learning or gaining insight is the final aim. We pondered that having

this kind of destination feedback might encourage users to be less proactive and lazier, and lean on the trial-and-error technique instead of on a more solid strategy or thinking.

Research by O'Hara and Payne (1999) supports the notion that a too strong reliance on external information leads to negative effects regarding the planning and transfer of skills. They drew a distinction between plan-based and display-based problem solving, which can be seen as analogue to what happens during internalization vs. externalization. During plan-based problem solving one has to construct problem strategies and subsequently use detailed problem strategies from long-term memory. Display-based problem solving on the other hand makes little use of learned knowledge but instead relies on interface information. Plan-based activity leads to a shorter solution route, because steps are planned and no unnecessary steps are taken, while a display-based strategy involves more steps because of more searching and less planning. Also, Svendsen (1991), who used the Towers of Hanoi problem, showed that an interface yielded improved understanding of problems.

The notion that too much feedback could be counterproductive while playing a game based on planning, led us to develop a case study with real learners. In the coming section we present the differences between having, and not having, destination feedback and the drawbacks of utilizing it while playing an educational simulation.

A Case Study: The Planning Educational Task (PET)

The Planning Educational Task is an open source software application that simulates the planning of speakers with different demands at a conference venue with rooms of varying constraints. The software (implemented with Macromedia Flash MX ©) was developed by The Open University of The Netherlands and funded by the European

UNFOLD Project (Burgos & van Nimwegen, 2005; Nimwegen, Osstendorp, Schijf & Burgos, 2005). The software presented a constraint-satisfaction scheduling task that involved planning speakers who give lectures at a 1-day conference. The problem solving situation was as follows (see Figure 1): There was a conference to be held in a facility, with a list of a number of speakers that would give a talk that day, displayed on the left. The conference facility had several auditoriums with differing features (listed on the right). Speakers, who as well had assigned specifications, had to be scheduled into a time grid over that day. Not all the timeslots in the grid were always available. Some of them were never available, indicated with light gray (e.g. the timeslots during lunchtime at 13:00), but there were also some arbitrary slots (e.g. 10:00, room “Maxima”). We designed the problems where a correct solution of fitting all of the speakers in the grid always existed. The empty available timeslots were shown in white, and the ones that were already occupied by a speaker would display their name.

A “feedback” interface (Figure 1) and a “no-feedback” interface were constructed (in the latter, the green feedback was simply absent). In the version where feedback was implemented, upon request (clicking on an object) users received feedback in the form of highlighted legal options where a speaker can be placed (the green timeslots look darker in Figure 1). Note that this did not show *the best* slot to place a speaker, but simply which slots are possible.

In situations such as the Planning Educational Task, students can first be expected to start to explore the application and in the meanwhile work towards the imposed goal: solving the problem. A routine or strategy will not be available in the beginning. Therefore, students will need to explore and discover in a most likely non-structured manner, which can be compared with Prensky’s (2001) statement that in games one of the most usual techniques is trial-and-error, defined as the absence of a systematic strategy when a learner

plays (Dempsey, Haynes, Lucassen, & Casey, 2002). The Planning Educational Task focused on the opposition between having the aforementioned destination feedback, or lack thereof. When the feedback is present, it might foster orientation on what to do next, and guide the player in the sense that it shows which choices are available, and serve as an orientation on what to do next. However, when moves are made, the player is at all times allowed to undo the taken action(s) and backtrack to establish a new strategy to follow. This strategy is partially based on trial-and-error movements, although the level of risk that a player takes in every movement can be different depending on the level of feedback provided, as we show in the coming sections.

In an experiment, 43 subjects were divided into a *feedback* and *no-feedback* group. Both groups had to solve a series of combinations with the conference planning software. We studied whether time based measures and move based measures were influenced by having feedback or not. At first, it seemed that the time the participants needed did not differ between the two groups or players, but when analyzed further, it showed that this only counts for overall time. When looking more specifically at time needed for certain parts of the task, two interesting observations were made. Firstly, the players who had no feedback took significantly ($F(1,39)=4.34$, $p<0.05$) more time studying the situation before they started solving the problems than the ones that did have feedback ($M=18.9s$, $SD=1.5$ vs. $M=14.4s$, $SD=1.6$). The lack of feedback also resulted in more time between the individual moves, ($F(1,39)=4.82$, $p<0.05$) ($M=4.8s$, $SD=1.4$ vs. $M=3.9s$, $SD=1.3$). Both these findings, are thought to reflect planning and contemplation for the task, and thus aim at meaningful cognitive processes. Then, one might wonder why are there no overall time differences? This is explained by a more important finding.

It must be taken into account that the issue here was not “can they solve it?” but “how smartly or efficiently do they solve it?”, since in the end each

Figure 1..Conference planner.in.version.with.feedback

Conferentie Planner 1.2

Sprekers					Zaal			
	Naam	Beamer	Uren	Toehoorders	Beamer	Beatrix	Maxima	Irene
						Nee	Ja	Ja
					Zitplaatsen	100	200	300
	Sam Gaart	Ja	1	200	09:00u			
	Ruud de Roy	Nee	1	100	10:00u			
	Pim Slagters	Nee	2	200	11:00u			
	Marie Beek	Ja	1	200	12:00u			
	Freek Leuve	Nee	2	100	13:00u			
	Marja Hart	Nee	1	100	14:00u			
	Bart Vink	Nee	2	100	15:00u			
	Ilse Groot	Ja	1	300	16:00u			
	Jindra Baat	Nee	1	100	17:00u			
	Sander Ool	Nee	1	100				
	Ria van Slag	Nee	2	100				
	Jan Janssen	Nee	1	100				
	Robert Pauw	Ja	2	300				
	Andre Rijken	Ja	1	300				

problem had a solution, and these tasks are not extremely difficult given the limited number of speakers. Results showed that having no feedback resulted in fewer superfluous moves than when having feedback, ($F(1,39)=4.17, p<0.05$) ($M=2.46, SD=0.61$ vs. $M=4.27, SD=0.63$). In other words, the lack of feedback led to doing the task in a more straightforward manner, thus with less deviation from the minimum amount of moves, resulting in greater efficiency. This finding is interesting, because it points at smarter strategies applied in the versions where no feedback was available. The players who had no feedback, thought longer before starting and between individual moves, but they needed significantly less moves and this, at the end, leveled out the time differences (all moves cost time).

With regards to the strategy that students chose, the results also indicated a more plan-based approach by students who worked with the no-feedback version. They filled the timetable by first scheduling speakers with the most constraints more often. This strategy again suggests planning, because students thought about whom they were going to schedule before starting with the task.

Problem knowledge of the students was tested afterwards by means of questions in which they had to judge situations where rules (sometimes) were violated. The effect of feedback on declarative knowledge was almost significant; having feedback resulted in less correct answers.

According to the results, feedback did not improve performance in any way. On the contrary, we found only positive effects of *no-feedback*: It led to more plan-based behavior, smarter solution paths and better declarative knowledge. *Feedback*, on the other hand led to a more display-based approach resulting in less economic solutions and shallower thinking. It seems that the option of deliberately leaving out certain types of guidance or assistance as was done in the no-feedback version can be fruitful. This would support Carroll's ideas (1990), who already two decades ago propagated minimalism in design and instructions.

Future Research Directions

Our findings show that computer-mediated tasks can take advantage of design considerations that

run deeper than plain usability, even when they go against common sense (making the task harder). Depending on the specific goal and situation, it can be valuable to design software in such a way that making inferences is provoked, and active learning takes place and users have better command of what it is they are doing.

There are various directions we are considering to extend our research. There are more ways to implement and vary feedback, and we are aware that “feedback” and “no feedback” by no means constitute a dichotomous variable, but can be positioned on a continuum. One could vary the amount of feedback by adaptively reducing or increasing feedback during the process, or to do this depending on the displayed behavior of the player. Another issue to mention is user expertise. We were aware that none of the subjects knew the task we used. Also, we did not focus on the more general level of computer experience, game playing experience or experience with office-like administration tasks. It might be worthwhile incorporating this in future research, since it might very well be that a person with almost no computer experience would display different behavior. Expertise in the sense of skill or knowledge in a particular domain also can be worthwhile to incorporate, especially in educational contexts. Regarding serious games, game based learning and training situations; we hope that our work partially paves the way for more research in that direction. Regarding Berlyne’s curiosity principle (1960), it might be too pretentious to claim that leaving out feedback as we did would arouse *an epistemic feeling of discontent not to know things*. Nevertheless, an information gap can play a part, albeit less drastically, and can be fruitful for these research areas. The more gaming moves towards educational realms, training and the like, the more interesting it can be to see how attention, mental effort and proactive behavior can be safeguarded. Likewise, the areas of educational systems and training can learn from principles that make games so successful.

Conclusion and Discussion

The idea of feedback, and what it can cause us to do, is reminiscent of research by Kiili (2005), in which he emphasized the importance of distinguishing between activities related to solving the tasks, and the use of the controls (the interface, which he calls “artifact”) of an educational game. He stated that “*all possible resources should be available for relevant processing (the main task), rather than for game control issues*”. Less of these artifacts being available leaves more resources for smarter processes, such as economically solving the task at hand as in our case study.

Interface-related events influenced behavior in approaching a task, especially concerning the motivation and effort involved. As an extra thought on motivation, central to many games is that curiosity is being fostered and that there is something to discover or to achieve, and not everything is given away too easily. Players are constantly triggered by *not knowing things*, and having to uncover them is a reason why the game is so intrinsically motivating. Regarding curiosity and motivation, there is research in which cognitive and information-processing factors have been used to explain curiosity. Regarding the discrepancy between what one knows, and what there is to know (which information is possibly available), an interesting perspective to look at in motivation is the notion of knowledge gaps, also referred to as information gaps (Loewenstein, 1994). A knowledge gap refers to the difference between what a person knows and what is presented to a person. When one becomes aware of the knowledge gap, curiosity arises (Berlyne, 1954, 1960). Then, the awareness of the information gap produces an aversive feeling of deprivation or discomfort that can be alleviated only by obtaining the information needed to close the gap, which consequently produces an intense desire to modify the existing knowledge structure (Berlyne, 1960). This fits well with the general notion that learning is more effective when people experiment and discover

for themselves. In the context of “not knowing things”, as in information gaps, and “wanting to know” there is an interesting experiment by Wishart (1990), who used a simulation to teach children what to do in case of a domestic fire. It showed that the amount of learning from an educational computer game increased by making it more challenging (among other mechanisms). Subjects learned more from a simulation that had a combination of challenge and complexity. She concluded that educational software could be improved by providing a greater variety of challenge and complexity with less emphasis on reinforcement. Information gaps are used as a technique to “move students out of their seats”, allowing critical thinking and opinion formation.

Electronic educational games and simulations are a powerful platform for learning. They are developed with game technology and game design principles but for a primary purpose other than pure entertainment. Serious games are seen as similar to educational games, but are often intended for an audience outside of primary or secondary education. Games are famous for their motivational or “fun” aspects, but also have the potential to facilitate cognitive processes such as making inferences and deeper thinking, which can be beneficial in an educational context

In our case study we explored the influence of providing versus leaving out visual destination feedback. We saw that the feedback as it was implemented was not beneficial in any way. In our two versions, students solved all the planning problems and, more importantly, in the same amount of time, so there was no advantage there. The version that provided *no feedback* resulted in longer thinking times *before* starting to solve the problem and to more time between moves. We take it as an indication that more contemplation was provoked and the students pondered longer before acting, so they studied the planning problem with more effort, also in between the initial actions and the subsequent ones. The *no-feedback* version also resulted in more time between moves,

which we also take as indicators of planning. This is in line with results of O’Hara and Payne (1999), who reported a longer inter-move latency for subjects in effortful conditions, indicating a more plan-based approach. Students who worked with the *feedback* version made more superfluous moves, thus they solved the problems with lower economy. We infer that this is caused by less planning, which resulted in worse solution paths. Similar results were also found by O’Hara and Payne (1999) who found that a more display-based approach resulted in more moves than a plan-based approach, and that *backtracking* (undo a move and return to the previous situation) occurs more during display-based behavior.

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REFERENCES

- Arts, E. (2005a). *SimCity.2004*. Retrieved August 20th, 2006, from <http://simcity.ea.com>
- Arts, E. (2005b). *The.Sims.2*. Retrieved August 20th, 2006, from www.eagames.com
- Auralog. (2005). *Talk.to.me*. Retrieved August 20th, 2006, from http://www.auralog.com/es/particulares_talktome.htm
- Baer, L. L. (2005). The Generation Gap: Bridging Learners and Educators. *The International Digital Media. & Arts Association Journal*, 2(1).
- Beck, J. C., & Wade, M. (2004). *Got.Game: how the gamer generation is reshaping business forever*. Boston, MA: Harvard Business School Press.

- Berlyne, D. E. (1954). A theory of human curiosity. *British Journal of Psychology*, 45(3), 180-191.
- Berlyne, D. E. (1960). *Conflict, Arousal, and Curiosity*. New York, NY: McGraw Hill.
- Bruckman, A. (1993). Community support for constructivist learning. In *Computer Supported Cooperative Work (CSCW)*, 7, 47-86. Springer
- Burgos, D. (2008, in press). Extension of the IMS Learning Design Specification based on Adaptation and Integration of Units of Learning (Extensión de la especificación IMS Learning Design desde la Adaptación y la Integración de Unidades de Aprendizaje). Doctoral thesis. University Carlos III, Leganés, Madrid, Spain
- Burgos, D., & van Nimwegen, C. (2005). *Planning Educational Task*. August 15th, 2006, from <http://moodle.learningnetworks.org/course/view.php?id=45>
- Burgos, D., Tattersall, C., & Koper, R. (2007). How to represent adaptation in eLearning with IMS Learning Design. *Interactive Learning Environments*, 15(2), 161-170.
- Caillois, R. (1958). *Les jeux. et. les homes: Le masque. et. le vertige*. Paris: Gallimard [English translation: (1962) *Man, play and games*. London: Thames and Hudson]
- Carrol, J. M. (1990). The Nurnberg Funnel: Designing Minimalist Instruction for Practical Computer Skill. Cambridge, MA: MIT Press.
- Chen, H., Wigand, R., & Nilan, M. S. (1999). Optimal experience of web activities. *Computers in Human Behavior*, 15, 585-608.
- Computer, A. (1992). *Macintosh Human Interface Guidelines*: Apple Computer, Inc.
- Crawford, C. (1984). *The art of computer game design*. New York: McGraw-Hill.
- Csikszentmihalyi, M. (1990). *Flow, the psychology of optimal experience*. USA: Harper & Row.
- Dempsey, J. V., Haynes, L. L., Lucassen, B. A., & Casey, M. S. (2002). Forty simple computer games and what they could mean to educators. *Simulation & Gaming*, 33(2), 157-168.
- Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. In *Educational Technology Research & Development*, 53(2), 67-83. New York: Springer.
- Eskelinen, M. (2001). The Gaming Situation. In *Game Studies*, 1(1).
- Evans, K., Kersh, N., & Kontianen, S. (2004). Recognition of tacit skills: sustaining learning outcomes in adult learning and work re-entry. *International Journal of Training and Development*, 8(1), 54-72.
- Fowlkes, J., Dwyer, D. J., Oser, R. L., & Salas, E. (1998). Event-based approach to training (EBAT). *The International Journal of Aviation Psychology*, 8(3), 209-222.
- Garries, R., Ahlers, R., & Driskel, J. E. (2002). Game based learning cycle. *Simulation & Gaming*, 33(4), 441-467.
- Gentner, D., & Nielsen, J. (1996). The Anti-Mac Interface. *Communications of the ACM*, 39(8), 70-82.
- Gherardi, S. (2006). *Organizational knowledge, the texture of workplace learning*. Malden, MA: Blackwell.
- Goldsmith, J. (1999). *A taxonomy of games*. Available at <http://www.gg.caltech.edu/~jeff/>. Last access in November 9th, 2005.
- Halttunen, K., & Sormunen, E. (2000). Learning information retrieval through an educational game. Is gaming sufficient for learning? *Education for Information*, 18(4), 289-311.
- Horn Abbot LTd. (2004) *Trivial Pursuit*. Available at www.trivialpursuit.com. Last access in November 16th, 2005.

- Huizinga, J. (1971). *Homo.Ludens*. UK: Beacon Press.
- Jenkins, H., & Squire, K. (2003) Understanding Civilization (III). In *Computer.Games.Magazine*. September 2003. Richmond, USA. Available at <http://www.educationarcade.org/modules.php?op=modload&name=Sections&file=index&req=viewarticle&artid=44&page=1>. Last access in November 15, 2005.
- Kernan, M. C., & Lord, R. G. (1990). Effects of valence, expectancies, and goal-performance discrepancies in single and multiple goal environments. *Journal. of. Applied. Psychology.*, 75, 194-203.
- Kiili, K. (2005). Digital game-based learning: Towards and experiential gaming model. *Internet. and.Higher.Education.*, 8, 13-24.
- Kirriemuir, J. (2002). *The. relevance. of. video. games. and. gaming. consoles. to. the. higher. and. further. education. learning. experience.* UK: Techwatch Report.
- Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological. Bulletin.*, 119, 254-284.
- Laurillard, D. (1998) Multimedia and the learner's experience of narrative. In *Computers.in.Education*, 31, 229-243.
- Loewenstein, G. (1994). The psychology of curiosity: a review and reinterpretation. *Psychological. Bulletin.*, 116(1), 75-98.
- Mason, B. J., & Bruning, R. (1999). Providing Feedback in Computer-based Instruction: What the Research Tells Us. Retrieved November 29th, 2006, from <http://dwb.unl.edu/Edit/MB/Mason-Bruning.html>
- Microsoft. (2006a). Bicycle games board. from <http://www.microsoft.com/games/bicycle/board/>
- Microsoft. (2006b). Flight Simulator X. from <http://www.microsoft.com/games/flightsimulatorx/>
- Mitchell, A., & Savill-Smith, C. (2004). *The.use. of. computer. and. video. games. for. learning.. A. review.of.the.literature.* UK: Learning and Skills Development Agency.
- Mory, E. H. (1996). Feedback Research Revisited. In D. H. Jonassen (Ed.), *Handbook.of.research.for. educational.communications.and.technology:..A. Project.of.the.Association.for.Educational.Com-munications.and.Technology* (pp. 745-774). New York, USA: Macmillan.
- Nimwegen, C. v., Oostendorp, H. v., Schijf, H. J. M., & Burgos, D. (2005). The Paradox of the Assisted User: Guidance Leads to more Shallow Behavior. Proceedings of SIGCHI conference on Human factors in computing systems. April 22 - 27, Montreal, Quebec, Canada: ACM Press.
- O'Hara, K. P., & Payne, S. J. (1999). Planning and the user interface: The effects of lockout time and error recovery cost. *International.Journal.of. Human-Computer.Studies.*, 50(1), 41-59.
- Piaget, J. (1962). *Play,.dreams.and.imitation.in. childhood.* New York: Norton.
- Prensky, M. (2001). *Digital.games-based.learning.* New York: McGraw-Hill.
- Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations and games. In *Educational.Technology.Research. and.Development*, 44(2), 43-58.
- SEGA. (2005). Rome. Total War. Barbarian Invasion. from www.sega.com.
- Squire, K. (2002). Video games in education. *International.Journal.of.Intelligent.Simulations. and.Gaming.*, 2(1).
- Squire, K. (2005). Changing the Game: What Happens When Video Games Enter the Classroom?

In *Innovate* 1(6). Florida: Nova Southeastern University. Available at <http://www.innovateonline.info/index.php?view=article&id=82>. Last access in November 15, 2005.

Squire, K., & Barab, S. (2004). Replaying History: Engaging Urban Underserved Students in Learning World History Through Computer Simulation Games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Embracing diversity in the Learning Sciences: Proceedings of the sixth international conference of the Learning Sciences* (pp. 505-512). Mahwah, NJ: Lawrence Erlbaum Associates.

Svendsen, G. B. (1991). The influence of interface style on problem solving. *International Journal for Man-Machine Studies*, 35.

Turkle, S. (1995) *Life on the screen: Identity in the age of the internet*. New York: Simon&Schuster.

Van Rosmalen, P., Vogten, H., Van Es, R., Van, P., H., Poelmans, P., & Koper, R. (2006). Authoring a full life cycle model in standards-based, adaptive e-learning. *Educational Technology & Society*, 9(1), 72-83.

Vygotsky, L. (1978) *Mind and society*. Cambridge, MA: MIT Press.

Weber, R. A. (2003). *Learning and Transfer of Learning with No Feedback: An Experimental Test Across Games*.

Wishart, J. (1990). Cognitive factors related to user involvement with computers and their effects upon learning from an educational computer game. *Computers Education*, 15(1-3), 145-150.

Zhang, J. (1997). The nature of external representations in problem solving. *Cognitive Science*, 21(2), 179-217.

Zhang, J., & Norman, D. A. (1994). Representations in distributed cognitive tasks. *Cognitive Science*, 18, 87-122.

Chapter IX

Profiling Users in Educational Games

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ABSTRACT

For a long time, users' emotions and behaviours have been considered to obstruct rather than to help the cognitive process. Educational systems have based their learning strategies almost solely at a cognitive level and the internal state of the learner has often been ignored. Even if it is now recognized that learners' personalities and learning styles influence greatly their cognitive process (e.g. Multiple intelligences), very few systems have managed to profile users and adapt the educational content accordingly. Part of the reason for this is the difficulty to measure learning styles reliably and to establish a valid model that accounts for most of the major factors contributing to learning. Furthermore, since the introduction of formal education, it can be argued that learning has lost its playful and emotional aspect, whereby information was transmitted through story telling and play. On the other hand, video games have become a very popular medium among our digital natives. They provide a rich sensory and emotional environment in which they can experience a state of flow and are willing to stay for extended period of time. Despite of initial preconceptions on the negative effect of video games on young adults, it is now admitted that video games implicitly include many instructional design strategies (collaboration, exploration, Socratic dialogues, zone of proximal development, etc.) that could be harnessed to make formal education an experience that is more interactive and rewarding. One of the key features of video games is the ability to provide a content that matches players' emotional needs (e.g. recognition, social bounding, self-esteem, etc.) and that provides a wide range of interaction... The authors believe that this potential can be harnessed to create an educational content that matches users' learning styles.

and motivations. They propose the PLEASE model (Personality, Learning styles, Emotions, Autonomy, Systematic Approach and Evaluation). This model addresses some of educational games design issues (e.g. choice of instructional strategy, type of feedback required, etc.); it categorizes and profiles users' learning styles in the light of educational and personality theories and defines a set of practical strategies for educational games designers in order to match students' learning styles and provide a user-centred content that is both motivating and educational. The authors explain how the Big-5 can be a more reliable alternative to measure learning styles, how emotions and personalities can be accounted in the cognitive process (e.g. information retrieval, memory retention, etc.) and also describe experiments they carried out in Cork to assess the effect of user-centred approaches in educational game design. Results are analysed and contrasted with current practices to show that unless personalities are accounted for in educational games, the educational outcomes could be different or even opposite to the one expected.

INTRODUCTION

In this chapter, the authors will describe the work they have carried out to assess the potential of educational video games to teach Mathematics to secondary school students. They describe the PLEASE model, a model that encompasses instructional design, educational psychology and game design theories to improve the design of more engaging and effective educational games.

The Please Model

History and Rationale

Since the 1970s, a new generation of students have emerged. They use digital devices extensively, and more importantly, they are avid video gamers. Computer games have had a profound impact on the way the vast majority of young people process information. They include many features that are not yet acknowledged or used in school settings but that might facilitate the learning experience. Video games represent real learning environments where learning occurs naturally to overcome challenges posed by the game play. In this context, video games can be compared to a language that supersedes current

languages. Using video games, young students can express themselves, communicate ideas, and collaborate with other peers. Using such a medium for teaching can prove effective to both motivate and illustrate effectively concepts and ideas to this young generation of students. While the military and some companies have embraced the use of video gaming technology to train new recruits, the move in the academic sphere has been slower, even if software such as Second-Life is progressively assessed and recognised as a valuable asset for collaborative and exploratory learning.

Video games can be compared to micro-worlds offering a wide range of opportunities for learning and adapting to each individual's learning style and preferences. Their rich interactive environment makes it possible for individuals to learn in a way that suits their abilities. Collaborating, reflecting, interacting with the content are some of the many possible ways to learn in these environments. However, despite a promising educational potential, video games designers still need to find means to adapt dynamically the content and the structure of the game depending on students' profiles. User profiling is a growing research field that aims to categorise the players and find ways to predict their actions, preferences or needs.

Developing educational games that adapt dynamically to users' cognitive and emotional

state represents an interesting challenge for developers and educators. The authors will describe their approach to designing dynamic educational games through the PLEASE model (**P**ersonality **L**earning styles **E**motions **A**utonomy **S**ystematic approach and **E**valuation). This model, inspired by observations of students' behaviours, accounts for users' differences at cognitive and emotional levels and offers a solution based on game design techniques to maximize learning strategies and outcomes. The following sections will explain the rationale for this model, its theoretical foundation and experiments carried-out to assess its validity.

BACKGROUND

Since March 2005 the authors have been involved in a project to evaluate the educational benefits of video games for teaching mathematics and sciences in secondary schools. This project involves teachers and students of two Cork secondary schools and seeks to help students to improve their skills and motivation for scientific topics through rich interactive experiences. Overall, it aims to address the issue of the shortage of science students at college level. By increasing their interest and proficiency in sciences, the hope is that they will embrace a scientific career after their leaving certificate. This project was initiated by a discussion with a school liaison officer in University College of Cork who had identified a need for more interest in scientific careers. This view was confirmed during further interviews with teachers. They expressed their concerns about students' lack of enthusiasm for scientific topics and the need to introduce tools and methodologies that could improve both their motivation and academic results. Subsequent meetings were conducted to identify areas of the curriculum that might benefit from a Game Based Learning (GBL) approach and several issues with existing tools were identified:

- Available software packages were often not based on the curriculum and failed to support teachers' classes.
- Training material often failed to engage and motivate students.
- Time available to use these tools was often limited making some of the tools unusable.

It was decided that a video game would be developed to support the teaching of algebra skills. To determine the format and structure of the game, it was decided that a survey would be conducted to evaluate pupils' preferences for particular types of games, their level of familiarity and proficiency at playing games. The questionnaire was designed and implemented through web technologies (PHP) to facilitate the collection and analysis of answers. It included a total of 19 questions in three different sections: game preferences, game qualities and personal information (e.g. gender, age, etc.). It included a combination of closed and open-ended questions. The questionnaire started with a brief introduction on its purpose, the topics covered and how the results would be used. 41 pupils aged between 13 and 14 (2nd and 3rd year) took part in the survey. Analysis of the responses showed that the majority of the pupils played video games (56%). They often preferred role-playing games and played regularly (once a week for 29.7% of the respondents). Interestingly, only 20% of the respondents had played an educational game previously and very few of them (20%) enjoyed them.

The game was named MathQuest and was designed to accommodate pupils with no frequent or prior experience of video games and to be played on a number of different platforms. Java3D was chosen as a programming language for this game as it allowed for platform independence as well as relatively fast 3D content creation. It featured a 3D-maze in which players had to navigate and find the exit to the next level in less than twelve minutes. Each level included a set of doors that

players had to open to progress further in the game. To open a door, players had to solve a linear equation, which consisted of five steps. The following screenshots shows the sequence of events encountered by players.

When the game is loaded, players can click on the green button to see the instructions (see Figure 1).

Instructions are provided to players on their objectives and controls (see Figure 2).

Players need to navigate through the maze. They have access to a map (top left corner) that can be hidden if necessary.

- Green square: symbolizes the exit.
- Blue Square: symbolizes a door.
- Red Square: the players' location
- Time is also displayed (top left corner) (see Figure 3)

When users are near a door, they are asked to solve an equation (see Figure 4).

After solving equations and finding the exit, players can access the next level. A map of the maze is also available; it shows the location of the user but also doors and the exit of the current level (see Figure 5).

The video game was developed using an incremental process whereby students and teachers were actively involved in the design of the game to make sure it was usable, educational and fun

Figure.1..Splash.screen



Figure.2..Instructions.screen

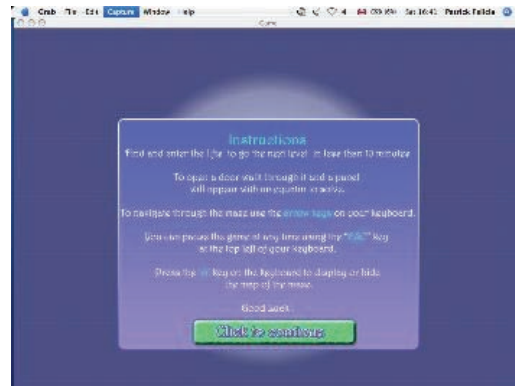
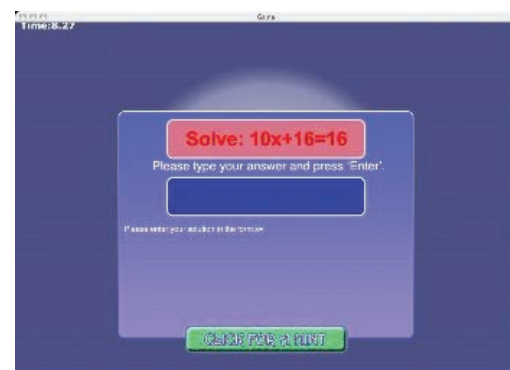


Figure.3..First.level



Figure.4..Solving.an.equation



to play. An iterative approach was used and feedback was noted and implemented in subsequent versions.

The game included a tutoring system able to track users' knowledge and misconceptions and

Figure.5..Second.level



to trigger appropriate corrective actions. The core of the tutoring system includes four separate modules: expert model, pedagogical model, student model and interface model.

- The expert model included knowledge to be gained by users on solving equations.
- The pedagogical model included strategies to apply to teach the required skills.
- The student model included information on the user such as: proficiency for a particular skill, common mistakes, time to complete equations and levels, etc.
- The interface model included different modes of representation of the information to the user. The software was also available as a text-only version (for testing purposes).

Using a controlled study, the educational effectiveness of the software was assessed. The experiments included two groups of students. Both groups had to take a written pre-test and post-test. The tests were divided into two sections. In the first section, students had to solve five equations and specify for each of them the steps followed to obtain the result. In the second section, students had to answer five additional questions. For these questions, they were asked to specify using an MCQ (Multiple Choice Question) which next step they would take to solve a particular equation. An

example of questions in this section would be: “If you had to solve $2x-2+2=4-2$, what would you do?”. Teachers had previously assessed each test. In the first section of the test, marks were awarded to students based on the results, accuracy and the level of detail of their answers (steps described). In the second section marks were awarded based on the answer selected. The two groups took the pre-test and post-test at the same time. They also played the video game at the same time and in the same room. The students were randomly assigned to the control group (A) and experimental group (group B). Students who belonged to groups A and B played two different version of the game. In the first version (group A), the game did not include any educational content and students were told that the game was designed to improve their spatial skills. In this version of the game, students needed to navigate through a maze, find and collect at least five boxes and reach the exit of the current level. The second version of the game included educational content and was designed to improve students’ mathematical skills by requiring them to solve equations as a condition to progress further in the game. In this version, students needed to navigate through a maze, open doors and reach the exit to the next level. However, in order to open a door, it was required that students solved an equation. Throughout the solving process, a tutoring system would help students, analyse their mistakes and misconceptions and provide dynamic feedback.

Initially, it had been planned that the control group would not play the game. However, teachers advised that all students played the game (in different versions) for none of them to feel left out.

Table 1 shows the difference between the pre and post-tests for both control and experimental groups.

Table 1 shows that the average marks for students who played the educational game have improved more than for those who played the placebo. It confirms that the game can bring noticeable improvements to the understanding

Figure 6. Game in educational mode. Walls are represented by grey squares, doors by blue squares, exit doors by green squares and the user is symbolized by a red square. Information on the significance of the coloured squares is provided below the map.



Figure 7. Game in placebo mode. Boxes are represented by pink squares on the map. For each additional box collected, a white square appears to the left of the text. "Boxes". One of the boxes to be collected can be seen at the bottom-left corner of the image.



of the process involved in solving equations and can therefore be effective to teach topics that could otherwise seem uninteresting. This study also provided an insight into the different ways in which the students benefited from the software. Several patterns, identified by teachers and the designers, suggested that behaviours and the emotional state of the pupils could have a significant impact on the way they could learn through the video game. Whereas some pupils were shy, introverted and nervous when playing the video game, some other pupils displayed more

extraverted and confident behaviours and seemed to outperform their classmates. Some other students, when asked to solve an equation, entered random solutions until it worked.

Table 1 shows that the two groups did not have similar average marks for the pre-test and suggested that the group B was generally initially more proficient at solving equations than group A. A discussion with teachers after the pilot group confirmed this assumption. They had assumed that the game would be more beneficial to pupils with lower skills and therefore decided that these

Table.1..Measuring.the.effects.of.the.educational.game,.marks.for.pre-.and.post.tests

Group Type	N	Mean		Improvement
		Pre-test	Post-test	
Control (A)	20	66.67%	57.50%	-0.14%
Experimental (B)	21	35.44%	60.46%	+70.60%

pupils would be allocated to group B. The results suggest that their assumption was partially correct in that the game would be highly beneficial for pupils who had great difficulties understanding the process of solving equations. It is believed that a slight confusion occurred between the groups A and B during experiments, which corrupted some of the results and their statistical analysis. It is possible that some of the pupils who belonged to the group B took part in the experiment as if they were part of the group A, hence lowering the percentage of improvement for the control group (-0.14%).

Following this study, it was decided that further research would be conducted in order to discover links between personality, emotions and learning in video games. The hope was that by understanding the interaction between pupils and the educational software at both cognitive and emotional levels, it would be possible to provide an environment that suits their preferences and emotional response and hence improve the learning outcomes.

The Importance of Personalizing Systems for Improved Learning

About Personality and Learning

In 1983, Gardner introduced the principle of multiple intelligences, which implied that individuals possess natural predispositions to understand specific topics and to process information. This is often referred to as learning or cognitive styles.

It is expected that, when students are taught in an environment that matches their learning style, relevance, interest in the topic taught and motivation can be increased (Lambert et al., 2002) and, as a result, educational outcomes can be improved (Levine, 1999; Green et al., 2006, Lambert et al., 2002). Learning styles have three essential aspects: cognitive (perceiving thinking, problem-solving and remembering), physiological (e.g. gender, nutrition, health and reactions to physical environment) and affective (e.g. personality, motivation, peer interaction, etc.) (Reef, 1992; Keefe, 1988). Whereas formal education has been focusing on cognitive aspects of learning styles, it can be argued that more emphasis should be put on the emotional aspect of leaning.

The difference between individuals' learning styles has been widely recognised among educational practitioners and educators. However, very few educational software packages have harnessed this potential despite increasingly personalized and rich interactive day-to-day applications. Part of the reason for this could be that it is very difficult to measure factors that influence learning; these factors can be multiple and complex (cultural background, behaviour, environment, etc.). Another issue is that learning styles can evolve over time; as a result, their measurement might be unreliable (Brown et al., 2006). Also, tools to measure these learning styles might lack validity and methodologies used to gather data might not always account for potential bias such as placebo effect, as suggested by Coffield et al. (2004).

Whereas the measurement of learning styles can prove difficult and unreliable, more reliable and accurate tools have been developed to assess

personality traits. While the study of personality cannot explain all the differences in learning styles, it is accepted that there are correlations between learning styles and personality traits and that it is possible to explain some information seeking strategies by analysing individuals' personality types or traits (Child, 2004; Honey and Mumford, 1982; Riding and Wigley 1997). For example, personality traits such as Neuroticism (e.g. prone to anxiety) can have a profound negative impact on working memory (Eysenck 1992; Calvo and Eysenck 1996; Elliman et al 1997; Hopko and Gute 1998). Conversely, if anxiety can be reduced then learning performance can be improved.

Learning styles represent a subset of personality characteristics (Jackson and Lawty-Jones, 1996) and hence can be measured through personality tests (Furnham, 1992). For example, the NEO-PI (Costa & McCrae, 1985, 1992) was proved to be correlated to the Eysenck Personality inventory (Eysenck and Eysenck, 1964) and to other thinking style variables such as creativity and divergent thinking (McCrae, 1987) and achievement motivation (Busato et al., 1999). Likewise, Zhang (2006) has identified that thinking style can vary according to personal characteristics, that teachers' thinking style is influenced by their teaching experience and that their evaluation of a student's work can also be influenced by the student's learning style. Their results show that Neuroticism could explain 41% of the variance in thinking styles whereas extraversion had the least influence explaining only 29% of the variance.

About Personality Traits and Styles

The field of personality study analyses common characteristics and behaviours across humans; it helps predict emotional response and behaviours in particular situations. This field is quite mature and tools to measure personality type or traits have been developed and recognized to be both valid and reliable. Furthermore, studies grounded

in educational psychology have determined correlations between students' personalities, their preferences for learning content and interactions between teachers' and students' personality types. The advantage of such an approach to determine and assess learning style is that personality types are relatively stable over a long period of time.

Personalities can be analysed and described in terms of personality traits or personality types. For the former, an individual belongs to only one of several pre-defined categories whereas, for the latter, individuals' personalities can be described in a 5-dimensional space. Personality types and personality traits can be respectively measured through the MBTI (Myers-Briggs Type Indicator) and the Big-5 model. These are two widely recognized personality models among psychologists that allow for a reliable and valid assessment of personalities.

The MBTI model was developed by Myers and Briggs (1980). It indicates peoples' preferences for a particular type of interaction or way of thinking rather than an ability and makes it possible to measure personality types. Not only does this model provide a solid basis for the prediction of human behaviour but studies also show that the categories it comprises can be correlated to learning preferences and information seeking strategies in information systems. Categories of this model include: Extraversion-Introversion (E-I), Sensing-Intuition (S-N), Thinking-Feeling (T-F) and Judgment-Perception (J-P). Each of the 16 personality types present in the MBTI is a combination of four mutually exclusive dichotomies (E-I, S-N, T-F and J-P). For each dichotomy, individuals do not have levels but instead a preference for one of its components (e.g. either Extraversion or Introversion, Sensing or Intuitive, etc).

The big-five model was initially introduced by Thurnstone (1934) and Norman (1963) and then further refined by McCrae and Costa with the NEO-PRI (1985). It uses five dimensions to measure people's personality: Openness (eager to learn and open to new experiences), Consci-

entiousness (hard worker), Extraversion (enjoys social interaction), Agreeableness and Neuroticism (prone to stress). In this model, individuals can have a combination of different levels (low or high) for each personality trait. The IPIP (International Personality Item Pool¹), a methodology based on the Big-five model, was created to measure personality traits through a set of 50 questions. Results show that the IPIP is reliable, valid and that it allows for an easy computerisation of the results.

There are correlations between the two models (McCrae and Costa, 1989; Furnham, 1996). E-I, S-N, T-F and J-P are respectively correlated to Extraversion ($\alpha = -0.74$), Openness ($\alpha = 0.72$), Agreeableness ($\alpha = 0.44$) and Conscientiousness ($\alpha = -0.49$). This makes it possible to extend some of the educational findings based on the MBTI to the big-five model and vice-versa.

Using Video Games to Provide New Means to Adapt to Learning Styles

Throughout the evolution of educational technology, the design of instructional software and tutoring systems has been significantly influenced by educational theories. Whereas CAI (Computer Assisted Instruction) was essentially based on behaviorist theories, subsequent versions applied cognitivist theories in an attempt to model and predict subject's cognitive processes. More recently, the emergence of 3D virtual learning environments has made it possible for students to learn by doing. This constructivist approach to learning is an opportunity for students who enjoy interacting with objects and other participants as part of the learning process. Recent systems such as Slooodle² encompass both benefits of tutoring systems and virtual reality. In these settings, users can achieve learning outcomes in many different ways. They can interact with their peers, use rich interactive content and interact with objects to further their understanding of a particular topic. For this reason, video games seem to be more

suitable than traditional school settings to adapt to students' preferences for learning.

The Role of Emotions in Learning and Video Games

The Role of Emotions and Emotional Intelligence in Education

Emotions are strongly related to motivation (Schilling, 1996) and they both play a major role in learning (Maslow, 1968). Educational content devoid of emotions makes the educational experience less vivid for students and also makes it more difficult to apply educational experiences to real world situations (Shilling, 1996). However, emotions have for long time been ignored in the educational system (Silberman, 1970; Neil, 1960). According to Astleitner & Hermann (2000), positive and negative emotions should be accounted for to accommodate and promote learning. It is advised that, to support learning activities, negative emotions such as fear or anger should be avoided, and that positive emotions such as sympathy and pleasure should be promoted. However, the polarity of emotions (positive or negative) can have both a positive or negative impact on the learning activities depending on the task in hand and on the learner's personality (Salovey et al., 2000). For example, positive emotions are associated with an open approach and creativity whereas negative emotions might trigger more focused and deliberate strategies. Furthermore, positive emotions impact more significantly on memory (Singer & Salovey, 1988) and the cognitive process (Stege et al., 1994).

The way individuals encode or recall information is usually influenced not only by the emotions of the learner at encoding but also by the emotional content or tone of the material to be learnt (Parrott and Spackman, 2000). Any information to be understood and memorized is analysed in the working memory, which controls

and integrates visual, spatial and verbal information (Riding, 2002). However, working memory differs across individuals (DaneMan and Carpenter, 1980) and can be influenced by emotions such as anxiety (neuroticism-stability). It is agreed that meaningful learning occurs when the new material is compared to existing knowledge and then incorporated and organised in the long-term memory according to students' cognitive styles. Therefore, positive emotions, curiosity and passion drive students toward their goals.

Perceiving and managing emotions can also have a profound impact on learning activities and it is suggested that emotions can help to promote self-awareness, decision-making and stress-management (Schilling, 1996). Emotional Intelligence has been outlined and shown to be in accordance with Gardner's theories on intra-personal and interpersonal skills (Salovey et al., 1990) which consists in knowing ones emotions, managing emotions, motivating oneself, recognizing emotions in others and handling relationships. Emotions and Emotional Intelligence progress and mature through childhood. For example, research has shown that some emotions such as shyness or boldness are genetically encoded but can however be improved with some experience (Schilling, 1996). Emotional Intelligence allows subjects to acquire and apply emotionally charged information. It has an impact on both learning and behaviours and it is agreed that Emotionally Intelligent pupils usually perform better and are less disruptive than their peers. Furthermore, it is suggested that IQ scores only account for 20% of success in challenges faced in daily life and that the remaining 80% can be predicted using Emotional Intelligence (Goleman, 1995). The reason for this is that IQ measures only cognitive skills but not emotions, which are in fact responsible for motivation, which to a certain extent affects the desire to learn and to achieve (Schilling, 1996).

According to their personality dominant traits, individuals can be more inclined to feel particular

emotions. For example, people with a high level of Neuroticism are inclined to feel negative emotions. Extraverts will be more inclined to feel positive emotions but they also will feel more intensely the excitement of a reward, which to some extent makes positive reinforcement an appropriate technique to improve learning (Depue and Collins, 1999).

Emotions in Educational Games and Intelligent Tutoring Systems

Video games allow players to feel a wide range of emotions (Lazzaro, 2004; Freeman, 2003) and to role-play through characters. By feeling and empathizing, children can develop their emotional intelligence and indirectly become better at learning, be more motivated and focused. In addition, role-playing can also increase emotional awareness; because role-play makes them aware of the feelings that one might experience in specific situations (e.g. bullying). As suggested by Shilling (1996) "The brightest future belongs to students who develop EQ along with IQ" and video games might well help the development of emotional skills.

There is a link between emotions, game play and interactions in video games. Emotions can be induced by game play variables and can influence players' behaviour and hence their interaction with the game. This interaction, if the game is of an open-ended nature, will in turn influence the game play. Conversely, changes in the system can be attributed to specific emotions. However, it is still difficult to measure emotions based on players' behaviours in video games. Some studies have correlated players' actions to the level of arousal of the player (e.g. pressure on the gamepad buttons; Sykes and Brown, 2003) however valence cannot always be measured accurately. Studies have managed to infer users' emotions based on their behaviour or to create virtual characters that show emotions. For example, Chaffar et al. (2005) have developed a system based on Gagne's

instructional conditions for learning. It induces emotions in users to support them through different learning stages (attention, acquisition, retrieval and response organisation).

Since emotions can play such an important role in memory retention and on the cognitive process, it is expected that designers should be able to influence how players learn in educational games using Mood Induction Procedures (MIP). For example, music can have a profound relaxing effect on subjects (Salamon et al., 2002) or conversely negative physical effects such as cardiovascular alterations, cardiac arrhythmias. When pleasant music is heard, positive memories and feelings can be experienced. Similarly, MIPs are designed to induce a specific feeling in a subject and can be achieved through a wide range of techniques including: self-statement, music, autobiographical recall or films (Banos et al., 2003). Some of these techniques (e.g. music, autobiographical recall, solitary recall and movies) can induce the required mood in 75% of cases, whereas other techniques such as Velten, social recall, facial expression and social feedback only achieve 50% (Velten, 1968; Gerrards-Hessert et al., 1994; Westermann et al., 1996). Some other methodologies based on the use of symbols and dialogues have been developed to create emotions in games (Freeman, 2003) and originate from the film industry.

Using Learning Styles and Emotions in Games: The Please Model

Rationale for the Model

The previous section has emphasised the benefits of considering pupils' emotions, personality type and learning styles to improve the effectiveness of educational games. It has illustrated how adaptive settings based on the users' internal state might improve both the cognitive process and motivation. Based on these observations,

Felicia & Pitt (2007) have created the PLEASE (Personality Learning styles Emotions Autonomy Systematic approach and Evaluation) which addresses common issues faced by designers and educators. Through this model, the authors provide guidelines and a systematic approach for educational game designers. It accounts for and analyses students' preferences, teachers' needs and environmental constraints. It also addresses learning at both cognitive and emotional levels but essentially focuses on a user-centred approach, whereby strategies are defined to accommodate students' personality and internal state.

Strategies Based on Personalities

Based on educational psychology theories, the authors have identified potential strategies to improve challenge and learning in educational games. They have identified five influential features for educational games: information type (true, false or misleading), information structure (e.g. linear), information presentation (e.g. audio, video, text, etc.), game structure (linear or open-ended) and type of learning activity (repetition drills, exploration, etc.). Based on the big-five model and related studies identifying information/learning preferences (Briggs-Myers et al, 1985; Keirse, 1998; Heinström, 2003), they established a model that specifies possible preferences in educational games based on personality traits.

Learning Styles and Information Seeking Strategies

Heinström (2003) carried out experiments aimed to evaluate how, based on their personality traits, subjects sought information in a computerized system. The study, based on the big-5 personality model, highlighted several patterns. It concluded that individual patterns of information seeking should be accounted for and that personality ought to influence information seeking-strategies. The study suggested that subjects with a

low level of Conscientiousness (careless subjects) might have a more impulsive and disorganised approach to learning whereas subjects with a high level of Conscientiousness will be more structured and methodical. Information seeking behaviours measured in this study included: time pressure as a barrier to information, confirmation of previous knowledge, critical information judgement, willingness to acquire new ideas from retrieved information and effort. The study showed that careless, competitive, sensitive and conservative subjects found it difficult to know if the information was relevant. Easy going, introverted, sensitive and competitive subjects experienced time pressure. Introverted, conservative and conscientious subjects preferred to retrieve information that confirmed their previous knowledge. Outgoing, open and conscientious subjects enjoyed acquiring new ideas. Moreover, extraverted subjects usually found information through informal sources like teachers and friends. The study concluded that subjects with high levels of Neuroticism were vulnerable to negative emotions, preferred confirming information and felt that lack of time was a barrier. Subjects with high levels of Extraversion preferred thought-provoking content. Subjects with high levels of Openness were prone to incidental information acquisition, critical information judgement, and enjoyed thought provoking content.

Learning Styles Based on the MBTI

According to Myers and Briggs, extraverted subjects, prefer to learn by doing through a process of trial and error whereas introverts prefer to reflect. Sensing students have a preference for concrete and tangible information, they are pragmatic and might prefer facts and data and therefore are ready to search further to find meaningful facts. Intuitive individuals have a preference for theoretical and conceptual information; they often see the bigger picture and how information gathered fits into a pattern or a theory. Thinking and Feeling

students make decision based on the information they receive. Whereas Feeling students will show empathy with the problem or situation encountered, thinking students will demonstrate a more deliberate and emotionally detached approach that will affect less their decision. Students with a preference for Judging are organised and prefer clear, structured material or activities that are planned well ahead of time. Perceiving students seems more flexible and might leave task until close to the deadline.

Personalised Strategies for Educational Game Design

Customizing the Type of Information Provided

Throughout video games, aural, visual or textual information is provided to users; they can be accurate, misleading, partial and false (Alessi and Trollip, 2001; Teem, 2001). This information can have different effects on players depending on their personality. Whereas misleading or partial information might increase challenge and motivation for users with a high level of Openness or Competitiveness, accurate information that confirms previous knowledge might be preferred for students with a high level of Neuroticism. In addition to the content of the information, the media used can also be tailored to students' learning styles.

Customizing the Format of Information Provided

Feedback in video games is essential so that students can reflect upon their action and perform corrective actions. Whereas time information might have a negative impact on students with a high level of Neuroticism, ranking information might be beneficial to students with a high level of Competitiveness as they strive to outperform their peers. In addition, feedback can also include emotional content. Whereas motivating or challenging sentences might be used for students

with a high low level of Neuroticism, reassuring sentences might be preferred for students with a high level of Neuroticism.

Learning by Doing or Using Booklets

Whereas players generally prefer to learn about a game by playing, booklets might prove useful for students with a high level of Neuroticism, Conservatism and Introversion because they enjoy written material and feel more confident using a medium or information that confirms or relates to information they already know. Demo levels where players can experiment with the game mechanics might be especially suited to students with a high level of Openness because they can enjoy exploring and experimenting without being penalised for incorrect moves or actions.

Linear vs. Open-Ended Game Play

According to Aldrich (2001), game-play can be of at least three types: linear, cyclical (drill and practice) and open-ended. Linear content might be especially suitable for users with a low level of Openness because they like clear objectives and structured material. On the other hand, open-ended content might appeal more to users with a high level of Openness who show a high degree of creativity and enjoy exploration. Cyclical information might be especially suitable for students with a high level of Neuroticism but might have the opposite effect for student with a high level of Openness who can see the bigger picture and might find repetition boring. Discovery learning might be used instead.

Using NPC Behaviours and Dialogues

NPCs in video games can be used to increase the emotional impact on players and also provide alternatives to find information by engaging in dialogues. Students with high level of Agreeableness who are prone to empathise with specific situations might appreciate dialogues with NPCs which use emotions that might touch the player.

Using Books and Videos

Video games often include items that can be found by players. Books or any written material might be suitable for players with a high level of Introversion.

Strategies Based on Emotional Response

The Neuroticism trait present in the big-five model often measures an emotional dimension for individuals and it is recognised that subjects with a low level of Neuroticism will have a relatively stable mood, which would allow mood dependent and mood independent techniques to be used efficiently. The authors suggest that positive moods could be used to:

- Facilitate the cognitive process,
- Facilitate creativity,
- Reassure subjects prone to stress,
- Create dialogues that engage players' emotions (e.g. empathy, pride, etc.).

These moods can be induced using music, especially with subjects with a low level of Neuroticism (Salamon et al., 2003; Banos et al., 2003). Therefore, the aural dimension of the game should be considered at the initial stage of the design of educational game. If the music is not synchronized to the game play, players can be distracted and their gaming "experience" affected. Sounds affect the users' mood and should be given as much importance as colours or graphics. Game designers and sound engineers should work together to provide each other with useful feedback and improve the overall game-design. The creation of a music design document can help this dynamic collaboration by defining what parts of the game should have music, what style of music is best for the game, when the music be ambient or intense, how transitions should be applied or aspects of the game could benefit from musical accents (Witmore, 2003). Correlating sounds to

the type of learning activities and methodologies early in the design process should allow for more effective mood induction techniques and hence improve results.

Systematic Approach

It is recognised that despite the obvious educational potential of several video games available on the market, some cannot be used in schools because they are not initially designed to match the environmental needs and curriculum requirements. Even if, in many cases, they increase motivation on the part of the student, it is often difficult to evaluate the knowledge gained due to playing the game; moreover, knowledge transfer can become an issue and there is a need to ensure that mechanisms that maximise knowledge transfer are developed. This lack of transparency and accountability is due to the fact that some of these software packages were designed with no particular learning outcome. On the other hand, developing video games that support particular topics can prove expensive and it is therefore suggested that they could be built with flexibility in mind, allowing teachers to create scenarios based on the lesson in hand (Alessi and Trollip, 2001).

According to Becta (2001), factors influencing the good design of educational games are not only related to the content or structure of the game but essentially to the software design process and the understanding of the real constraints (other than motivation) imposed on both learners and teachers (settings, time, curriculum, etc.). Educational games should be designed to support and complement current teaching practices. For example, when the game is used in the classroom, teachers should be given the opportunity to focus on specific parts of the game to support their lesson plan (e.g. using pre-defined scenarios and scenario builders). They should be provided with tools to create such scenarios and hence decrease the time needed to prepare related teaching. In addition, teachers should be provided with game

playing ideas for the classroom and guidance and the way the game might be used (McFarlane et al., 2002). An approach based on Analysis, Design, Development, Implementation and Evaluation (ADDIE) should ensure that both educational and motivational objectives are met. It has the potential to address most of today's educational game pitfalls because it is an iterative instructional design process based on learners' needs and governed by learning outcomes. It also accounts for the environmental constraints through needs assessment, problem identification and task analysis, and includes an evaluation process to determine the adequacy of the instruction. As suggested by Fullerton (2004) and Rouse (2001), game design is an incremental process whereby new specifications can be discovered as the video game is being developed, however learning objectives and educational outcomes should be specified at an early stage in the process to make sure that the game play allows for learning opportunities.

Assessing the Model

A study was carried out to assess the ideas proposed in the PLEASE model. The authors particularly sought to find out whether there was a benefit of displaying time for students with a high level of neuroticism or displaying ranking information for students for students with a high level of competitiveness. The study also sought to determine if there was a link between users' personalities and their action during play and if particular game genres were most suitable to specific personalities. The hypotheses were as follows:

- **H₁:** Students with a high level of Neuroticism for whom time is displayed during the game will learn significantly better than those for which time is not displayed
- **H₂:** Students with a high level of competitiveness for whom ranking information is displayed will learn significantly better than

students for whom ranking information is not displayed

- **H₃:** Students with a low level of conscientiousness whose answers are systematically questioned will learn significantly better than those whose answers are not questioned
- **H₄:** Students with a low level of conscientiousness whose answers are not systematically questioned will earn significantly worse than those whose answers are questioned
- **H₅:** There will be a statistical difference in game style preferences between students with two significantly different personality profiles
- **H₆:** There will be a statistical difference in preferences to seek for information inside the game between students with two significantly different personality profiles

A controlled study was carried out involving 80 students from two secondary schools aged between 13 and 14. Students' personality was measured through an online questionnaire using the IPIP methodology. The following sections explain the construction of the questionnaire as well as the IPIP methodology.

Constructing the Personality Questionnaire

A questionnaire was initially built to measure the students' personality traits (in the light of the big-5 model) prior to playing the video game. This questionnaire was based on the IPIP and included a total of 50 questions, each assessing a particular personality trait. The reliability of the questionnaire was measured using the split-half method to avoid possible sources of variability (Thorndike, 1949) such as test-wiseness, stable response, health, fatigue, motivation, comprehension or sheer guessing. Results showed that the questionnaire was highly reliable with a confi-

dence of 95%. The validity of the questionnaire was measured to detect if users had answered in a sociably desirable manner and avoid possible bias; an analysis of the standard deviation revealed that only three students answered in a socially desirable manner.

About the IPIP

Most of the personality inventories developed since 1917 are in the public domain but have a limited bandwidth because they measure three traits at most. On the other hand, broad-bandwidth personality inventories such as the MMPI³, the NEO-PI⁴ or the 16PF⁵ are proprietary and therefore cannot be used freely by scientist. These tools are rarely revised, and their validity is not compared to other tools. The IPIP was created to address these issues. It makes it possible provide an accurate, up-to-date and freely available information on personality traits (Goldberg, 1999; Goldberg et al., 2006). The following table illustrates how questionnaire can be constructed using the IPIP including sample questions.

Table 2 illustrates how a questionnaire can be constructed using the IPIP. Questions 1,2,3,4,5 are respectively correlated to Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness. The sign before the question indicates if the question is positively or negatively related to the personality trait assessed. The personality traits are cyclically assessed. For example extraversion is assessed in questions 1,6,11, etc. For every cycle, the sign of the relationship between the personality trait assessed and the question changes. The IPIP used for the personality test includes 50 questions. For each question, subjects need to describe themselves and how they react or feel in particular situations by answering using a five-point Likert scale. Each answer is correlated to a personality trait (Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism). For questions related positively to a personality trait, the answer "Strongly Agree"

Table.2..An.example.of.questions.and.associated.personality.traits.for.the.IPIP

Question	Personality trait assessed	Sign	Question
1	Extraversion	+	Am the life of the party
2	Agreeableness	-	Feel little concerns for others
3	Conscientiousness	+	Am always prepared
4	Neuroticism	-	Get Stressed out easily
5	Openness	+	Have a rich vocabulary
6	Extraversion	-	Don't talk a lot
7	Agreeableness	+	Am interested in people
8	Conscientiousness	-	Leave my belongings around
9	Neuroticism	+	Am relaxed most of the time
10	Openness	-	Have difficulties understanding abstract ideas
...	...	...	...

corresponded to a score of five, and the answer “Strongly disagree” corresponded to a score of one. If the question is negatively correlated to a personality trait, the answer “Strongly Agree” has a score of one, and the answer “Strongly disagree” has a score of five. The scores are then added for each of the personality traits to determine the resulting levels. To determine if a subject has a high or low level of a particular personality trait, the following method was used in accordance with the NEO-PI-R manual (Costa & Mc Crae, 1992):

- Compute the mean for the set of scores collected for all students
- Compute the standard deviation for the set of scores collected for all students
- Scores within .5 and -.5 standard deviation of the mean are designated as average
- Scores below .5 standard deviation of the mean are designated as low
- Scores above .5 standard deviation of the mean are designated as high

The Experiments

The experiments were conducted as follows:

- Pre-test
- Play the game
- Post-test
- Questionnaire on game preferences
- Questionnaire about the game

The game used for these experiments was a modified version of the initial game MathQuest. Additional features made it possible for the game content to adapt to players' personality traits.

Knowledge gained was measured by calculating the absolute improvement between pre- and post-tests. Preferences for game styles and information seeking strategies in the game were measured through a questionnaire with a five-point Likert scale for each question. Data was analysed with the Mann-Whitney U test and a factor analysis.

Pupils were invited to take a written pre-test on linear equations and then to play the educational game. They would login into the game using a unique identifier, and their profile and group would be retrieved from a database. The game would then tailor its content and structure (e.g. displaying time, access to ranking information, probing players' answers) according to the student's profile. Written pre- and post-tests were used to assess knowledge gained by students.

Questionnaires were provided before and after the experiments to assess students' preferences for video games, their information seeking strategies in games (e.g. how they would obtain information), to evaluate how they appreciated the game and how it affected or improved their confidence in solving equations.

The pre and post-tests were similar to the tests used in the previous study. The tests were divided in two parts and comprised a total of 10 questions (five questions in each part). In the first part of the test, students were asked to solve a linear equation. They were required to describe all steps used leading to the result. Marks were awarded for the solution and the different steps explained. In the second part of the test, students were given an equation and had to select the next step to solve the equation using an MCQ (Multiple Choice Questions). For this part of the test, answers were mutually exclusive and only one answer was correct. Marks were attributed to correct answers. Tests were taken in a classroom supervised by a teacher. The pre- and post-tests had similar structure and level of difficulty. Students scripts were corrected and results saved on a spreadsheet. The knowledge gained was measured as the difference between the score obtained for the pre-test and the score obtained for the post-test. After the test, students were given a questionnaire evaluating how they felt playing the game had increased their confidence in solving equations and if they would be willing to use the game at home.

Following the collection of data, a statistical analysis was carried out to assess the three hypotheses mentioned previously. Mean and standard deviation of the pre-, post-test and post questionnaire's answers were measured for each group. A Mann-Whitney test was used to assess the statistical significance of the results. In addition, in the view to determine how personality traits were correlated to information seeking strategies and players' behaviours in video games, a factor analysis was carried out. The independent (explanatory) variables were the personality traits

levels for each student. The dependant variable reflected information seeking strategy and behaviours in games.

For the hypothesis H_1 (influence of displaying time for users with a high level of Neuroticism), students who belonged to the experimental group had to complete each level within 12 minutes and the time was displayed in the upper left corner of the screen; students who belonged to the control group did not have any time constraints. Therefore, no time was displayed on the screen.

For the hypothesis H_2 (influence of displaying ranking on users with a high level of Competitiveness), students who belonged to the experimental group had to complete each level within 12 minutes. Time and real-time ranking were available in the upper left corner of the screen; students who belonged to the control group did not have any ranking information available on the screen.

For the hypothesis H_3 and H_4 (influence of probing answers for users with a low level of Conscientiousness), when asked to solve an equation, students were asked to confirm their answer (e.g. *"Are you sure this is the correct answer.?"*). This offered an opportunity for students to reflect upon their answer and to reduce the occurrence of lucky guesses. The frequency of the confirmation messages was based on students' previous answers (the more accurate the previous answers and the less often the students were asked to confirm their answer). Students who belonged to the control group were never asked to confirm their answer.

For the hypothesis H_5 and H_6 (influence of personality on game and information seeking preferences) results from the post questionnaire were used to determine trends.

Influence of Time on Subjects with High Level of Neuroticism

The following table shows the results for the first hypothesis [Students with a high level of Neuroticism for whom time is displayed during the game will learn significantly better than those for which time is not displayed].

Table 3 shows that displaying time in the educational game for subjects with a high level of Neuroticism increased their proficiency in solving equations. The absolute improvement was almost double (81%) for students with a time limit than for students with no time limit (43%). In addition to the marks for the pre- and post-tests, data from the game was also analysed to evaluate how displaying time in the game affected the time spent by students to solve equations in the game. These results are displayed in Table 4.

Table 4 shows the mean, standard deviation and average time to solve an equation in the game for students with a high level of Neuroticism. On average, students who belonged to the experimental group (time displayed) needed less time to solve an equation (81.40 seconds) than students who belonged to the control group (201.90). The average time to solve an equation for students who belonged to the control group was almost twice the average time for all students taking part in the experiments (1.95 times). The standard deviation for the control group was high (212), which means that the students in this group behaved in ways that could not be predicted. However, the low standard deviation for the experimental group indicates that when time is not displayed,

students with a high level of Neuroticism have a relatively predictive behaviour.

The Mann-Whitney U-test showed that displaying time in educational games for subjects with high level of Neuroticism had the opposite effect to the one expected: it increased students' academic results: ($U.(14,12) = .39; p = .0.05$). An additional statistical analysis also showed that the difference in confidence in solving equations (expressed in a post questionnaire) was significantly related to displaying the time in the game ($U.(8,5) = .1; p = .0.05$). (Not all students who played the game had the opportunity to fill-out the post-test questionnaire).

Influence of Displaying Ranking on Subjects with High Level of Competitiveness

The following table shows the results relative to the second hypothesis [Students with a high level of competitiveness for whom ranking information is displayed will learn significantly better than students for whom ranking information is not displayed].

Table 5 and Table 6 show that displaying ranking in the educational game for subjects with a high level of Competitiveness did not increase their marks but did decrease the time to solve

Table 3..Post-test.results.for.subjects.with.a.high.levels.of.Neuroticism

Group Type	N	Improvement	Standard deviation		Average for all students
			Pre	Post	
Control (A)	14	43%	3.43	2.76	5.07
Experimental (B)	12	81%	3.25	3.74	

Table 4..In-Game.measurement.for.subjects.with.a.high.level.of.Neuroticism

Group Type	N	Average time to solve an equation (in seconds)	Standard deviation	Average for all students
Control (A)	14	201.90	212.05	103.18
Experimental (B)	12	81.40	24.60	

equations in the game. On average, time to solve an equation in the game, was almost twice as less for students from the control group (82.37 seconds) than for those who belonged to the experimental group (41.92 seconds).

The raw data does not support the second hypothesis however statistical analysis does not prove that displaying ranking in educational games for subject with a high level of Competitiveness increases their academic results.

A Mann-Whitney U-test has shown that the difference between the two groups for the average time to solve equations in the game can be due to displaying ranking information: $U(4,6) = 18; p > 0.05$. This analysis has also shown that the difference in confidence in solving equations (expressed in a post questionnaire) cannot be due to displaying ranking information in the game.

$U(3,4) = 6; p > 0.05$.

Influence of Probing Students' Answers on Subjects with Low Levels of Conscientiousness

Table 7 shows the difference in average knowledge gained and average time to solve an equation in the game between the experimental and control groups. When players had to solve an equation in

the game, the tutoring system questioned answers from students who belonged to the experimental group (A) but did not probe answers from students who belonged to the control group (B).

Statistical testing was carried out to evaluate if there was any statistical difference between the two groups. In average, pupils who belonged to the experimental group improved more than the students from the control group. However, the difference in improvement between the two groups was not significant ($U(19,17) = 185, p = 0.23$).

Personality Traits and Academic Results

Table 8 shows the average knowledge gained based on students' personality traits. It reveals that students with high levels of Openness and Extraversion benefited the most from the use of the educational game (respectively 2.06 and 2.05 increase of marks).

Players' Personality and their Preferences

Another aspect of the study was to determine if players' personality traits were correlated to preferences for particular game genres (adventure, fps, etc.) and methods to seek information in the game. These were formulated in the hypotheses H_5 and H_6 :

Table.5..Improvement.between.pre-.and.post-test.for.subjects.with.high.levels.of.competitiveness

Group Type	N	Average Improvement	Standard deviation		Average for all students
			Pre	Post	
Control (A)	3	15%	3.52	2.91	103.18
Experimental (B)	4	11.3%	3.25	4.52	

Table.6..In-game.measurement.for.subjects.with.high.levels.of.competitiveness

Group Type	N	Average time to solve an equation (in seconds)	Standard deviation	Average for all students
Control (A)	4	82.37	70.29	103.18
Experimental (B)	6	41.92	25.67	

Table.7..Difference.in.knowledge.between.experimental.and.control.group

Group Type	N	Average knowledge gained	Standard deviation
Experimental (A)	19	1.96	2.47
Control (B)	17	1.72	2.42

Table.8..Difference.in.knowledge.gained.based.on.students'personality.traits

Personality Trait	N	Average Knowledge Gained	Standard deviation
High Levels of Openness	11	2.05	1.63
High Levels of Conscientiousness	9	1.16	1.48
High Levels of Extraversion	18	2.06	2.5
High Levels of Agreeableness	11	1.86	2.14
High Levels of Neuroticism	13	1.36	1.41

- H_5 : There will be a statistical difference in game style preferences between students with two significantly different personality profiles.
- H_6 : There will be a statistical difference in preferences to seek for information inside the game between students with two significantly different personality profiles.

A factor analysis was carried-out. The independent variables were the five personality traits of the big-five model (Openness, Contentiousness, Extraversion, Agreeableness and Neuroticism) and dependant variables were successively: (1) tendency to game the system and (2) tendency to ask friends for help. The analysis revealed the following:

- Pupils with low levels of neuroticism are more inclined to game the system (try any possible solution until it worked). The analysis was significant and the five independent variables accounted for 95% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and

Neuroticism were respectively 0.092, -0.193, 0.197, 0.079 and -0.516.

- Pupils with high levels of Competitiveness and Extraversion are more inclined to ask friends for help. The analysis was significant and the five independent variables accounted for 74.73% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism were respectively 0.187, -0.118, 0.414, -0.393 and -0.089.
- Pupils with high levels of Openness and Extraversion play video games to discover new levels. The analysis was significant and the five independent variables accounted for 74.84% of the changes. Coefficients for Openness, Conscientiousness, Extraversion, Agreeableness and Neuroticism were respectively 0.62, -0.27, 0.54, -0.29 and -0.53
- No significant correlations were found between students' personalities and preferred game features (story, video, audio, etc.), character customization, need for reward or preference for online games.

Table.9..Correlations.between.students'personality.traits.and.their.behaviours.in.games

	Openness	Conscientiousness	Extraversion	Agreeableness	Neuroticism
Gaming the system	0.092	-0.193	0.197	0.079	<u>-0.516</u>
Ask friends for help	0.187	-0.118	<u>0.414</u>	<u>-0.393</u>	-0.089
Play to Discover	<u>0.62</u>	-0.27	<u>0.54</u>	-0.29	-0.53

Table 9 shows how correlations between student's personality traits and their behaviour in the game. Strong correlations are underlined. The results revealed that the way in which pupils played and sought information while playing the educational game was to some extent correlated to their personality. It verified the assumptions made based on observation of students' behaviours while playing MathQuest and justified the need to profile users in educational games and tailor the environments accordingly.

Summary of Findings

Statistical analysis of the results showed that the hypotheses based on educational psychology were not all valid, notably that displaying a time limit for students with a high level of neuroticism had no significant impact on the learning outcomes and that probing answers for students with a low level of conscientiousness (a.k.a. careless students) had no significant effect on their learning performance ($p=0.28$). However the study did show that displaying ranking information for students with a high level of competitiveness (low agreeableness) affected their learning performance positively. Results give an idea about how competition can drive pupils with a high level of competitiveness to outperform their peers and hence to improve their results. In addition, students with a high level of extraversion and a high level of openness seemed to benefit the most from the game as described.

Conclusions, Implications and Future Work

Conclusion

In the previous sections the authors have explained the basis for the PLEASE model. They have explained and illustrated how emotions and personality traits can influence learning and that they should be accounted for in the design of educational games. Some aspects of the PLEASE model were assessed through a controlled study conducted with the game MathQuest. This study has revealed that adaptive educational games can be beneficial for improved learning outcomes. It has shown that the degree to which students benefit from an educational game can be correlated to their personality profile, but also that the motivation to play video games and strategies to find information in them can be personality-dependent. Overall it suggests that not all students will benefit from a video game but that in some cases, when the settings and options match their preferences and learning style, improvements can be obtained. Despite the sample size used for this study, clear trends have been identified and ought to be confirmed in a larger study.

Implications

The PLEASE model provides guidelines on the customization of the learning environment, however, the state of the user could also be accounted for to increase the dramatic features of the game

and hence improve focus and motivation just as adaptive games attempt to adapt the game play to users so that their enjoyment is increased. This need for adaptation is due to the diversity across players in their motivations to play and source of enjoyment (Griebel, 2006; Salen & Zimmerman, 2003; Lazzaro, 2004). Because players have different emotional needs, their expectations will differ. Overall, adaptive games make it possible to dynamically adapt the dramatic features of the game to players' actions and behaviours. Recent studies show that, for example, in massively Multiplayer Online Role Playing Games (MMORPG), players' motivation to play can be described in a five-dimensional space: Relationship, Immersion, Grief, Achievement and Leadership. To some extent, personality traits can explain players' behaviours in video games (Hopson, 2001; Griebel, 2006) and more specifically in educational games (Zhou & Conati, 2003). This suggests that user profiling based on personality traits could make it possible to improve individually both motivational and educational aspects of serious games.

Future Work

In the previous chapter, the authors have suggested that the format in which information is delivered to players can impact on their motivation and understanding of the topic taught. For example providing exact, true or misleading information might have an impact on learning outcomes based on pupils' personality traits. They have also suggested that the game-play could also be tailored to suit particular learning styles. Based on these considerations, the authors are developing a game prototype, which is based on the Irish curriculum and supports the teaching of sciences. In this adventure game, an unknown virus has struck the city and the player has just been hired by a company to find a cure to this terrible disease and save the entire population from dying. The game includes multiple-levels through which the player can:

- Find necessary items to conduct experiments,
- Conducting experiments in a lab based on methodologies described in the curriculum,
- Communicate with Non Player Characters (NPCs) who might provide useful explanations on how to conduct experiments successfully (e.g. device needed, methodology, etc.). Some colleagues might not be trustworthy, provide misleading information and sabotage the work of the player.

NPCs can be of different types and provide exact or false information based on the players' personality. For example, if the player is identified as having a high level of Openness, misleading information is provided., whereas exact information is provided to players with a high level of Neuroticism. In addition, during their conversation with the character, NPCs provide information to players on resources that might match their learning styles. For instance, players with a low level of extraversion might be given the opportunity to gain access to information in a written format. Nevertheless, all types of information format are available to players regardless of their learning style and access to these resources is monitored to further refine learners' behaviours in educational games.

A controlled study based on this game should make it possible determining how the game play can effectively be modified dynamically to match students' learning styles and improve both results and enjoyment. It should also reveal further correlations between players' behaviours in an educational game and their personality traits.

REFERENCES

Alessi, S., & Trollip, S. (2001). *Multimedia for learning; methods and development*. (3rd Edition). Pearson Education. USA.

- Astleitner, H. (2000). Designing emotionally sound instruction: the FEASP-approach. *Instructional Science*, 28, 169-198.
- Banos, R. M., Botella, C., Liano, V., Rey, B., Guerrero, B., & Alcaniz, M. (2003). Virtual reality as mood induction procedure. *Presented at. PRESENCE. 2003, 6th. Annual. International. Workshop.on.Presence*. Available at: <http://www.presence-research.org/papers/Banos.html>
- Becta (2001). *What.aspects.of.games.might.contribute.to.learning*. Available at: <http://partners.becta.org.uk/index.php?section=rh&rid=13588>
- Briggs-Myers, I., & McCaulley, M. (1985). *A guide to the development and use of the Myers-Briggs Type Indicator*. Consulting psychologists Pr.
- Brown, E., Fisher, T., & Brailsford, T. (2006). Real users, real results: Examining the limitations of learning styles within AEH, *ACM. SIGWEB Newsletter*.
- Calvo, M. G., & Eysenck, M. W. (1996). Phonological working memory and reading in test anxiety. *Memory*, 4, 289-305.
- Chaffar, S., & Frasson, C. (2005). The emotional conditions for learning. Available at: http://www.iro.umontreal.ca/labs/HERON/art/chaffar_frasson_2005.pdf
- Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning. *A systematic and critical review*. London: Learning and Skills Research Centre.
- Costa, P. T., Jr., & McCrae, R. R. (1985). *The NEO Personality Inventory manual*. Odessa, FL: Psychological Assessment Resources.
- Costa, P. T., Jr., & McCrae, R. R. (1992). *Revised NEO Personality Inventory. (NEO-PI-R™). and NEO Five-Factor Inventory. (NEO-FFI): Professional manual*. Odessa, FL: Psychological Assessment Resources.
- Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading, *Journal of Verbal Learning and Verbal Behaviour*, 19, 450-66.
- Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences*, 22, 491-517.
- Elliman, N. A., Green, M. W., Togers, P. J., & Finsch, G. M. (1997). Processing efficiency theory and the working memory system: Impairment associated with sub-clinical anxiety. *Personality and Individual Differences*, 23, 31-5.
- Eysenck, M. W. (1992). Anxiety: the cognitive perspective. Hove: Lawrence Erlbaum Associates.
- Eysenck, H. J., & Eysenck, S. B. G. (1964). *Manual of the Eysenck Personality Inventory*. London: University of London Press.
- Freeman, D. (2003). *Creating emotions in games*. Peachpit (New Riders Games series).
- Felicia, P., & Pitt, I. J. (2007). *The PLEASE model: An emotional and cognitive approach to learning in video games*. International Technology Education and Development Conference (INTED), Valencia, Spain, 8-10 March 2007.
- Fullerton, T., Swain, C., & Hoffman, S. (2004). *Game design workshop: designing, prototyping, and playtesting games*. Gama Network Series.
- Furnham, A. (1992). *Personality at work. The role of individual differences in the workplace*. London and New York: Routledge.
- Furnham, A. (1996). The Big five versus the Big four: The relationship between the Myers-Briggs Type Indicator (MBTI) and NEO-PI Five-Factor model of personality. *Personality and Individual Differences*, 21(2), 303-307.
- Gerrards-Hesse, A., Spies, K., & Hesse, F. W. (1994). Experimental inductions of emotional

- states and their effectiveness: a review. *British Journal of Psychology*, 85, 55-78.
- Goldberg, L. R. (1999). A broad-bandwidth, public-domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, F. Deary, De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe*, 7, 7-28. Tilburg, The Netherlands: Tilburg University Press.
- Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. *Journal of Research in Personality*, 40, 84-96.
- Goleman, D. (1995). *Emotional Intelligence*. New York: Bantam Books.
- Green, H., Facer, K., & Rudd, T. (2006). *Personalisation and digital technologies*. Nesta Future Lab. Available at: http://www.futurelab.org.uk/resources/publications_reports_articles/opening_education_reports/Opening_Education_Report201/
- Griebel, T. (2006). Self-portrayal in a simulated life: projecting personality and values in The Sims2, *International Journal of Computer Game Research*, 6(1), December 2006.
- Heinström, J. (2003). Five personality dimensions and their influence on information behaviour. *Information Research*, 9. Available at: <http://informationr.net/ir/9-1/paper165.html>.
- Honey, P., & Mumford, A. (1982). *The manual of learning styles*. Maidenhead: Peter Honey.
- Hopko, D. R., Ashcraft, M. H., & Gute, J. (1998). Mathematics anxiety and working memory: support for a deficient inhibition mechanism, *Journal of Anxiety Disorders*, 12, 343-55.
- Hopson, J. (2001). Behavioural game design. Gamasutra, April 2001. Available at: http://www.gamasutra.com/features/20010427/hopson_pfv.htm
- Jackson, C., & Lawty Jones, M. (1996). Explaining the overlap between personality and learning style. *Personality and Individual Differences*, 20, 293-300.
- Keefe, J. W. (1988). *Profiling and utilizing learning styles*. Reston: NASSP (National Association of Secondary School Principals).
- Keirse, D. (1998). *Please, understand me. II, temperament, character, intelligence*. Prometheus Nemesis Book Company.
- Lambert, N., M., & McCombs, B., L. (2002). *How students learn: reforming schools through learner-centered education*. Washington DC: American Psychological Association.
- Lazzaro, N. (2004). *Four keys to more emotions in games*. Available at: http://www.xeodesign.com/xeodesign_whyweplaygames.pdf
- Levine, J. (1999). *The Enneagram intelligences: understanding personality for effective teaching and learning*. Bergin and Garvey Publishers.
- Maslow, A. (1968). Some educational implications of the humanistic psychologies. *Harvard Educational Review*, 38(4), 685-696.
- McCrae, R., R., & Costa, P., T. (1989). Reinterpreting the Myers-Briggs Type Indicator from the perspective of the Five-factor model of personality. *Journal of Psychology*, 57, 17-40.
- McFarlane, A., Sparrowhawk, A., & Heald, Y. (2002). *Report on the educational use of games, an exploration by TEEM of the contribution which games can make to the education process*. Teem Publication. Available at: http://www.teem.org.uk/publications/teem_gamesined_full.pdf

- Myers, I. B., & Myers, P. B. (1980). *Gifts differing: understanding personality type*. Mountain View, CA: Davies-Black Publishing.
- Norman, W. T. (1963). Toward an adequate taxonomy of personality attributes: replicated factor structure in peer nomination personality ratings. *Journal of Abnormal and Social Psychology*, 66, 574-583.
- Parrott, W. G., & Spackman, M. P. (2000). *Emotion and memory*. In M. Lewis & J. M. Haviland-Jones *Handbook of emotions* (2nd ed.). New York: Guilford Press.
- Reiff, J. C. (1992). *Learning styles*. Washington, DC: National Education Association.
- Riding, R. J., & Wigley, S. (1997). The relationship between cognitive style and personality in further education students. *Personality and Individual Differences*, 23, 379-389.
- Riding, R. (2002). *School learning and cognitive style*. London: David Fulton.
- Rouse, R. (2001). *Game design: Theory and practice*. Wordware Publishing.
- Salamon, E. K. M., Beaulieu, J., & Stefano, G. B. (2003). Sound therapy induced relaxation: Down regulating stress processes and pathologies. *Med. Sci. Monit* 2003, 9(5).
- Salen, K., & Zimmerman, E. (2003). *Rules of play*. MIT Press.
- Salovey, P., & Mayer, J. D. (1990). Emotional intelligence, imagination. *Cognition and Personality*, 9, 1990.
- Salovey, P., Bedell, B. T., Detweiler, J. B., & Mayer, J. D. (2000). Current directions in emotional intelligence research. In M. Lewis, & J. M. Haviland-Jones (Eds.), *Handbook of emotions* (2nd edition). New York: Guilford Press.
- Schilling, D. (1996). *50 activities for teaching emotional intelligence*. Torrance: Innerchoice publishing.
- Silberman, C. E. (1970). *Crisis in the classroom*. New York: Random House.
- Singer, J. A., & Salovey, P. (1988). Mood and memory: evaluating the network theory of affect. *Clinical Psychology Review*, 8, 211-251.
- Steg, H., Tergwagt, M., & Koops, W. (1994). Positive and negative mood effects in children: the mediating influence of task characteristics. *Journal of General Psychology*, October 1994.
- Sykes, J., & Brown, S. (2003). Affective gaming, measuring emotions through the gamepad. In *Proc. CHI.2003, ACM*, (pp. 732-733).
- Thorndike, R. L. (1949). *Personnel selection*. New York: Wiley & Sons.
- Thurstone, L. L. (1934). The vectors of the mind. *Psychological Review*, 41, 1-32.
- Velten, E. (1968). A Laboratory task for induction of mood states. *Behaviour Research and Therapy*, 6, 473-482.
- Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: a meta-analysis. *European Journal of Social Psychology*, 26, 557-580.
- Witmore, G. (2003). Design with music in mind: A guide to adaptive audio for game designer. Available at: http://www.gamasutra.com/resource_guide/20030528/whitmore_pfv.htm
- Zang, L. (2006). Thinking styles and the Big-Five personality traits revisited. *Personality and Individual Differences*, 40(2006), 177-1187.
- Zhou, X., & Conati, C. (2003). Inferring user goals from personality and behaviour in a causal model of user affect. *International Conference on user interfaces*, Miami, Florida.

ENDNOTES

¹ <http://ipip.ori.org/ipip>

² <http://www.sloodle.org>

³ Minnesota Multiphasic Personality inventory

⁴ Neuroticism-Extroversion-Openness Personality inventory

⁵ 16 Personality Factor

Chapter X

The Use of Role-Playing in Learning

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ABSTRACT

The use of Role-Playing is becoming prominent in Serious Games due to its positive effects on learning. In this chapter the author will provide a comprehensive definition of role-playing games, drawing inspiration from the many different definitions provided in the existing literature. Then, will propose a five-dimension taxonomy for Serious Role Playing Games, applying it to a small selection of successful Serious Games in five different domains. An overview of the literature will help the reader understand when Role-Playing should be used, and when it might be useless or detrimental. Finally, a brief analysis will be performed on the reviewed games, in order to point out the correlations among the taxonomy dimensions and the domains of application.

INTRODUCTION

Many different definitions have been proposed in the last forty years for "Role-Playing" (RP). In a role-play, the participants take on a "role" in a specific situation or scenario. They can play their own part or someone else's in a safe environment where they can act, experiment, learn and teach without risking irreversible consequences. The emotional freedom from the risk of experiencing personal consequences from their behaviour,

that is consequently less cautious, inhibited and risk averse, can mean a more positive attitude towards learning.

Starting from three different definitions, I'll provide one brief but comprehensive definition of Role-Playing Games (RPGs). Then, I'll propose a five-dimensional taxonomy, which will include three key characteristics of RP that have been identified in the literature (the level of involvement, the role being played, and the degree of response specificity) and two additional ones (the com-

petitiveness and the didactic purpose). Through a review of several papers, I will provide some evidence that can be useful to game developers, concerning the situations when RP has proven to be effective as a didactic instrument. However, even though there aren't any papers explicitly critical of the use of RP in Serious Games (SG), I will cite the contributions of several authors suggesting when RP might be useless or detrimental. In the last part of the chapter, a selection of sixteen SG from five different domains will be classified with the proposed taxonomy. Even if the sample group is really small, some meaningful correlations will be highlighted in the conclusions, leaving plenty of space for future developments.

Definitions of Role Playing Games

In a role-play, the participants play a "role" in a specific situation or scenario. They can play their own part or someone else's in a safe environment where they can act, experiment, learn and teach with no risks of irreversible consequences (Ladousse, 1987). Since people won't fear the personal consequences of their behaviour, they are less cautious, inhibited and risk averse. Such emotional states might encourage them to learn. Some scholars (Bolter & Grusin, 1999; King & Krzywinska, 2002, as cited in Apperley, 2006) state that RPGs simply re-mediate the writer Tolkien, assuming that they need to be considered closely tied to the literary genre of fantasy. Apperley (2006) considers their description an "oversight" (p. 17). He reckons the pencil-and-paper RPGs are the precursors of the genre, of which the most widely known is Dungeons & Dragons®. He is led to this conclusion because pencil-and-paper RPGs differ from fantasy literature in that they include a set of rules for interaction between players and the fantasy environment. Anyway, the origin of RPGs can be also found in Moreno's

"Psychodrama" (1946): a technique designed for the treatment of disturbed patients and used in the group therapy setting.

Greco (2007) suggests that, in spite of official formalization, role-play had already existed long before, in the genuine form of children's games, where most of the times everyone plays a role (e.g. say a girl playing with a doll, pretending to be her mother). A similar concept had been expressed in (Graham & Gray, 1969, p. 18): "*In one sense all gaming involves role playing since the individual participants are asked to assume the situation assigned*".

Since many different definitions have been proposed in the last forty years for "Role Playing", I will cite those three which contribute best to provide a wide comprehension of the genre.

Aronson & Carlsmith (1968, p. 26) described "Role Playing Study" as "*an as-if experiment in which the subject is asked to behave as if he [or she] were a particular person in a particular situation*". This definition clearly doesn't consider the amusement, which is a formidable motivational lever: it is an interesting snapshot of the didactic approach in that historic period.

Recently, Tychsen *et.al.* provided a clear definition of Role Playing Game, which is reported below:

- 1.. *The core of the game is role playing guided by rules. Each player takes control of one or more (although typically only one) character. A character is a fictional figure that the player tries to act (as role play).*
- 2.. *The player will usually have full control of decision making at the character level. There is no author-audience relationship: each player has a hand in developing a personal, perceived story.*
3. *The game is usually set in a fictional reality, which is communicated via the fictional contract. The contract is the shared understanding among the game participants of the game setting/world.*

- 4.. *With very few exceptions, the games are supervised or guided by a Game Master (GM), who assumes a variety of responsibilities depending on game type and style of play, notably, (a) facilitation of game flow, (b) environmental content, (c) administration of rules, and (d) engagement/entertainment..*
- 5.. *At least two participants are required. In general, noting the above exception, these will be a player and a GM. Typically, these roles are fixed, although in some games, the roles are interchangeable. The players and GMs together are the participants of the game..* (2006, p.254)

This definition shows the characteristics of contemporary RPGs, well highlighting their formal structure. The second point is very important since Fine (1983) argued that players try to create a satisfying storyline for their characters, rather than successfully complete their adventure. For this reason Zagal *et al.* (2006) suggest that from a game-theory perspective, the players are not playing a game, but creating a narrative.

The fourth and the fifth points of the list seem to be excessively restrictive since in most computer RPGs there is no need of a Game Master and in many of them it is possible to play in a single-player mode.

Finally, this is Lee's *et al.* brief definition which points out the cognitive aspects of RPGs used for didactic purposes:

Role-play, in general, refers to situations when a participant assumes a "role" by playing a part in a specific situation or scenario. Role-play in the classroom reflects a Vygotskian approach toward learning, which states that learning and cognition begin with social interaction. (2007, p. 539)

On the whole, a RPG can be defined as follows:

A game where each player takes on the role of a character. The character's story takes shape and evolves depending on the player's decisions and choices. RP implies a complex interaction among the players (social interaction) or among a player and computer-controlled characters.

The definitions of some specific categories of RPGs need some details to be exacerbated due to their peculiar characteristics.

In addition to the definitions provided above, *Live Action Role Playing Games* are characterized by two unique features:

1. the game takes place in a physical frame;
2. physical actions of players are regarded as those of the characters (Tychsen, *et al.*, 2006).

Massive. Multiplayer. Online. Role. Playing. Games (MMORPG) are internet-based games that can be accessed by a huge number of players at the same time. The player's character ("avatar") lives in a virtual world, interacting with others' ones, purchasing, producing and consuming goods (Castronova, 2002). MMORPGs are the most common type of MMOGs (Massive Multiplayer Online Games), accounting for almost 98% of their whole market share (Woodcock, 2006). The massive number of players, the generation of virtual social institutions (like guilds or cities) and the presence of efficient spontaneous markets are MMORPGs' unique features.

Characteristics and Taxonomy of Role Playing Games

Greenberg & Folger (1988) proposed an interesting taxonomy with reference to Role Playing Studies that seems to suit RPGs in general very well. This taxonomy has three key dimensions: the level of involvement, the role being played and the degree of response specificity. The *level of involvement*

the participants encounter while playing a game can be described as an ordinal variable which is qualitatively rated from “low” to “very high”. In the first case, there are “non-active” role-plays, in which the players are asked to pretend they are in a certain situation (Hendrick, 1977). When the involvement is very high there are highly active RPGs - the simulations - where each relevant variable is very close to reality. Table 1 summarizes various points along the level of involvement continuum and notes examples of games representative of each. A similar description has been provided in (Greenberg & Eskew, 1993) for Role Playing Studies. The level of involvement combines several elements including the level of realism, multimediality, interaction among players, effort of the players.

The second dimension of the taxonomy is the *role being played*. Greenberg & Eskew (1993) suggest envisioning it as differing along two independent dimensions: person and familiarity. In some RPGs the players can “play themselves”. In other words, they have to act, think and choose

spontaneously, just the way they are, without pretending to be someone else. On the other hand, in the vast majority of RPGs, characters are quite different from players: they have their own personality, skills and experiences. Moreover, the player may be familiar or unfamiliar with the context where the role is enacted. The role of a Chief Executive Officer in a business game can be familiar for a businessman, but the same role is very unfamiliar for a child. By cross-cutting the kind of person played as a role and the familiarity of the role being played, four distinct categories of games may be identified (Table 2).

The third element of Greenberg’s taxonomy is the *degree of response specificity*: it describes “the degree to which subjects are free to improvise their reaction to game events, by acting in a free and spontaneous manner as opposed to a highly restricted, specified manner” (Greenberg & Eskew, 1993, p. 231). For example in the negotiation game “Zap Dramatic” (<http://www.zap.ca/>), the player can choose among a few predetermined sentences when he “talks” with the computer

Table 1..Level of involvement continuum of RPGs, including representative examples

Level of Involvement	Example of Genre	Generic Description and Example
Low	Choose “as if you were in a generic situation”	Imagine a situation, then make a choice. It is a frequent situation in games carried on in experimental economics <i>Ultimatum Game</i> (Guth, et.al., 1982).
Moderately low	Choose “as if you were in a detailed situation”	A more detailed scenario than the example above is described to the player, who has to make more complex decisions MIT’s Beer Game (Senge, 1990).
Moderate	Browser based - MMORPG	Manage you own medieval fief, fight against neighbouring liege lords etc. <i>Kings of Chaos</i> © (http://www.kingsofchaos.com/).
Moderately high	Business game	Very detailed background of the situation and of the role <i>Win.Win.Manager</i> (http://www.wwinmanager.it/).
High	Virtual Worlds	Characters live in a Virtual World (simulated by a software or imagined by the players in a pencil-and-paper RPG). Often players can’t distinguish themselves from their own character. They care a lot for their avatar’s story, future, reputation, awards. <i>War of Warcraft</i> © (http://www.worldofwarcraft.com/) or <i>Dungeons & Dragons</i> ©.
Very High	Virtual Reality	Players barely distinguish reality from virtual reality. Their actions cause immediate and realistic reactions by the simulated environment. <i>Virtual Reality Parachute Trainer</i> (“Parachute Flight”, 2008).

Table.2..Taxonomy.of.roles.played.in.RPGs.including.representative.examples

		Familiarity with Role	
		Familiar	Unfamiliar
Person Played	Self	<i>Play.oneself.in.a.familiar.role</i> Example: a businessman playing the role of a Chief Executive Officer in a business game <i>Global.Management.Challenge</i> . (http://www.worldgmc.com/)	<i>Play.oneself.in.an.unfamiliar.role</i> Example: a student playing the role of a Chief Executive Officer in a business game.
	Other	<i>Play.someone.else.different.from.you.in.a.familiar.role</i> Example: an MBA student playing the role of a Chief Executive Officer in a business game	<i>Play.someone.else.different.from.you.in.an.unfamiliar.role</i> Example: a college student asked to play the role of a negotiator in a Union – Management negotiation simulation (Raiffa, 1982).

animated character he is negotiating with. On the other hand, in the negotiation game “Win Win Manager”, the players can say whatever they want while negotiating on the bulletin board.

In order to complete Greenberg’s taxonomy, two more dimensions should be considered: the *competitiveness* of the game and its *didactic purpose*.

Pimenidis (2007) suggests that RPGs are not competitive, assuming that the fun of the game does not consist in winning or defeating the other players. In his vision, the players always cooperate in order to find the best answers to the adventure proposed situations. Even if such a consideration is correct for most RPGs, it can’t be considered correct in absolute terms. In many RPGs, especially those that are set in a virtual world, players both cooperate and compete. For example, in a virtual world two enemy guilds can fight one against each other for the control of a powerful item. In the same world, at the same time, somewhere else, the players of a group can cooperate in order to explore a dungeon and find a treasure. Some other RPGs, for instance the First Person Shooter games, are strictly competitive when the player tries to kill other players’ characters, taking on the role of a killer, or a soldier. The competitiveness of a game is very important since making a game more competi-

tive can increase the engagement of the players (Prensky, 2007), while stressing the importance of cooperation can support team-building and team-playing (McConnell, 2000).

Finally, I believe that Serious Games can be developed in order to accomplish one or more of the following goals:

- improving interpersonal skills (e.g. communication, leadership);
- improving specific skills (e.g. negotiation, hotel’s management);
- gaining knowledge about something (e.g. internet security, university settings).

By including this fifth dimension in the taxonomy, it’s possible to identify how the developers change the design of the Role Playing accordingly to their aim. As I will show later on, it’s possible to find several similarities even with a small sample group of SG.

Introducing Role Playing In a Game: A Few Design Suggestions

Across the board, the higher the level of involvement, the more the players have fun and are prone

to learn (Bisson & Luckner, 1996). Unfortunately, as the desired level of involvement increases, the financial effort for the producer skyrockets. In the most recent RPGs, the producers try to boost players' involvement by developing impressive, very realistic 3D-graphics. However, I suggest that in a computer based game the level of involvement should be considered as the result of a symbiosis between graphics and content.

The content of the game being the story, the role of the player and the decisions he is asked to make. The importance of the story has been stressed by Bateman (2007) too. A lot of old games with tin pot graphic elements are still played and loved nowadays by many players. Many modern games are seen as graphic evolutions of old ideas: players appreciate amazing graphics but never forget exciting, original stories. Moreover, like many other kind of innovations, graphics development is subject to decreasing returns of scale. While cheap graphics can be compensated by the player's imagination, a featureless content can't be compensated at all. Don't forget that pen-and-pencil RPGs are still flourishing in spite of the cut-throat competition of digital games. Too many SG experts are focusing their research on Digital Game Based Learning, forgetting the great power of face-to-face interaction among players. As Clark & Choi (2005) claim multimedia benefits have not been adequately proved while evidence of undesirable effects have been found.

Introducing RP in a game can significantly increase the engagement of the players (as seen, for example, in Wishart, *et al.*, 2007) consequently enhancing learning. Moreover, RP can enable players to empathise with others (e.g. in the case of pupils or mentally ill patients), to understand their motivation and to practice the concepts being taught (Van Ments, 1989).

Even in the past, research on the effectiveness of RP found it successful in modifying attitudes (Janis & King, 1954). The modification of attitudes is a peculiar characteristic of RPGs which is very

useful in different domains. For example, De Bono (1987) uses this feature for his "Six Thinking Hats" method for boosting creativity. Each player has to enact the "hat's character" regardless of his own (e.g. the player wearing the black hat has to be a pessimist) while brainstorming. In Holley, Armenakis, & Feild (1977) the attitude-modifying feature of RPGs were used in order to influence the perceptions of management and union leaders, in order to change their reciprocal attitude (often ideological).

Dozens of later papers reinforced such research, finding more and more successful applications to RP. According to Klingman (1982) "*participants benefit from the advantages of emotional, cognitive, and imaginary aspects of role playing*" (p. 39).

The great majority of the SG experts regard RP as an excellent tool for teaching interpersonal skills. For example, Alkin & Christie (2002) use it to teach evaluation procedures, needing to improve both technical and interpersonal skills in a free of fear and distress environment. Lee, *et al.* (2007) use RP in order to train evaluators as well, pointing out that, since such discipline is practice-based, "*when it is not possible to engage students into a practicum*" (p. 537) RP is a useful alternative.

RP recurs also in Thiagarajan's "Laws of Learning" (2003), in which it is considered to increase the link between the learning situation and the real world, consequently improving the effectiveness of learning.

RP has been used in order to forecast the outcome of real negotiations in several papers. For example in Green (2002) the outcome of the negotiations simulated by the participants have been compared with unaided forecasts, resulting in much more reliable predictions.

Those situations in which RP has proven to be effective are summarised resumed in Table 3.

Table.3.. Overview of the situations when RP has proven to be effective

Use Role Playing when...	Reference
The discipline you want to teach is practice – based.	(Lee, <i>et.al.</i> , 2007)
You want to increase the engagement of players.	(Clark & Choi, 2005; Wishart, et al., 2007)
You want to promote interaction among players.	(Van Ments, 1989)
You want to modify attitudes.	(De Bono, 1987; Janis & King, 1954)
You want to improve interpersonal skills.	(Alkin & Christie, 2002)
You want to soften a positional negotiation approach.	(Holley, Armenakis, & Feild, 1977)
You want to increase the link between the learning situation and the real world.	(Thiagarajan, 2003)
You want to forecast the decisions in conflicts and negotiations.	(Green, 2002)
You want to create an environment free of fear and distress.	(Alkin & Christie, 2002)

Criticisms of Role Playing Applications

Even if RP has a formidable history as a facilitator of learning, it has been subject of considerable debate as an experimental method (Greenberg & Folger, 1988). Freedman observed that role-Playing Studies reveal “what people think they would do, not necessarily what they [actually] would do” (Freedman, 1969, as cited in Greenberg & Eskew, 1993). According to Aronson & Carlsmith (1968), such criticism is caused by the lack of realism in those studies, which is a basic requirement for the validation of a scientific experiment. The answer to this criticism comes from Greenberg & Eskew (1993), who point out that the value of Role-Playing Studies “doesn’t lie in assuming that people really would do what they say, but in learning what they say they would do” (p. 225). He backs his thesis by citing Harré & Secord (1972) who pointed out that the mere expression of intended behaviour can reveal a great deal about people’s beliefs regarding the patterns that regulate their behaviour.

Cabral (1987) suggests that RP shouldn’t be used if only a limited amount of time is available; since effective RP requires enough time to let the participants discuss and enact different roles, as

well as practice new skills. Moreover, she argues that this technique shouldn’t be used when major status differences exist among players. Indeed, “they may not feel free to express their feeling if, in the presence of a supervisor, they are concerned with saving face” (p. 479). Finally, she points out that RP is not appropriate when the situation to be played is not convincing or relevant, or when the degree of response specificity is very low.

A useful contribution has been given by Quinn during an interview: he argued that RP shouldn’t be foregrounded when the game objectives aren’t about interpersonal interactions.

Applications of Role-Playing for Didactic Purposes

This section provides an overview of the hundreds interesting and successful applications of Role-Playing cited in the SG literature. I will describe RP applications in medicine, education, management, security and technical sectors. Each game will be evaluated according to the five dimensions that I previously defined in the second paragraph: the level of involvement (**I**), the role being played (**R**), the degree of response specificity (**D**), the competitiveness (**C**) and the didactic purpose (**P**).

Table 4. Overview of the situations when RP is useless or detrimental

Don't use Role Playing when...	Reference
You only want to see how people would act in a specific situation.	(Freedman, 1969)
The game or the experiment will not last long.	
Major status differences exist among players.	(Cabral, 1987)
The situation to be enacted is not convincing or relevant.	
The degree of response specificity is very low.	
The discipline being taught doesn't need any interpersonal interaction.	(C. Quinn, personal interview, February 12, 2008)

RP in Medicine

As previously mentioned, the first known “serious” application of RP was proposed by Moreno, referring to the treatment of patients with psychological disorders. Many other applications can be found in medicine since then: the most frequent is the recourse to simulated patients. Students have shown to prefer such didactical approach for learning communication skills more than the traditional instructional one, and more than experiencing “on the job” with real patients as well (Rees, Sheard, & McPherson, 2004).

Nurses and simulated patients. In (Kruijver *et al.*, 2001).

I: high; R: self, familiar; D: very high; C: cooperative; P: interpersonal skills

This simulation focuses on teaching the nurses the communication skills which are important in handling patients' emotions. The nurses have to speak with three actors, who are trained to play the role of cancer patients. The interaction allows the nurses to practice communication techniques, improving their attitude in actively exploring patients' feelings.

Smoking-cessation counselling. In (Koerber, *et al.*, 2003)

I: high; R: self, familiar; D: very high; C: cooperative; P: interpersonal skills

In this simulation, dental students practice Motivational Interviewing, a patient-centred approach that begins with patients' goals and encourages patients to choose themselves the ways to reach those goals. A brief version of this technique is chosen for this specific contest, in which the students practice offering counselling to standardized patients who wish to stop smoking. Two women are recruited to play the roles of patients. The dental students are asked to spend five to ten minutes offering counselling to the above mentioned patients. Such training allows students to improve their counselling skills as well as the skills needed to involve patients more.

RP in Education

RP has always been frequently used in Primary school, since some children aren't responsive to more traditional instructionist approaches. RP has been creeping in higher education in order to grow closer to the specific characteristics of the “*Digital Natives*” (Prensky, 2007), who prefer innovative didactic approaches.

Net detectives. (Wishart, Oades, & Morris, 2007)

I: high; R: self, familiar; D: high; C: cooperative; P: knowledge

“Net detectives” is an online RPG which aims to make pupils aware about the risks of the Internet. Working in teams children have to investigate about realistic cases of wrong Internet usage (e.g. a schoolgirl being deceived by an older person as she joins a chat on the Internet). Pupils are shown to learn very well the dangers of the Internet through using Net detectives.

Language learning game. (Brox, Evertsen, & Heggelund, 2007)

I: moderate; R: self, familiar; D: moderate; C: cooperative; P: knowledge

In this case, the non-linearity of RPGs is used in order to teach Finnish in Norwegian and Swedish schools. The language is usually taught in a very linear way: simple forms first, and then the complex ones. This game is a really radical innovation, since it allows the students to find their own way to learn. They have to solve exercises in order to gain points, which are needed to “win” the game.

Team Play Hotel. (Maxwell, 2007)

I: moderately high; R: other, unfamiliar; D: moderately low; C: cooperative; P: interpersonal skills

In this game a team of players plays the roles of the manager and the staff of a hotel. They have to manage the hotel, completing tasks in order to finish the game. The players are given a feedback at the end of the game in the form of a statistical breakdown of how they performed in the tasks. The team analyses the feedback in order to plan a strategy for their next attempt at the game. Team Play Hotel is mainly aimed at improving team-working attitudes (the authors wanted to improve

employability skills amongst college students), since the players have to cooperate in order to complete the game. The game, as well, has been useful in improving numeracy, communication and problem solving skills.

University Explorer. (Blecic, Cecchini, & Colorni, 2007)

I: moderately high; R: self, unfamiliar; D: moderate; C: both¹; P: knowledge

This is a Web-Based RPG developed for orientation to university for final year high-school students. It is structured as an adventure in an unknown territory in search of the solution of an enigma. Each player can choose among four different characters: the scientist, the strategist, the wizard and the hacker. Each character has specific “powers” and information which are useful in order to win the game. The players are divided in four-member teams (each character type has to be present in each team). They can obtain information about the academic structure, the most suitable course for their characteristics and professional aspirations, and other educational and professional opportunities provided by the campus.

RP in Management

Managers need to practice many interpersonal skills, as well as the technical ones. There are countless “business games” that help managers to learn leadership, negotiation, communication, marketing, logistics and so on. This specific sector of SG is flourishing, but there is still little usage of RP.

StraDe. (Blecic, Cecchini, & Colorni, 2007)

I: moderately high; R: self, unfamiliar; D: moderately high; C: both²; P: interpersonal skills

“Strategies & Decisions” is a Web-based multi-user RPG. It simulates the period after the adoption of a strategic plan by the city administration. In the first version of the game, the player can choose to play his role among five different points of view: city municipality, finance and banks, enterprises, environmental associations, civic and citizens’ associations. Before the game begins, the players are asked to answer some questions, which allow the system to measure some of their characteristics: their “social tolerance”, their “innovativeness” and their “localism”. These characteristics influence players’ payoffs. The players are divided in five-member teams. During the game, players have to invest “resource points” on some project of interest for the city. A proposed project takes place only if there are enough resources, and enough players approve of it. Finding an agreement among the players in the team is the most formative part of the game, since each player has to practice his negotiation, communication and forecasting skills, in order to find the way to get the maximum score.

Fiat Stilo. (Olazar, 2007)

I: moderately.low; R: self, unfamiliar; D: moderately.high; C: cooperative; P: specific skills

This single-player computer-based-case is divided in two stages. At first, the players are provided with many pieces of information about the company, the sector and the product (a car). Information comes in many different forms, like videos, interviews and graphs. In the second part of the game the players enact the role of the Marketing Manager or the role of the Sales Manager, dealing with the decisions regarding the positioning of a product, and analysing the coherence of the company’s marketing strategy. Then, the players confront their own opinions in a class session, creating a precious formative context.

Global Management Challenge. (<http://www.worldgmc.com/>)

I: moderately.high; R: self, both³; D: moderate; C: both⁴; P: specific and interpersonal skills

The Global Management Challenge is a classic management simulation in which up to eight teams of players are asked to run virtual companies for five quarters. Usually each player has the responsibility of a specific management function among marketing, production, human resources management and finance. A computer model simulates the interactions among the various parts of each company, the competitive relationship among the companies and the background economic situation. The players are also given a five-quarter historic review of the company’s past board of directors’ decisions. The team with the highest share price wins the round. The game has been played in 30 different nations for 28 years. Actually, every year SDG organizes the International Final of the Global Management Challenge among the best teams of the 30 involved nations.

Win Win Manager (Greco & Murgia, 2007)

I: high; R: self, both⁵; D: moderately. high; C: both⁶; P: specific and interpersonal skills

Win Win Manager is the first business game which really exploits RP to its full potential. The players negotiate online in randomly selected couples using a private discussion board on ten scenarios provided by the game. They get a score according to the outcomes of their negotiations. In point of fact, many negotiation role-playing experiments had been proposed in the past to college students (among the many: Raiffa, 1982). However, these experiments were rarely aimed at formative goals. Win Win Manager seems to be effective in a didactic perspective in two ways:

- Firstly, the players are free to explore different strategies during the phase of the negotiation in order to understand which one suits them best, and to explore their counter-parts' reactions.
- Secondly, they receive feedback explaining the score assigned by the system to the player after each contract is signed. Thus, they are informed both about their mistakes and about their good choices.

The authors, through an analysis of mean scores, show that the game has been useful in improving players' negotiation skills. In the meantime, the players have shown to be really engaged by the game: playing an unfamiliar role is challenging as the player is allowed to take critical strategic decisions (e.g. spending millions of dollars while buying a mining claim in a developing country). On the other hand, enacting a familiar role is even more challenging, since the player takes decisions about topics that he knows well. Unfortunately such familiarity may distort the negotiating process, since the player may resort to pieces of information that are not provided in the game background, leveraging on them in order to get a better agreement. Thus, a player familiar with the role could find it easier to get a higher score than another one who is not. Such inequality could be fixed only by resorting to scenarios that are familiar or unfamiliar to all the players. In the first case, topics should be of a very low level (e.g. bargaining with the partner for the destination of summer holidays), while in the second case, topics should be set in an imaginary environment (e.g. far future, different dimension, medieval age).

Leadership in Action. ("Leadership-in-Action", 2008)

I: moderately low; R: other, familiar; D: low; C: n.a.; P: interpersonal skills

In this simple single-player game, players play the role of the leaders of a development team responsible for writing a new software application. The project must be completed within six game-time months. The players exert all their influence on the group by choosing the variables that influence the virtual team's morale, stress and productivity.

RP in Security

The most complex and expensive RPGs are developed for the training of defence and security specialists. In fact, the American Defence Department is the world's main financier and user of didactic simulations and games. Beyond the classic flight simulator, submarine simulator and tank simulator, there are several games aimed at the development of soft skills which use RP.

Angel Five. ("Visual Purple", 2008)

I: high; R: self, familiar; D: high; C: cooperative; P: specific skills

In Angel Five, a game used for the training of F.B.I. agents, players take on the role of special agents dealing with a terrorist cell. Since the agents are very skilled in investigating, the core of the game is quite different from that: they have to learn how to interact with the other American agencies. At intervals during the game, the virtual terrorists carry out actions that are shown to the players through short video clips. The agents then have to decide what to do. The software behaves according to hundreds of variables, simulating 12 days of life of a terrorist cell differently in each match. As the players make decisions, they learn something new about the cell. Depending on the players' decisions, the simulation changes, terrorist actions vary and their lives are very dynamically influenced. It is interesting to cite the "*i-squared*" system, that recognizes the decisional style of the player and uses this information

against him (e.g. if the software recognizes that the player needs a lot of information in order to make a decision, it gives him less information).

Hostage negotiation training. In (Van Hasselt, et al., 2006)

I: moderately low; R: self, familiar; D: high; C: cooperative; P: interpersonal skills (assessment of)

This is a “role–playing test” aimed at conducting an empirical assessment of the National Crisis Negotiation Course’s effectiveness for training targeted negotiation skills in F.B.I. agents. The test includes twelve audio taped narrated scenarios describing some crisis negotiation situations. The participants have to respond to the audio taped scenarios according to advanced communication techniques. Their responses are recorded and evaluated after the simulation according to the effectiveness of the chosen techniques. The negotiation ability of the participating FBI agents is assessed via measurement of active listening and additional response categories.

RP in Engineering and Computer Science

SG are also creeping into technical contexts such as engineering and computer science, and they sometimes use RP, as in the following examples.

COSIGA. (Sakiroglu, Riedel, & Pawar, 2007)

I: moderate; R: self, familiar; D: high; C: cooperative; P: knowledge

COSIGA simulates the process of product development, with emphasis on an engineering approach. The players are divided into teams and enact the roles of product developers, working collaboratively together, in order to develop the

final product: a truck. They have to draw up a market and a product specification, design the product, purchase the components and allocate manufacturing processes. According to the authors of the paper, students aren’t learning about the technical aspects of design and manufacturing of a truck while playing, but they are increasing their awareness of the many issues of the design process.

ViRPlay3D. (Jiménez-Díaz, et al., 2007)

I: moderately low; R: other, familiar; D: moderate; C: cooperative; P: specific skills

In this game, the players are surrounded by a 3D environment using a first-person view. ViRPlay3D is aimed at making students understand object-oriented software behaviour. According to the authors, a role-playing approach is needed, since the skills required for in depth comprehension can’t be successfully transferred to the students using traditional lectures. The game is a metaphor of the subject since the players play the role of the objects passing on messages among them, which represents the execution of each “use case”. During the role-play, the participants interact among each other learning from one another as well as from their own experience and the played roles. The authors developed the game after having tested the effectiveness of the method in class sessions too.

The Monkey Wrench Conspiracy. (Prensky, 2007)

I: moderately high; R: other, unfamiliar; D: moderate; C: n.a.; P: specific skills

This famous game was developed in the 90s to spread the use of a new 3D design application: “Thinkdesign”. Even if the incumbent software “Autocad” was performing worse than “Thinkdesign”, its three millions users weren’t prone to

pass many hours studying another application. Thus, the developers decided to find an engaging way to make those three millions engineers learn their program. The players enact the role of a special space agent: they have to enter the space station called “Copernicus” that has been conquered by aliens and chase them away; their only equipment is a special laptop that allows them to build whatever tool they desire. Obviously, the design of those tools has to be made through *Thinkdesign*: “the most powerful CAD application in the Universe”, installed on the special laptop. This milestone of game based learning has distributed more than one million copies, becoming an unheard of success for a serious game.

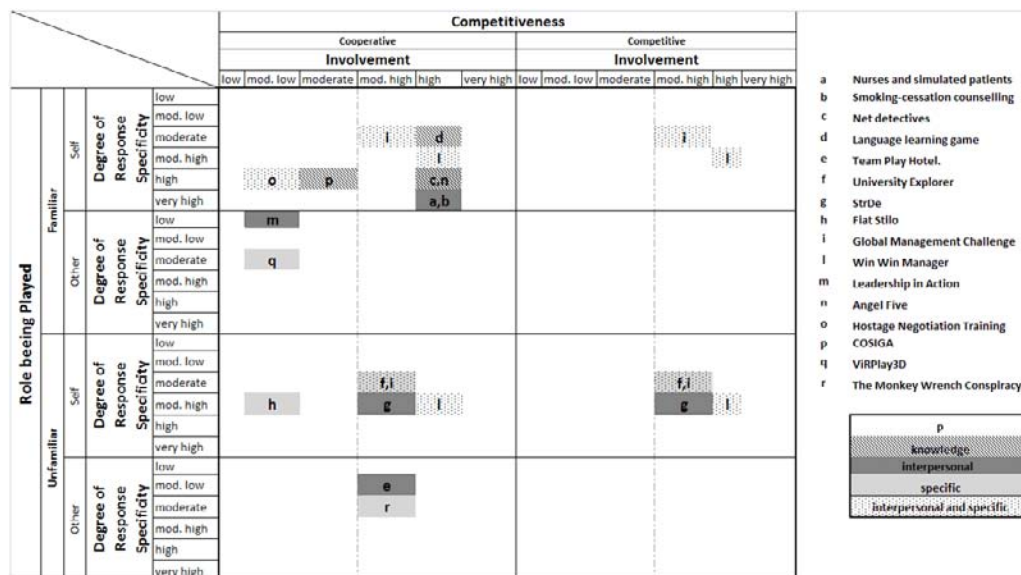
Conclusion and Future Research Directions

In this chapter I provided a general definition for Role-Playing Games, drawing inspiration from several authors’ contributions. Then, I specified a taxonomy in order to classify RPGs according

to five different dimensions. Three dimensions were previously described by Greenberg and Folger with reference to Role Playing Studies and I added two more dimensions: Competitiveness and Didactic Purpose. These dimensions have been useful in highlighting the differences among the cited branches of serious gaming (medicine, education, management, security, and engineering). Drawing inspiration from the literature, I then made some suggestions about the development of games using RP, pointing out when different approaches have been found to be successful. I finally offered a review of selected role-playing games, in order to apply the proposed taxonomy and highlight differences between them.

Figure 1 illustrates each of the games reviewed in terms of their position in a matrix representing the five dimensions, level of involvement (*I*), role being played (*R*), degree of response specificity (*D*), competitiveness (*C*) and didactic purpose (*P*). Although the sample group is very small, Figure 1 highlights that developing a game with a complex didactic purpose (both interpersonal and specific), requires a high level of all the taxonomy dimensions, including an approach that couples

Figure 1..Allocation of the reviewed SG in the taxonomy matrix



competition and cooperation. Such an approach seems to be effective in increasing the level of involvement. It has been mainly used in the Management SG domain. Most of the cited games have been found to increase interpersonal skills, even if a significant portion focuses on specific skills and on the transfer of information. Most of the reviewed games (75%) let the player enact his own role and are developed in a familiar context. *R*, anyway, doesn't seem to be correlated with *I*. On the other hand, Spearman's Rho between *I* and *D* is 0.45, ($p=0.05$) highlighting a meaningful correlation in spite of the small sample⁷. The highest levels of *I* and *D* have been found in the Medicine domain, where often actors are a key element of the game.

The interesting interconnections among the five taxonomy dimensions and the fields of application of SG can lead, after an analysis on a larger number of RPGs to show the design tendencies in the SG sector and the correlations among the taxonomy dimensions. An effort should be made to complete the submitted taxonomy in order to make the format comparable to the dimensions, in particular with regards to *R*. I will provide in a forthcoming paper a rigorous method in order to univocally determine the values of the qualitative dimensions of the taxonomy (*I* and *D*).

REFERENCES

- Alkin, M., & Christie, C. (2002). The use of role-play in teaching evaluation. *American Journal of Evaluation*, 23(2), 209-218.
- Apperley, T. (2006). Genre and game studies: Toward a critical approach to video game genres. *Simulation. & Gaming*, 37(1), 6-23.
- Aronson, E., & Carlsmith, J. M. (1968). Experimentation in social psychology. In G. Lindzey, & E. Aronson (Eds.), *Handbook of Social Psychology*, 2, 1-79 (2nd ed.) Reading, MA: Addison-Wesley.
- Baruch, Y. (2006). Role-play teaching: Acting in the classroom. *Management Learning*, 37(1), 43-61.
- Bateman, C. (2007). *Game Writing. Narrative Skills for Videogames*. Boston, MA: Charles River Media.
- Blecic, I., Cecchini, A., & Colorni, A. (2007). StraDe: a Web-based Role-play Game for Strategic Planning. In M. Taisch, & J. Cassina (Eds.), *Learning with Games* (pp. 17-23). Sophia Antipolis, FR: Politecnico di Milano.
- Blecic, I., Cecchini, A., & Colorni, A. (2007). University Explorer: a Web-based Role-play Game for University Orientation. In M. Taisch, & J. Cassina (Eds.), *Learning with Games* (pp. 337-342). Sophia Antipolis, FR: Politecnico di Milano.
- Bisson, C., & Luckner, J. (1996). Fun in learning: The pedagogical role of fun in education. *Journal of Experimental Education*, 19(2), 109-110.
- Brox, E., Evertsen, G., & Heggelund, A. (2007). A Competence Jigsaw Puzzle – Making a Language Learning Game in a European Project With Diverse Competence and Diverging Standings. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 47-54). Paisley, UK: Academic Conference Limited.
- Cabral, R. (1987). Role Playing As a Group Intervention. *Small Group Research*, 18(4), 470-482.
- Castronova, E. (July 2002). On Virtual Economies. *International Journal of Computer Game Research*, 3(2). Retrieved June 29, 2008, from <http://www.gamestudies.org/0302/castronova/>
- Clark, R., & Choi, S. (2005). Five design principles for experiments on the effects of animated pedagogical agents. *Journal of Educational Computing Research*, 32(3), 209-223.
- De Bono, E. (1987). *Six Thinking Hats*. London, UK: Penguin.

- Fine, G. (1983). *Shared.fantasy*. Chicago: The University of Chicago Press.
- Graham, R., & Gray, C. (1969). *Business.games.handbook*. New York: American Management Association.
- Greco, M. (2007). *Il. Game.Based.Learning: .le. Nuove.Frontiere.dell'Apprendimento.dalla.Simulazione.al.Gioco.di.Ruolo*. Unpublished master's thesis, Tor Vergata University of Rome, Italy.
- Greco, M., & Murgia, G. (2007). Improving Negotiation Skills Through an Online Business Game. In D. Remenyi (Ed.), *European.Conference.on.Game.Based.Learning* (pp. 97-104). Paisley, UK: Academic Conferences Limited.
- Green, K. C. (2002). Forecasting Decisions in Conflict Situations: A Comparison of Game Theory, Role-Playing, and Unaided Judgment. *International.Journal.of.Forecasting*, 18, 321-344.
- Greenberg, J., & Eskew, D. (1993). The Role of Role Playing in Organizational Research. *Journal.of.Management*, 19(2), 221-241.
- Greenberg, J., & Folger, R. (1988). *Controversial.issues.in.social.research.methods*. New York: Springer-Verlag.
- Guth, W., Schmittberger, R., & Schwarze, B. (1982). An experimental analysis of ultimatum bargaining. *Journal.of.Economic.Behavior.&.Organization*, 3(4), 367-388.
- Harré, R., & Secord, P. F. (1972). *The.explanation.of.social.behaviour*. Totowa, NJ: Blackwell.
- Hendrick, C. (1977). Role-taking, role-playing, and the laboratory experiment. *Personality.and.Social.Psychology.Bulletin*, 3, 467-478.
- Holley, W., Armenakis, A., & Feild, H. (1977). Effects of Role-Playing on Perceptions of Union Leaders. *Journal.of.Management*, 3(2), 41-46.
- Janis, I., & King, b. (1954). The Influence of Role Playing in Opinion Change. *Journal.of.Abnormal.and.Social.Psychology*, 49, 211-218.
- Jiménez-Díaz, G., González-Calero, P., & Gómez-Albarrán, M. (2007). Using Role-Play Virtual Environments to Learn Software Design. In D. Remenyi (Ed.), *European.Conference.on.Game.Based.Learning* (pp. 143-152). Paisley, UK: Academic Conference Limited.
- Klingman, A. (1982). Persuasive Communication in Avoidance Behaviour: Using Role Simulation as a Strategy. *Simulation.&.Games*, 13(1), 37-50.
- Koerber, A., Crawford, J., & O'Connell, K. (2003). The effects of teaching dental students brief motivational interviewing for smoking-cessation counseling: a pilot study. *Journal.of.Dental.Education*, 67(4), 439-447.
- Kruijver, I., Kerkstra, A., Kerssens, J., Holtkamp, C., Bensing, J., & Van de Wiel, H. (2001). Communication between nurses and simulated patients with cancer: evaluation of a communication training programme. *European.Journal.of.Oncology.Nursing*, 5(3), 140-150.
- Ladousse, G. P. (1987). *Role-play*. Oxford, UK: Oxford University Press.
- Leadership-in-Action Project Management Simulation. (2008). Retrieved August 22, 2008, from <http://forio.com/lead.htm>
- Lee, J., LeBaron Wallace, T., & Alkin, M. (2007). Using Problem-Based Learning to Train Evaluators. *American.Evaluation.Association*, 8(4), 536-545.
- Maxwell, C. (2007). Team Play – Using Computer Games to Engage Learners in Teamworking. In D. Remenyi (Ed.), *European.Conference.on.Game.Based.Learning* (pp. 193-196). Paisley, UK: Academic Conference Limited.
- McConnell, D. (2000). *Implementing.Computer.Supported.Cooperative.Learning*. London, UK: Kogan Page Ltd.
- Moreno, J. (1946). *Psychodrama*. Beacon, NY: Beacon House.

- Olazar, I. (2007). The Use of Online Games in Business Education: The IE Business School Experience. In D. Remenyi (Ed.), *European Conference on Game-Based Learning* (pp. 205-214). Peasley, UK: Academic Conference Limited.
- Parachute Flight Training Simulator. (2008). Retrieved June 9, 2008, from <http://www.pia.com/fxc/vrweb1.htm>
- Pimenidis, E. (2007). Developing a Computer Game for University Library Induction. In D. Remenyi (Ed.), *European Conference on Game-Based Learning* (pp. 215-222). Paisley, UK: Academic Conferences Limited.
- Prensky, M. (2007). *Digital Game-Based Learning*. St. Paul, MN: Paragon House.
- Raiffa, H. (1982). *The Art and Science of Negotiation*. Cambridge, MA: Belknap Press.
- Rees, C., Sheard, C., & McPherson, A. (2004). Medical Students' Views and Experiences of Methods of Teaching and Learning Communication Skills. *Patient Education and Counseling*, 54, 119-121.
- Sakiroglu, M., Riedel, J., & Pawar, K. (2007). Empirical Study of Creating Engineering Knowledge through Simulation Gaming – the case of COSIGA. In G. Goch, D.H. Müller, K.D. Thoben, & B. Sholz-Reiter (Eds.), *IFIP WG.5.7. Special Interest Group on Experimental Interactive Learning in Industrial Management* (pp. 121-133). Bremen: University of Bremen.
- Senge, P. (1990). *The Fifth Discipline: The Art & Practice of The Learning Organization*. New York: Doubleday.
- Thiagarajan, S. (2003). *Laws of Learning: 14 Important Principles Every Trainer Should Know*. Retrieved February 12, 2008, from: <http://www.thiagi.com/laws-of-learning.html>
- Tychsen, A., Hitchens, M., Brolund, T., & Kavakli, M. (2006). Live Action Role-Playing Games: Control, Communication, Storytelling, and MMORPG Similarities. *Games and Culture*, 1(3), 252-275.
- Van Hasselt, V., Baker, M., Romano, S., Schlesinger, K., Zucker, M., Dragone, et. al. (2006). Crisis (Hostage) Negotiation Training: A Preliminary Evaluation of Program Efficacy. *Criminal Justice and Behavior*, 33(1), 56-69.
- Van Ments, M. (1989). *The effective use of role play: A handbook for teachers and trainers*. London: Kogan Page.
- Visual Purple. (2008). Retrieved August 22, 2008, from http://www.visualpurple.com/pdfs/press_kit.pdf
- Wishart, J., Oades, C., & Morris, M. (2007). Using online role play to teach internet safety awareness. *Computers & Education*, 48(3), 460-473.
- Woodcock, B. (2006). *An Analysis of MMOG Subscription Growth - Version 20.0*. Retrieved from: <http://www.mmogchart.com/>
- Zagal, J. P., Rick, J., & Hsi, I. (2006). Collaborative games: Lessons learned from board games. *Simulation & Gaming*, 37(1), 24-40.

ENDNOTES

- 1 Players cooperate with team-mates while competing with other teams.
- 2 In StraDe, each player wants to gain maximum score, thus sometimes his interests may be in opposition with other players' ones, causing a competitive situation. As well, a cooperative approach is needed with some players in order to let a project take place.
- 3 The GMC is played by students, MBA students and managers. Thus, some players feel familiar with enacting the role of director, while others aren't familiar with it.
- 4 Players cooperate with team-mates while competing with other teams.

- ⁵ Since WWM provides ten very different scenarios and it's played by different kind of users (students, managers, etc...) it's easy for a player to feel familiar with a scenario and unfamiliar with others.
- ⁶ Even if WWM is intended to teach how to conduct a "win-win" negotiation (i.e. collaborative), players are free to choose their approach, which can be positional and aggressive (i.e. competitive) too.
- ⁷ In order to evaluate the Rho, ***I*** and ***D*** were assigned values among 1 and 6 according to the qualitative evaluation shown in Figure 1.

Chapter XI

Telling Stories with Digital Board Games: Narrative Game Worlds in Literacies Learning

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ABSTRACT

In the context of computer games, learning is an inherent feature of computer game playing. Computer games can be seen as multimodal texts that connect separate means of expression and require new kinds of literacy skills from the readers. In this chapter, the authors consider how the computer-based learning tool Talarius, which enables students to make their own digital games and play them, lends itself to literacy learning. The learning subject is a children's novel, and thus it is narrative by its nature. In addition, the learning tool provides the potential to interweave narrative contents into the games made by it. The focus of this chapter is on the relationship between narrativity and learning in computer games, in this case, digital board games. The research question is: How do the narrative functions of the learning tool support learning in game creation and game playing?

INTRODUCTION

Computer games are a substantial part of the contemporary youth culture. Nowadays, games are seen from the perspective of contemporary entertainment, in which activity and social participation are essential characteristics. In the context of games, learning plays an important role. It is an inherent feature of game playing. That is why computer games seem to offer promising support for school learning in the future. At the same time, computer games can be seen as multimodal texts. These new kinds of texts connect separate means of expression and require new kinds of literacy skills from the readers. Computer games can include narrative contents but, in comparison with traditional storytelling, there are also notable differences. Altogether, we believe that computer games can be connected with literacies learning as effective learning tools, but also as learning objectives.

In this chapter, we discuss how the computer-based learning tool *Talarius*, which enables students to create their own digital games and play them, lends itself to literacy learning. The learning subject is a literary text, a children's novel, and thus it is narrative by its nature. Additionally, the learning tool includes the potential to incorporate narrative contents into the games made within it. The focus of this chapter is on the relationship between narrativity and learning in computer games, in this case, digital board games. Thus, the most important research question is how the narrative functions of the learning tool support learning in game creation and game playing.

First we will briefly consider literacy learning with computer games, and connections between narratives and computer games. In the empirical part of this chapter, we will discuss a use experiment of *Talarius* within literature studies, as well as textual literacy and game literacy practicing. As one result of the experiment, we propose a classification of various possible relations between a story and a computer game. In the conclusion,

we will highlight the successes, but also the considerations that should be taken into account during the use and design of this kind of a narrative learning environment in the future.

As such, the topic presented here is little discussed in the literature. Digital board game-formed learning games and environments are quite sparsely researched. There is already some research in the domain of the educational usage of computer game-making process. In this chapter, we are going to join in these discussions by uniting and extending them.

The discussion about game making and its effects for learning is in its early stages yet. The educational effects of game creation from the pedagogical perspective have been discussed by Kafai (2006). She reviewed the use of computer games for learning from two pedagogical perspectives, instructionist and constructionist. The first one, instructionism, deals with educational games that, in most cases, "integrate the game idea with the content to be learned" (Kafai, 2006, p. 37). On the contrary, the constructivist perspective has highlighted the value of a game creation approach, which allows students to learn and examine knowledge through a creative process. Researchers have also discussed what kind of motivational and learning affordances are inherent within the game creation process (Good & Robertson, 2006), how the game creation process can develop one's narrative skills (Robertson & Good, 2004; Szafron et al, 2005), and what the model of game literacy could be when it is observed through the students' creative authoring practices (Buckingham & Burn, 2007).

In the previous works, the researchers primarily considered game creation practices in which the games belonged to the computer role playing game (CRPG) and adventure game genres that are mainly based on three-dimensional presentation. Our case study differs from the previous works in that the games made in this experiment were board games in digital form. Previous works show promising results regarding the use of game cre-

ation and interactive story authoring in learning. Such activities have been found to be interesting and motivating to the students, to enhance collaboration and interactivity between them, and to provide various learning benefits (Good & Robertson, 2006; Robertson & Good, 2004; Szafron et al., 2005). Szafron et al. highlight the value of such authoring tools in integrating technology into the curriculum, especially in English classes where the use of technological solutions has been rather sparse compared to several other subjects. In the study of Robertson and Good (2004), the participants especially enjoyed activities that had a great deal in common with designing plays and other kinds of drama (i.e., creating characters and areas), which was seen as educationally encouraging. However, it has been noted by Szafron et al. (2005) that the users cannot necessarily use the full potential of the technological authoring tools. For example, it might not be easy for the users to learn to take full advantage of nonlinearity or other features not associated with traditional storytelling media.

While our study deals with game creation with a somewhat different, board-game-like tool, many elements of the process are similar to the making of CRPGs. The process entails planning the contents and the goals of the game as well as creating characters and the setting where the game takes place. In the case of this particular use experiment, the Talarius tool was used in Finnish class to explore a literary work, which brought the narrative aspects even more prominently onto the forefront.

Computer Games as Tools for Literacies Learning

Although the main interest of this chapter is on the narrativity of a computer-based learning tool, and literacy learning is primarily in the role of the objective of the students' task in the experiment, the practicing of literacy with computer

games is briefly considered from a couple of viewpoints in this section. From the point of view of narrative support for computer based learning literacy offers interesting challenges as a learning goal, because the game playing itself requires, in addition to textual literacy, also certain game literacy (Buckingham & Burn, 2007). This is true in a variety of cases when computer games and game-like learning environments are utilized in teaching and learning.

As Burn (2005), among many others, has noticed, literature cannot be considered a separate part of cultural products anymore. Equally, the skills of literacy do not remain as their own distinct enclave in the context of literature and printed texts. This progress has evoked needs to examine different literacies that are required in multiform media surroundings. The proposed concepts and the means to construct classifications for this domain are various. For example, depending on the scientific discipline of the speaker, the concept can be "multiliteracies" (Cope & Kalantzis, 2000), "media literacy" (e.g., Buckingham, 2003; Livingstone, 2003), or Internet literacy (Leu, Kinzer, Coiro & Cammack, 2004). In the context of transmediality, Burn (2005) uses the term "cross-media literacy" when he discusses following a story through the different forms of media. Depending on the medium on which the discussion may be focused, the concept can be for example "television literacy," or "moving image literacy" (Buckingham & Burn, 2007). In our case, two particular types of literacy are observed: traditional "textual literacy" and "game literacy," which are seen as partially overlapping skills in the sense that game literacy sometimes utilizes textual literacy, but does not totally include it. As an umbrella concept for both of these concepts we will use *media literacy*.

A media literate person is able to decode, evaluate, analyze, and produce both printed and electronic media (Aufderheide, 1997); therefore textual literacy can be seen as a natural part of media literacy. Media literacy and textual literacy

have many aspects in common: For example, both are taken to develop throughout one's life, are regarded as key competencies for modern active citizenship, and essentially involve critical evaluation and reflective consideration. Social and community aspects are present in both types of literacy: Texts are constructed and their meanings are understood in social interaction within particular surroundings and cultural settings. Furthermore, both have also cognitive, emotional, aesthetic, and moral dimensions and operate at multiple levels (see, e.g., Buckingham, 2003; Livingstone, 2003; Linnakylä, 2000; Potter, 1998.)

Game literacy, a concept proposed by Buckingham and Burn (2007), is a recent proposal for examining skills needed in game playing and game creating processes. In this concept, computer games and their use are recognized in an extensive, multidimensional sense, which advocates considering games in their own right. Buckingham and Burn describe that game literacy theory is one that

addresses both the representational and the ludic dimensions of game; that incorporates a critical as well as a functional dimension; that addresses the textual dimensions of games, while also recognising the social contexts and social processes through which literacy is manifested and developed; and that entails a focus on the creative writing dimensions as well as on reading or consumption. (Buckingham & Burn, 2007, p. 345)

According to Buckingham and Burn (2007), critical and functional dimensions that are typical of textual literacy can be applied to the medium of games. In the context of games, critical literacy includes analysis, evaluation, and critical reflection but also understanding of the wider social and cultural meanings of digital games. Functional literacy involves various basic hardware- and software-related skills. Naturally there are many other ways to divide media literacy and

its subliteracies into different aspects or levels (e.g., Hankala, 2007; Linnakylä, 2000; Sanford & Madill, 2006), but the division into critical and functional dimensions is useful when considering what kinds of textual literacy and game literacy skills are required when students are designing, achieving, and playing digital board games related to a literary text.

What is the reading of a computer game like? A number of researchers (e.g., Buckingham & Burn, 2007; Gee, 2003; Marsh, 2002) consider computer games as multimodal texts. Marsh (2002) explains this choice of words by stating that skills required with computer games overlap in part with skills that are used with printed texts. Marsh continues that computer games players need to interpret different images and animations to fathom the rules of the game. Gee (2003) highlights that the reading of a computer game is situated similarly as in traditional literary reading, "we always read [...] something in some way" (Gee, 2003, p. 14). Buckingham and Burn (2007) state also that the way by which individual computer games utilize different modes of communication are studied at least by similar methods as in the case of written language.

Marsh (2002) also suggests that computer games present a narrative to user, and in this narrative the player embodies the roles of consumer and producer. However, Juul (2001) states that the argument that computer games always include a narrative is misleading. But *if* a game content includes a story, as Buckingham and Burn (2007) state that they often do, then the role of the player/reader cannot be viewed in the customary way of traditional storytelling media. This is the case even though the conception of a literary reader nowadays is seen in a more active role, rather than a passive receiver. The social side of contemporary literacies, especially in the case of game literacy, leads to obscuring the division between author and receiver. In the case of computer games, this is obvious because of their particular interactive quality: The receiver cannot possibly take a passive role.

Marsh (2005) names two characteristics of this social literacy of computer games: media intertextuality and direct audience participation in the narratives. The situation behind new textual practices provides very dissimilar pleasures when compared with traditional book reading. In general, the new media literacies demand various skills, knowledge, and understanding from the reader. Therefore, new kinds of practices are needed to master them.

New practices are already emerging at schools that enables the use of computer games in school classes and practicing different literacies with aspects of them by the students. In these practices, the approach is not conventional in the sense that a game used in a class should be a particular learning game with defined purposes. Rather, in this context computer games are considered cultural media forms in their own right. Examples of these new practices include presentations and discussions related to games, collections and analyses of game information, reading and writing game reviews, and the design of one's own computer games and game characters (Kankaanranta, 2007). This final practice can be adapted and harnessed to deal with both textual and game literacies, and thus is illustrated in the experiment that is the focus of this chapter.

Computer Games and Narratives

The focus of this subsection is on exploring the narratives that games may include. *Narrative*—which refers to both the narration and the story—can be approached from the viewpoints of expression or content. A game can include or use a story as a subject or frame and, in this respect, a narrative can be already existing or new. Thus, the relationship between game and narrative can be considered from the viewpoint of participation within the wider storytelling phenomenon. In this kind of discussion, the emphasis is no longer on the word *telling* in its traditional sense.

When multiple media forms constitute a relationship with the same story, the overlap of contents in separate works may foreground the ways of action. The phenomena and terminology of “transmedia storytelling” (Jenkins, 2003), “transmedial narratives” (Ryan, 2003), and even “transmedial worlds” (Klastrup and Tosca, 2004) have evoked absorbing discussions. Different choices of words refer to different emphases between the central concepts of media, story, narrative, or (art)work, but the various phrases are not always referring to completely distinct phenomena. The three aforementioned concepts are addressed briefly.

Along with Jenkins (2003), the discussion about how different media forms should utilize previous works seems to go back to the ideal aims of the first actual adaptation theorist, George Bluestone (1957). In adaptation research, Bluestone embodied a so-called media-specific approach, which emphasized unique characteristics and capabilities of each media form. Jenkins (2003, p. 3) says, “in the ideal form of transmedia storytelling, each medium does what it does best”. If we think of computer games or board games, then, “the best” is not necessary *storytelling*.

Yet, despite the bygone debate between narratologists and “ludologists” that revolved around the basic question of the essence of a computer game, it is clear that, in its own way, a game can *use* and *utilize* storytelling—even if storytelling is not always advantageous for the gameness proper (Costikyan, 2000; Juul, 1998). Getting back to Jenkins's ideas, he proposes that instead of seeing computer games as a competing media form for literature, it may be more productive to approach the transmedia storytelling as cooperation, where every unique medium does what it does best. The specific workings of the various media forms are inherent because of the distinct qualities of the forms. Jenkins presents that computer games, in particular, offer the possibility for exploring and experiencing fictional worlds through game playing.

Klastrup and Tosca (2004) propose the concept of transmedial worlds for discussing content systems that rely on particular original works and actualize them through a variety of media forms in new works. Klastrup and Tosca explain that, for maintaining the essence of the transmedial world related to a given source, a certain level of fidelity is necessary. The concept of transmedial worlds can be useful within the discussion of intermedial adaptation because the concept of adaptation, according to its latest readings (e.g., Stam, 2000), does not necessarily include the requirement for fidelity to the source text. Deviations from the source text or transmedial worlds can be one useful approach or talking point in the classrooms, when traditional and multimedial literacies are practiced.

Ryan (2003) invited us to review the concept of narrative by noticing the need to expand its use within transmedial contexts. This requires that language should not be viewed as the only form of expressing narratives. In Ryan's proposal, narrative is a kind of mental image. This cognitive construct can be considered separately from the original factor that induced the image construction. It would, then, be the task of transmedial narratology to recognize the different modes of expression that could serve as stimuli in the process of narrative construction.

When attention moves from the story content to a form or a way of expression, the concept of narration takes us back to consider the possibilities of computer games. Telling and representing narratives in or through computer games are the activities that have evoked strong disagreement among the researchers who have been especially interested in the inherent essence and characteristics of computer games. Juul (1998, 2001) expounded that since a computer game player wants to interact with the game events, there can be no actual storytelling at the same time. He highlighted that narration and interaction cannot be simultaneous because the act of telling expresses events that must have happened prior to

the telling act itself, whereas interaction requires events in present.

Salen and Zimmerman (2003) discussed storytelling in computer games more broadly. They stated that a player can experience a game narrative in two ways. First, a game narrative can be an interactively told story that a game designer has constructed in advance of the game play. This situation can cause such problems as Juul discussed above. Secondly, according to Salen and Zimmerman, a story can be an emergent experience that happens during the game play. The modes are named by LeBlanc as embedded and emergent narratives, respectively (Salen & Zimmerman, 2003, p. 383).

One way to observe the literacy practice that will be soon described is to consider it from the transmedia storytelling viewpoint. When this perspective is connected to different concepts of literacies, the nature of the exercise starts to reveal its scopes. The concept of transmedial worlds will be useful when we observe the results of the use experiment. When the focus moves further, and we ponder the alternatives by which one could seize the task, the reasoning is probably more in line with the transmedial narratology—not by recognizing different narrative modes but more like sketching angles of incidences for posing the construction of (existing) narrative.

Narrative Talarius

The use experiment in this study was accomplished with Talarius software. Talarius (lat., “having to do with dice or diceplaying”) is a software application with which children can make and play their own educational computer-based board games. The application allows the children to create questions, a game board, and game characters. From an educational perspective, the goals of Talarius are related to both the instructionist and constructionist approaches (cf. Kafai, 2006): The children both make their own

games and play games made by other children. In order to make a game for his classmates to play, the child must understand the subject matter in question well enough to identify what is essential in it. Then he must formulate questions and tasks on the topic, which potentially develops the child's information searching skills and his ability to assess the quality of information sources. Moreover, a computer-based learning environment such as Talarius can support learning through the children's interactions with one another when making or playing games. In order to collaborate successfully, the children must express their thoughts to other children and to listen and respond to others' ideas, thereby making their thinking visible to themselves and to others.

Talarius has been developed at the Agora Game Lab, University of Jyväskylä, in Finland. It was designed in several phases, each carried out in collaboration with potential future users. The original idea for the application came from a real school context: A school class made geometry-related board games out of paper, which encouraged the teacher to come up with the idea of transforming such games into digital form. The idea further developed into a game creation tool for children. Narrative Talarius is the latest version of the application. The aim in its development has been to enhance the potential for storytelling within the application by implementing features that enable users to integrate various narrative elements within the games they make. The development of Narrative Talarius was based on a model that integrated the abstract structure of games on the one hand and of narratives on the other (Nevala, 2007). From the game design point of view, this model merged two other models, namely Järvinen's (2003) typology of the formal structure of games and the MDA (mechanics, dynamics, aesthetics) model by Hunicke, LeBlanc, & Zubeck (2004). This integrated model was then further elaborated with elements derived from narrative theory and literature related to drama. Conflict and tension, as well as different constituents

of stories and narratives, were merged into the model to enable it to better address the narrative aspects of games (see Nevala, 2007). This model was then used as a framework for implementing narrative elements into Talarius in practice. Another, equally important, source of ideas for the implementation of narrative elements was the users' ideas and feedback, obtained from several use experiments carried out with the earlier versions of Talarius.

The narrative elements are related to several different aspects of the application. In order to enhance conflict and tension, new possibilities for defining the goal of a game were implemented. These include, for example, determining the winner of a game and the number of points acquired by answering a particular multiple-choice question. Moreover, the users can create their own sets of characters to fit the theme of their games. The characters can be given background stories as well as various attributes, each of which can be assigned a specific value. The attribute values play a role in certain events in the game, affecting what happens to the character. Another element aiming to add more tension to the games is the possibility for players to try to steal points from other players at certain stages of a game. Further additions include a branching game path, shortcuts, and non-automated game token movements, all of which aim to allow the players to make choices in terms of how to proceed along the game path.

A collection of tools for event making is one of the most crucial features implemented in Narrative Talarius. The different types of tools for events entail, for example, character attribute changes, compulsory stops, and obstacles (i.e., entering a certain area on the game board requires the player to possess, e.g., a particular object or a minimum number of points). In the use experiment described in this chapter, the children used a diversity of event tools in their games. In one game, the characters had to find a lost baby fox on the game path and take it to the nest that was

located elsewhere on the board. This was realized by using the “Object” event tool, in which a certain object is hidden in a particular square on the game path, and once the object is found by a player, the attributes of his character are modified accordingly. In this game, the hidden object was the baby fox (Figure 1). Its discovery was represented by a key to the nest; thus the value of an attribute called “Keys” changed from zero to one. Another approach could have been, however, a customized attribute when making the characters called, for instance, “Foxes.” After finding the fox, the player would have had to take it to a particular square on the board. This was fulfilled with the “Object Obstacle” function. In other words, upon arriving at the square representing the nest, the game checked whether the “Keys” attribute of the player’s character had a value bigger than zero, and if it did, the player was allowed into the nest. The nest also was defined as an “End of Game” square, meaning that once one of the players made it there, the game was over.

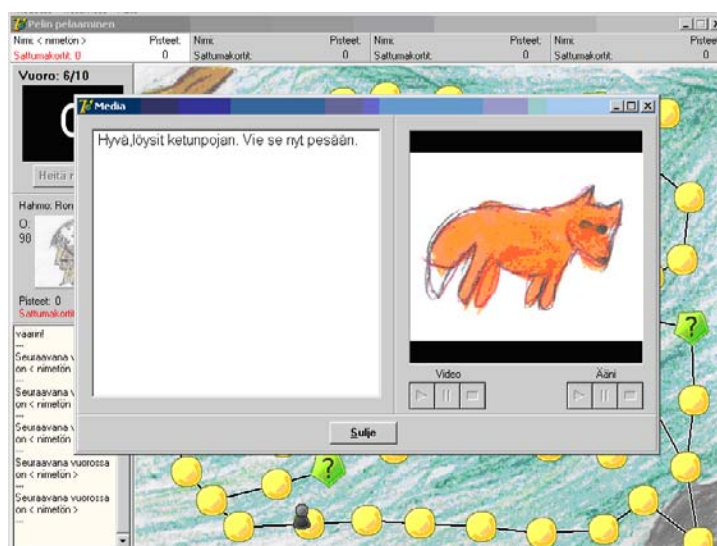
Important supporting features in terms of the narrative of a game include also media windows, through which the players are presented information in the form of text, images, video, and/or audio.

In Figure 1, a media window tells a player that she has found the baby fox and instructs her to take it to its nest. The purpose of the information presented in media windows can be to advance the plot, to provide more information about one or more of the characters, or to narrate certain events that enhance the tension and conflict in the game.

A Case Study in the Field of Literature Studies

The use experiment was accomplished with a class of 9-year-old pupils at a Finnish primary school in December 2007. The 21 pupils were divided into five game-design groups. The main aims of the practice were to assist the children in acquainting themselves with the world of text and to develop their story construction and reading skills by creative action. The topic of the selected novel for this use experiment was familiar to the children because the teacher had read the book to the class earlier in the semester. Some of the children had also seen the movie with the same title that was based on the novel.

Figure 1. Media window displaying a message about finding the baby fox



Narrative Talarius has potential for creating narrativity into a game. The theme of the lessons was a literary work, Astrid Lindgren's *Ronja, ryövärintytär* ("Ronja - The Robber's Daughter"). Thus, the use experiment dealt with narrativity in computer games and in learning on several levels.

The implementation of the use experiment was distributed into two main steps: game creation and game playing. The game creation step was further divided into the game design stage and the realization stage. At first, pupils got topics each of which referred to a certain scene in the book. The scenes were Bear's Cave, Robbers' Walk, Hell's Gap, Matt's Wood, and Matt's Fort. First, the students prepared mind maps about the background information related to their topic. Next, they designed and scripted their board games using paper forms that were structured in accord with the user interface of Narrative Talarius. The forms were prepared specifically for the purpose of this experiment: They were meant to ease the segue from the design stage to the realization stage by directing the pupils to include and define the contents in their designs that Narrative Talarius would require during the realization stage, such as requisites related to the events or character attributes. As the last task of the game creation step the plans were realized by Narrative Talarius, and all of the students were interviewed as small groups.

In the game playing step, the topics were exchanged between the small groups, and the pupils made mind maps about their new topics. Next, each group played the digital board game related to their new topic, made by their classmates. When the game play was complete, the pupils got the chance to make alterations with colored pencils to the mind maps related to the topic of the game they played. At the end of the experiment, the students were interviewed again.

Data was collected in multiple forms: it consists of mind maps, scripts, prepared board games, observational notes, videotaped interviews and

log-information. The main aim of the analysis was to examine how the narrative functions of the learning tool supported learning in both the stage of game creation and the stage of game playing. This main question was divided into several sub-questions: (1) how the pupils were utilizing different narrative functions of Narrative Talarius, (2) how they planned their games, (3) how easily they could realize their plans by Narrative Talarius, and (4) what kind of problems they encountered during the game creation process. The data was analyzed using a qualitative analysis method driven by these questions. The analysis also revealed the pedagogical meaning of playing finished games for the reading practice. During the analysis, the observational notes and transcribed interviews were coded according to the research questions. Also the mind maps, scripts, digital board games and log-information were analyzed in the light of the research-questions.

In our use experiment, the games created belong to the computer game genre of board games. Thus, games created by Narrative Talarius are adaptations in the sense that they transfer some actions of tangible board games into the form of a digital game. From the storytelling viewpoint, this brings new kinds of challenges. It is obvious that, in connection with board games, the storytelling modes and technicalities must be different than, for example, those used in adventure games. In this use experiment, the task of making a board game related to particular settings of a literary text that included as well the possibility to understand the task from an adaptation viewpoint. This led the pupils to deliberate how to utilize the story contents of the source text. In the following paragraphs, the games created by the pupils—the core of the data—are described briefly.

- **Robber's Walk:** The main goal for the player is to collect as many points as possible. The points can be received by answering correctly the questions posed at question squares. Another way a player can gain

points is to rob the other players of their points. Moreover, two treasure chests, which give a great deal of points to the finders, are hidden along the branching path. To open a chest, the player needs first to pick keys that are in evidence along the path. The game ends when the turn limit set at the beginning of the game is reached, and the winner is the player with the most points.

- **Hell's Gap:** The main goal of the game is to reach the other side of a chasm. The chasm is represented in the background picture and it is crossed by two branches of the path. The start is in a corner of the board named Matt's Fort, and the finish is positioned in the opposing corner named Borka's Fort.
- **Matt's Wood:** In the Matt's Wood game, a background story has been presented in a way that motivates the player to execute the main task. The story tells that the mother fox had lost one of its whelp, and asks the player(s) to find the baby fox and return it to the nest. The winner is the player who completes this task. The baby fox's position is hidden along the branching path. The nest is depicted as a drawing in the corner of the board at the end of the path.
- **Matt's Fort:** The initial state of this game is that each player is inside a castle and has to find a key for getting out. The background picture of the board represents a floor plan of the castle. Branches lead to separate rooms of the castle. The key is hidden in one room, and the player accomplishes the goal by taking the key to the place where the path seems to leave the castle.
- **Bear's Cave:** The main goal of the player is to find a knife and to take it to Bear's Cave. The player who first fulfills this task is the winner. The knives appear as pictures along the path. The location of the finish is a bit unclear, but the form of the path includes a hint: It is at the end of the longest branch of the path.

Making Digital Board Games

In the analysis, many different research questions were posed against the data. This chapter focuses on the question regarding how the narrative functions of this learning tool support students' learning during both the game creation and game playing stages. Both game creation and playing are considered as learning situations.

The games created in the experiment share many common characteristics. In four cases of the five, the content of the games is more interpretative than iterative in relation to the content of source text. In all the five cases, the central domains for game ideas and playing are the board, path, and events. Slightly less important are the characters and the questions series. This means that the events are often related to the main goal set for the player, whereas, for example, selecting the character for playing does not have an effect on the gaming situation. All of these are results of decisions made by the students in the design stage. If the games are observed from the viewpoint of storytelling, the narratives of the games are almost solely emerging ones. Only one game, Matt's Wood, included a clear story frame, the situation of the missing baby fox. Yet, the source novel is present in every game, at least because of the naming of the characters, their back stories, and the naming of the places.

In the game creation process, the preparation of the questions series in particular seemed to work as an instrument for detecting the factual content from the novel. It became clear that the pupils did not want to handle any interpretative contents in the questions, although they would not have needed to define the right answers if they had used open-ended questions. The creation of the board and the characters seemed to belong to interpretative reading. The pupils discussed the appearance or the landscape of the setting when they were designing the boards. They seemed to construct their shared readings through drawing and making the game path. Determining the main

idea, goals, and events of the board was also part of this constructing process. Likewise, during the character-making process, the pupils represented their mental pictures of the characters of the novel by drawing and describing them.

As noted above, most of these games are interpretative. Similarly, central domains in the games are the board and the path, as well as the events. The creation of the board supported the establishment of interpretations. If these remarks are merged, board making will appear important for interpretative reading, that is, critical reading. The board embodies the spatial dimension of the game. The notion that the creation of the board supported the establishment of interpretations agrees with Jenkins's (2003) view that computer games offer the possibility for exploring fictional worlds, though in digital board games the fictional worlds are not clearly experienced like in adventure games. In this case, the exploration happened through the game board making, which compelled the pupils to construct a conception of the story world. Now we explore how the use of critical game and textual literacies is exemplified by the games made by the students.

In the Robber's Walk game, the pupils did not build any particular narrative structures. Actually, in the beginning of the process they told that they had almost no background information about their topic. Their achievement of the task was, then, reminiscent of game-like exploration. Robber's Walk is a place where the robbers stole from travelers (Lindgren, 1981, p. 16). The pupils took this factual content and transformed it to be the main goal of the game: During the game, the players must collect as many points as possible. One of the ways by which a player can win is to rob another player of his points. This is in line with the book's plot, where readers learned that the robber crews stole not only from travelers but also from other robbers if there was nothing else to steal (Lindgren, 1981, p. 16). Thus, this action in the game is motivated by the source novel.

Because the students did not know enough about the topic at first, the preparation of questions played an important role in this group's game creation process. They made questions like, "Is someone living in the Robber's Walk?" and "Does one rob in the Robber's Walk?" These questions were prepared as multiple choice, so that the pupils needed to decide the right answers. This got them to read the book and to ponder and discuss their opinions about the text.

The students who designed the Matt's Fort game created a situation that partially resembled a couple of scenes in the source novel. The initial situation of the game is that the player is inside a castle and he has to find a key for getting out. In the book, there are two scenes in which Ronia is inside the castle and wants to get out, but there lies some kind of an obstacle or tension in the way of that desire. But in the book, there is no such scene where Ronia would look for a key for getting out of her home castle. There is no situation where someone wants to keep her from going out of the castle. Her home life in the castle is described many times as happy and warm. Even, when the relationship between Ronia and her father becomes strained, Ronia can still go outside if she wants.

However, in the book there is a tension related to being inside versus outside the home castle. This home castle split in half in the beginning of the book, which also mirrors the basic theme and tension of the book. The tension exists between the Matt's robber group and the Borka's robber group, as well as between children and adults. The pupils have probably dealt with the tension between children and adults when making their game. They have intensified the configuration and set a possibility for a player to defuse this tension. The narrative of this game is more emerging than embedded, for there is no kind of constant story structure designed in the game. Because the narrative emerges more from the relationship between the tensions of the source novel and the

basic situation in the game, it is possible that a player, especially one unfamiliar with the novel, may not notice it at all during the game play.

The pupils in the group that made the Matt's Wood game had a great deal of previous knowledge about the setting, but only a small part of this was utilized in the game creation. Instead, they decided to extend one detail, namely a fox, related to their topic setting by creating a brief story around it. This extension was then executed as a game. In one sense, through their game making this group wrote an extension they imagined inside the story of the novel.

In the Hell's Gap group, the tension related to the setting was recognized during the game design stage. Thus, the idea of the game is based on this tension: The players have to try to get to the other side of the chasm. In this case, the pupils were just repeating a detail (not a particular event) of the source text.

The Bear's Cave pupils had previous knowledge about the setting, but only very little of this was utilized. This group used one event related to the topic setting, a disappearance of a knife, for shaping the main idea, the target, and the goal of the game. But, while using this detail in the way they did, they ignored the deeper meaning related to this event as presented in the novel. Thus, in this case, it seemed that the understanding of the themes that were contained in the topic did not become deeper. The traditional reading of the text was laid aside. This shows that there are some challenges when many different literacies are required. In particular, this highlights the need of sufficient time for making the games.

In all groups, the major challenges encountered during the game creation stage were mainly practical, like questions related to time consumption and direction. These matters were doubtlessly also related to the problems that were seen in the achievements of some of the games. These technical faults or weaknesses in the coherence of the game ideas also may have arisen from the

separation of game design and game achieving processes. It could be improved by including a circulation of design and testing steps in the overall practice of game making.

What, then, was the pedagogical meaning of playing the finished games? How did the games work? In the interviews, the pupils agreed that they had not learned anything special about the novel or the process of reading when they played the games made by their classmates. Yet, in the next breath, they were comparing the games to their own constructions of the topic and describing their own opinions of the setting, the events, and characters related to it. They also pondered how they would have made the game if they had received a certain topic at the beginning.

When the pupils commented on the games they had played, there appeared to be some "It was not like this in the book!" opinions when the main function, the appearance, or a detail of the game did not match their view of the transmedial world (using the term of Klastrup and Tosca, 2004) of the source text. The congruity between the game and the source novel seemed to have an influence on the pleasantness of the game idea during the play. This phenomenon is well-known from the adaptation debates, but in this case the causal chain of unfaithfulness and pupils interest constitutes an interesting challenge. During the game creation process, the varying and altering of contents of the textual work can be a reflection of the pondering and determined striving toward a desired outcome of interpretation. When another group of pupils played the game later, their opinions of the topic clashed with the student-creators' opinions constructed previously during a separate situation. The original thought processes, discussions, and decisions remain invisible to the other pupils if it is not revealed by group discussions or in some other way.

What did the pupils learn in the game making and playing process? The results are varied. When this question was posed to the students,

they did not feel they learned anything special about the novel or interpretative reading during either process related to the game. Clearly, they did not recognize the pondering of a literacy text as learning. This should be expected, because students at the age of 9 years have not yet worked through many, if any, interpretative practices of this kind. Instead, they saw that they had practiced, for example, different functional computer skills, designing methods, digital board game making, and cooperative skills.

Nevertheless, during the game creation process, the pupils were practicing their critical textual literacy skills by creating digital board games related to certain settings of a literary text. Because of the form of the task, they also needed critical game literacy skills outlined by Buckingham and Burn (2007). Naturally, the functional aspects of these literacies also were required, although these skills are not considered deeply within this chapter. In practice, it seemed that during the task, the pupils were required to alternate between textual literacy and game literacy skills. This movement was needed in the game creation stage, as well as following the game playing stage, when pupils were discussing their interpretations and opinions about the novel and the games created by their classmates.

It became apparent during the game design process that some of the pupils in the groups already held some game literacy skills. This included, on the one hand, knowledge about computer games and, on the other hand, knowledge about board games. The pupils utilized this kind of game literacy to investigate the literary text world. In a way, they often tried to view the world of the novel through the digital board game medium form and create their own opinions of the text within the Narrative Talarius game. In this sense, Narrative Talarius was used as an inspiring and easy enough learning tool for quite a challenging exercise.

Viewpoints to Possible Relationships Between a Story and a Computer Game

During the planning and accomplishing of this use experiment, a classification of various possible relations between a story and a computer game started to take form. In this chapter, this classification is suggested as a starting point for observing these relations from a game-making viewpoint. The basis for the discussion is to approach the relations as broadly as possible. In this classification, the focus is not on the *ways* in which a computer game can or cannot tell stories, but on the relationships between an already-existing story and a computer game. Still, the focus is not only on the adaptations in the traditional sense, because the “story” is a more abstract object than a particular source text or artwork. While the story can, in the first two cases of the classification, be seen nearly as analogous with “source text,” the wider and more abstract story takes its place in the third case. Also the question of fidelity to some particular version of the story (the “original”) stays out of this classification.

The classification includes three cases, which are named *Referral*, *Traditional storytelling* and *Involvement in the intermedial storytelling*. In the case of Referral, a computer game is meant to deal with, or even teach, a particular story. It is possible that the game in this case includes a narrative, but the narrative does not correspond to the narrative of the story from which the idea of the game arises. While the story is one subjective element of the game, the connection between the contents of the game and the story is indirect.

The case of Traditional storytelling means such games that emphasize the storytelling function, and may thus occasionally lay aside the interactivity and the functions of game playing. In this case, the storytelling is mainly embedded in the game, and the connection between the game contents and the story contents is obvious.

In the case of *Involvement* in the intermedial storytelling the interactivity and other characteristics inherent for computer games are not superseded in the name of storytelling. Instead, computer game as an independent media form takes part in much wider multimedial storytelling in its own terms. In this case, the storytelling in a computer game can be both embedded and emerging. If we follow Jenkins' (2003) notion, instead of *storytelling*, the more important point may be to proffer the possibility to explore and experience the story world.

The perspective to the story contents of both *Referral* and *Involvement in the intermedial storytelling* can be seen as exploratory, but there are also important differences. In the former case, the nature of the examination is more external, and maybe also more instructional. In the latter case, the exploration is enabled through empathizing to the story world, and thus it is part of game-like storytelling.

Conclusion

In this chapter, we have viewed literacy learning through game-making and game-playing processes in the context of transmedial storytelling. While the pupils were playing games created by their classmates and when they discussed this activity during the interviews, they were in fact considering their classmates' game-like interpretations and extensions of the novel. The unfolding interpretations evoked acceptance, but also resistance. Notable is that the pupils pondered their own opinions about the text, its events, relationships, and story world. They also practiced various literacies, including traditional textual literacy and game literacy. Furthermore, these two literacies include many different skills, out of which, for example, knowledge about genres and interpretation were especially required. These skills were named in this chapter within critical literacy.

The use experiment tentatively supports the view that a learning tool like Narrative Talarius lends itself quite well to literacy learning, when literacy is understood in the contemporary wide-ranging meaning. When literacy practice is accomplished using a game-creating tool, it has to be recognized that also this game literacy practicing is inextricably immanent. In the exercise accomplished in our use experiment, narrative functions of the learning tool supported the students in constructing interpretations, enabling them to make the interpretations visible as multimodal texts so that their classmates who played their game could, for one, assess and compare the game-makers' interpretations to their own. Equally, the preparation of the questions series helped the students map and test their knowledge about the factual contents of the source text; yet this part of the game making also could have been used in the students' interpretative work.

It became clear that some of the students already possessed some game literacy skills, gained from earlier game-playing experiences, and that they utilized these skills in their game-creation process. The pupils who seemed to have no or little game literacy skills would have needed more time for their game-creation process. Thus, if a learning tool like Talarius is used in a class for learning different subjects, a game-making process can become more effective in the pedagogical sense, as well as more entertaining, when the students get more practice and knowledge about game making. The teacher can also help the pupils to improve their game literacy, while many pupils do this in their leisure time. Perhaps, the essential point here is that the teacher needs to teach *about* the computer game process, not only by it, as Buckingham and Burn (2007) have remarked.

Stories and computer games can constitute connections in different ways, or computer games can evoke narrative construction through different practices. In our experiment, the students who seemed to work most successfully seemed

to approach the process in a game-like way, which was named in the proposed classification as *Involvement.in.the.intermedial.storytelling*. If there is a desire to further develop the narrative functions in a learning tool like Talarius, this way of taking part in transmedia storytelling may be effective. Crucial questions for research that follow from this would involve what transmedia storytelling would mean in the context of board games, and how this game-like storytelling in board games would be translatable within the digital form. Further research regarding the proposed classification in the context of learning games would also be useful. Such a classification could be used as a framework for the research that continues to consider the larger question: How can learning with computer games be supported by narratives?

REFERENCES

- Aufderheide, P. (1997). Media literacy: From a report of the National Leadership Conference on Media Literacy. In R. Kubey (Ed.), *Media literacy. in. the. Information. Age.: Current perspectives.* (pp. 79-86). New Brunswick, NJ: Transaction Publishers.
- Bluestone, G. (1957). *Novels into film*. Baltimore, MD: The Johns Hopkins Press.
- Buckingham, D. (2003). *Media. education.. Literacy,. learning. and. contemporary. culture.* Cambridge, UK: Polity Press.
- Buckingham, D., & Burn, A. (2007). Game literacy in theory and practice. *Journal.of.Educational. Multimedia.and.Hypermedia*, 16, 323-349.
- Burn, A. (2005). Potter-literacy: From book to game and back again; Literature, film, game and cross-media literacy. *Papers:.Explorations.into. Children's.Literature*, 14(3).
- Cope, B., & Kalantzis, M. (Eds.). (2000). *Multiliteracies:.Literacy.learning.and.the.design.of. social.futures.* London: Routledge.
- Costikyan, G. (2000). *Where. stories. end. and. games. begin.* Retrieved March 13, 2008, from <http://www.costik.com/gamnstry.html>
- Gee, J. P. (2003). *What.video.games.have.to.teach.us.about.learning.and.literacy?* Gordonsville, VA: Palgrave Macmillan.
- Good, J., & Robertson, J. (2006). Learning and motivational affordances in narrative-based game authoring. In the *Proceedings.of.the.4th. International. Conference.for.Narrative.and. Interactive.Learning. Environments.* (NILE; pp. 37-51). Retrieved April 1, 2008, from http://www.cogs.susx.ac.uk/users/judithg/papers/NILE2006_GoodRobertson.doc
- Hankala, M. (2007). From traditional literacy to media literacy: How to bring up media literate citizens? In P. Linnakylä & I. Arffman (Eds.), *Finnish. reading. literacy.. When. quality. and. equity. meet.* (pp. 249-268). Jyväskylä, Finland: Institute for Educational Research, University of Jyväskylä.
- Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings.of.the.Challenges. in. Game. AI. Workshop,. Nineteenth. National. Conference on Artificial Intelligence.* Retrieved June 10, 2008, from <http://www.cs.northwestern.edu/~hunicke/MDA.pdf>
- Jenkins, H. (2003, January 15). Transmedia storytelling. *Technology.Review.* Retrieved March 11, 2008, from <http://www.technologyreview.com/Biotech/13052/>
- Juul, J. (1998, November). *A.clash.between.games. and. narrative.* Paper presented at the Digital Arts and Culture conference, Bergen, Norway. Retrieved December 13, 2007, from http://www.jesperjuul.net/text/clash_between_game_and_narrative.html

- Juul, J. (2001). Games telling stories? A brief note on games and narratives. *Game Studies*, 1(1). Retrieved December 13, 2007, from <http://www.gamestudies.org/0101/juul-gts/>
- Järvinen, A. (2003). Making and breaking games: A typology of rules. In M. Copier & J. Raessens (Eds.). *Proceedings of Level Up: Digital Games Research Conference* (pp. 92-99). Utrecht, Country: University of Utrecht.
- Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, 1, 36-40.
- Kankaanranta, M. (2007). Digital games and literacy. In P. Linnakylä and I. Arffman (Eds.) *Finnish reading literacy: When quality and equity meet* (pp. 281-307). Jyväskylä, Finland: Institute for Educational Research, University of Jyväskylä.
- Klastrup, L., & Tosca, S. (2004). Transmedial worlds: Rethinking cyberworld design. In *Proceedings. International Conference on Cyberworlds 2004* (pp. 409-416). Washington, DC, USA: IEEE Computer Society.
- Leu, D. J. Jr., Kinze, C. K., Coiro, J. L., & Cammack, D. W. (2004). *Toward a theory of new literacies emerging from the Internet and other information and communication technologies*. Retrieved December 4, 2006 from <http://www.reading.org/Library/Retrieve.cfm?D=10.1598/0872075028.54&F=bk502-54-Leu.pdf>
- Lindgren, A. (1981). *Ronja, ryövärintytär*. [English translation here]. Juva, Finland: WSOY.
- Linnakylä, P. (2000). Lukutaito tiedon ja oppimisen yhteiskunnassa [English translation here]. In K. Sajavaara & A. Piirainen-Marsh (Eds.). *Kieli, diskurssi ja yhteisö* (pp. 107-132). Jyväskylä, Finland: Centre for Applied Language Studies, University of Jyväskylä.
- Livingstone, S. (2003). The changing nature and uses of media literacy. MEDIA@LSE Electronic Working Papers 4. Retrieved June 23, 2008, from http://www.lse.ac.uk/collections/media@lse/pdf/Media@lseEWP4_july03.pdf
- Marsh, J. (2002). Popular culture, computer games and the primary literacy curriculum. In M. Monteith (Ed.) *Teaching primary literacy with ICT*. Buckingham, UK: Open University Press.
- Nevala, H. (2007). *Narratiivit, pelisuunnittelijan työkaluina* [Narratives as tools for game designer]. Unpublished Master's Thesis, Department of Mathematical Information Technology, University of Jyväskylä, Finland.
- Potter, W. J. (1998). *Media literacy*. Thousand Oaks, CA: Sage Publications.
- Robertson, J., & Good, J. (2004). Children's narrative development through computer game authoring. Retrieved April 7, 2008, from <http://delivery.acm.org/10.1145/1020000/1017841/p57-roberston.pdf?key1=1017841&key2=4664757021&coll=GUIDE&dl=GUIDE&CFID=23200458&CFTOKEN=83234777>
- Ryan, M-L. (2003, November). *Transmedial narratology and concepts of narrative*. Paper presented at the 2nd International Colloquium on Narratology Beyond Literary Criticism, University of Hamburg, Germany.
- Sanford, K., & Madill, L. (2006). Resistance through video game play: It's a boy thing. *Canadian Journal of Education*, 29, 287-306.
- Salen, K., & Zimmerman, E. (2003). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.
- Stam, R. (2000). Beyond fidelity: The dialogics of adaptation. In J. Naremore (Ed.), *Film adaptation* (pp. 54-76). New Brunswick, NJ: Rutgers University Press.

Szafron, D., Carbonaro, M., Cutumisu, M., Gillis, S., McNaughton, M., Onuczko, C. et. al. (2005). *Writing. interactive. stories. in. the. classroom.* Retrieved March 1, 2008, from <http://www.imej.wfu.edu/articles/2005/1/02/index.asp>

Chapter XII

The Path between Pedagogy and Technology: Establishing a Theoretical Basis for the Development of Educational Game Environments

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ABSTRACT

The power of computer game technology is currently being harnessed to produce “serious games”. These “games” are targeted at the education and training marketplace, and employ various key game-engine components such as the graphics and physics engines to produce realistic “digital-world” simulations of the real “physical world”. Many approaches are driven by the technology and often lack a consideration of a firm pedagogical underpinning. The authors believe that an analysis and deployment of both the technological and pedagogical dimensions should occur together, with the pedagogical dimension providing the lead. This chapter explores the relationship between these two dimensions, and explores how “pedagogy may inform the use of technology”, how various learning theories may be mapped onto the use of the affordances of computer game engines. Autonomous and collaborative learning approaches are discussed. The design of a serious game is broken down into spatial and temporal elements. The spatial dimension is related to the theories of knowledge structures, especially “concept maps”. The temporal dimension is related to “experiential learning”, especially the approach of Kolb. The multi-player aspect of serious games is related to theories of “collaborative learning” which is broken down into a discussion of “discourse” versus “dialogue”. Several general guiding principles are explored, such as the use of “metaphor” (including metaphors of space, embodiment, systems thinking, the internet and emergence). The topological design of a serious game is also highlighted. The discussion of pedagogy is related to various serious games we have recently produced and researched, and is presented in the hope of informing the “serious game community”.

INTRODUCTION

The use of computer game technology, especially the deployment of commercial game engines such as Unreal Tournament 2004 (UT2004) is becoming an established activity with ‘Serious Games’ research projects. Despite these projects, there has been little attempt to develop a theoretical basis for the production of educational and training immersive environments (IEs). In this chapter we discuss our approach to establishing a theoretical basis for the construction of Serious Game IEs based upon pedagogical principles. The domain discussed in this paper refers to physics education, though our research has included other domains such as software programming, education of architects and artists, and training of police officers. In this section we establish a correspondence between the various affordances of the game engine and associated pedagogical principles. In subsequent sections we discuss several pedagogical principles which map neatly onto game engine affordances. Within a discussion of (i) non-collaborative, i.e. instructional and autonomous learning and (ii) collaborative learning, we highlight approaches derived from Concept Maps, Experiential Learning Theory, Adaptive Learning and the socio-cultural theory of Vygotsky. Within (ii) we apply theories of collaborative learning based on the cognitive approaches of Dillenbourg, discourse analysis and contemporary dialogic theory according to Bakhtin. Theoretical approaches are juxtaposed with a discussion of the practical affordances of the UT2004 game engine. Many, but not all of our theories and design principles have been tested in various IEs, yet we believe that a theoretical approach, as suggested here, may be of great use to educational game developers. There is of yet, no ‘theory’ of computer games, since the discipline is too young, there is insufficient material to be subject to a scientific analysis and therefore to the establishment of a theory. The design of computer games is grounded in principles which have been

informed by classical (e.g. board) games, as well as the digital technology which supports the development of commercial games..

An example of an IE created with UT2004 is shown in Figure 1. Here, in this room, two learners and an instructor are engaged in collaborative discussion about a physics experiment involving objects, shown as spheres, which move under the influence of gravity with or without the friction provided by air resistance. Each person has ‘logged in’ through an internet connection to the game engine supporting the IE. The engine faithfully represents the motion of the objects (through the physics engine component). Collaborative learning is supported through spoken communication; each person has headphones and a microphone. Through discussion they may negotiate which experiment to perform and how to perform it, setting parameters and analysing logged data. This room is connected to other rooms where additional approaches to learning about gravity are explored. Further rooms explore additional concepts associated with this aspect of physics. This structure provides a rich learning environment which supports linking of concepts, attention to individual learning styles, and approaches to collaborative and adaptive learning. This chapter explores theoretical approaches to aid the construction of such rich learning environments.

Figure 1.



We suggest that the generation of educational materials must be grounded in theories based on pedagogy and not solely driven by contemporary technology. There is a clear dialectic here which must be resolved. As a first step in addressing this, we have aligned ‘affordances’ of computer game technology (the tools and game elements available for use) and have set these affordances alongside pedagogical principles; the result of this mapping is shown in Table 1.

The affordances have been divided into several sections. In (a) we consider the IE as a whole, i.e. a network of rooms containing interactive elements. How do we design the layout or ‘topology’ of this network of rooms? This is the first question for an IE designer. The entire IE can be considered as an analogue of the physical world. Behaviour within the IE is close to that observed in the physical world, but of course not identical. This is a strength; an IE can be constructed to contain the desired learning experiences without any distracting information. For example in physics experiments friction can be turned off, which simplifies the study of motion. This not easy to do in a laboratory setting. Also, learning within an IE is *experiential* driven principally by the learner’s experience of phenomena. This suggests we must take on board theories of *experiential learning*. The topology of the IE (which rooms are connected to others and why) must be considered. As we explain in detail below we use the spatial metaphor to link the IE topology to the knowledge structures of the expert educator. Each room is associated with a subject concept (e.g. friction) and is linked by passageways to other concepts (e.g. falling under gravity). As the learner journeys through the IE rooms, he/she is effectively traversing the knowledge structure of the expert, thanks to this spatial metaphor. IEs may contain a single learner, who therefore learns in an autonomous mode, or else via the internet which may contain several learners allowing for guided or collaborative learning. In (b) we consider the dynamics of the game engine in the broadest

sense of learner-IE interaction. On a short time scale we identify with the dynamics of experiential learning, e.g. a movement around the four states of the ‘Kolb cycle’. On a longer time scale we identify with the dynamics of adaptive learning where the IE may change as a consequence of the learner’s actions. Various technology components are listed in (c). Of importance here is sound which supports the use of the spoken word. This may be used to establish a narrative, storytelling, discourse and dialogue. In (d) the interaction between learner and IE objects is provided by the console and Heads-Up-Display (HUD). We have programmed many HUDs to display e.g., the current parameters for a physics experiment or even the results of that experiment. This provides another dimension of learner-IE interaction. The functionality of an IE based on a commercial game engine can be extended by programming. In (e) we identify three areas where this has been done to increase the functionality of our IEs. We have programmed physics actors to solve mathematical equations (e.g. the Lorentz equations), and to display the results as objects located within the IE and to log their state to a text file for further analysis. We have programmed NPCs to act as ‘guides’, leading the learner through the network of concepts and activities contained within the IE. The learner is embodied in the IE as an animated character; the learner may choose either a first or third person view of the IE. This avatar has been programmed to log the player’s state (such as actions performed, test scores), as well as to manipulate learning objects, such as picking up words to assemble into text or controlling physics experiments.

As already mentioned, the technology associated with our IE worlds provides an analogy of our experienced physical world, though not in exact detail. Indeed it is the lack of detail (or ‘noise’) which makes these IEs so attractive in education; there are few ‘distracters’, extraneous influences which reduce the educational efficiency. But what is the fundamental characteristic of an IE which

Table.1..This table provides a mapping between the affordances of the game-engine technology we have used in the production of IEs. (left column), with associated pedagogical principles. (right column)...The centre column is a bridge, asserting the ontology or the metaphor we invoke.

	Game/IE Technology	Ontology/Metaphor	Pedagogy
(a)	Virtual and Immersive Worlds	Immersion, Simplification	Analogue of the Physical World
	Networks of interconnected rooms	Spatial Metaphor	Concept Maps
	Multi-player Environments	Networked Chat	Collaboration
	Single-player Environments	Learner plus Non-Player Characters	Guided Learning
			Autonomous Learning
(b)	Reactive Action	Dynamic System Metaphor	Experiential Learning
	Strategic Action	Dynamic System Metaphor	Adaptive Learning
(c)	Movers		Progression
	Textures (Color, Tone)		Static Learning Resources
	Static Meshes (Objects)		
	Triggers	Learner Interaction	Active Experimentation
	Pickups	Collectable Information	Problem Solving
	Sound (talk)	Programmed Non-Player Characters	Narrative
			Discourse
			Dialogue
	Music		Inspiration, Focussing
	Teleporters	Hyperlinks	Progression
(d)	Head-Up-display	Programmable Interaction	Feedback of learner state
	Console	Programmable Interaction	Interaction with learning Material
(e)	Programmed Actors	Dynamic text, sound, shapes	Interactive Learning Resources
	Programmed NPCs		Narrative, Adaptive Instruction
	Programmed Player Avatar	Logging of Learner's state	Adaptation, Evaluation
(f)	Game Rules: Conflict Resolution	Dialectic	Kolb (Dialectic)
	Game Design	Approaches to Game Design	Narrative
	Game Goals		

resonates with education? The fundamental nature of an IE is that it is experiential, where learning results from a direct engagement of the learner with the environment through reciprocal influence and change. An IE contains buildings or rooms which the learner may explore, activities to initiate and to observe, and opportunities to converse with other learners, teachers and programmed non-player characters (NPCs). The fundamental characteristic of such IEs is experience. As a starting point to construct a theoretical basis for the construction of IEs, we have therefore embraced Experiential Learning Theory (ELT) as proposed by David Kolb, (Kolb 1984).

We have tried to establish a ‘middle ground’ between the affordances of game/IE technology and pedagogical principles, either directly or through metaphor. Two significant metaphors have emerged. The first is the metaphor of space which relates to the topological structure of the IE; a network of locations (often rooms) connected by passageways, doors or paths. The second is the metaphor of time which captures the interactive, dynamic aspect of the IE. Interactions may be reactive (such as shooting) or more strategic (such as making a detour to pick up assets). Strategic actions are guided by game rules and goals where the player is either explicitly moved towards a goal, or where the goal is discovered through play. Non-player characters (NPCs) imbued with some degree of artificial intelligence (AI) also interact with the IE, the player and other NPCs.

It is interesting to note that our chosen starting point of ELT as exemplified by Kolb’s theory of learning, which is “the process whereby knowledge is created through the transformation of experience” (Kolb 1984) picks up many of the correspondences noted in Table 1. He states that (i) learning is a process and not an outcome, (ii) it is grounded in experience, (iii) it requires the learner to resolve dialectically opposed demands, (iv) it is a holistic process of adaptation to the world, (v) it requires interaction between the learner and the environment and (vi) it results in

the creation of knowledge. Concerning (i) our IEs support learning as a process through interaction of learners, assets and other learners within the IE. Learners may, for example, make experiments concerning gravity, observe phenomena, and change parameters. Concerning (ii) our IEs are constructed in close analogy with the physical world. (iv) Learning is *the* most fundamental way in which the human adapts to the changing world, afforded within our IEs which provide a reduction in complexity. (v) Here the learner responds to the environment (e.g. by observing a projectile) and the environment responds to the observer (when he or she changes the value of gravity). (vi) Creation of knowledge is obtained as the learner moves through the spatial metaphor of the concept map, which is derived from the **knowledge structure** of the expert teacher. The learner’s concept map is not a static object, but is dynamic; it grows as the learner learns.

Our goal in this paper is to reflect on the matter of various subject domains which include pedagogy, the affordances of the UT2004 game engine, and philosophical reflections. The approach is theoretical; there is no reference to formal evaluations of our theory, but we provide substantial grounding in our designed and deployed IEs. We present a synthesis of educational theory and the results of constructing IEs to test these theories. Such a synthesis of theory and experiment is important to advance research in this area. This chapter is organised as follows: First we consider non-collaborative learning (instructional, teacher-led or autonomous). Second we consider collaborative learning. Further sections discuss metaphor and topology.

Non-Collaborative Learning

We define non-collaborative learning as learning situations which involve just one learner. These situations may involve direct contact with a teacher, such as in a ‘lecture’ or consist of autonomous

learning activities where no teacher is present. We have addressed the issue of non-collaborative learning through the development of a new instructional medium called ‘UnrealPowerPoint’ (UPPT). Here, PowerPoint slides are embedded within an IE in a novel structure; details are provided in Price (2008). Rooms within the UPPT may contain a number of PowerPoint slides, but are connected in a non-linear (i.e. non-sequential) manner which liberates the teacher from the usual sequential mode of PowerPoint presentations. The teacher may choose a particular path through a set of slides according to the real-time needs of the student group. For example, when students indicate a good comprehension of the presented material, the teacher may choose to enter rooms containing supplementary activities, or where students indicate uncertainty, the teacher may choose to enter rooms containing supporting or remedial material.

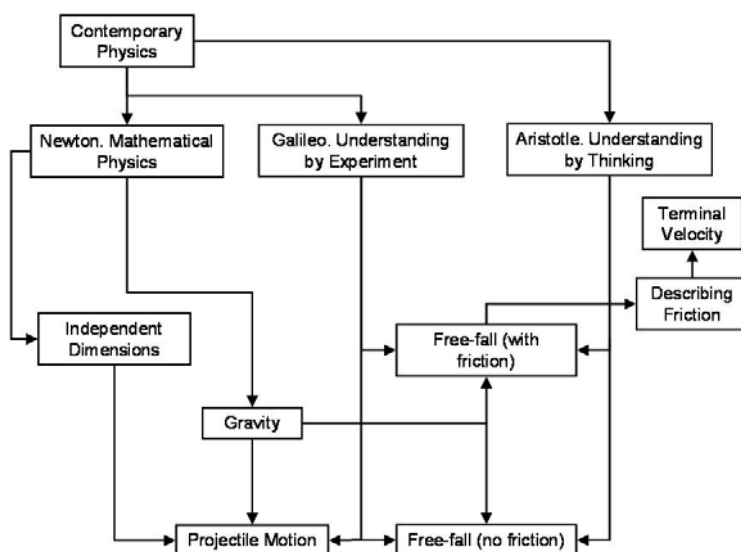
Structures for Learning: Concept Maps

One approach to modelling the learning process is to posit the existence of knowledge structures,

complex inter-related networks of concepts linked by relationships which exist in the minds of both novice and expert. Such structures are referred to as ‘concept maps’ or ‘semantic networks’. Here, learning involves a transformation of the naïve concept map of the learner into the expert concept map of the teacher (Kinchin and Alias, 2005). Concept maps were introduced by Novak while studying children’s development of science knowledge (Novak and Musonda, 1991). They form a graphical representation of concepts and their relationships in a hierarchical manner. A typical example from the study of motion under gravity is shown in Figure 2.

Such a concept map could inform the topology of the IE. For example, first the concept of ‘free-fall’ (of an object) without friction could be explored through experiments and reflection located in several IE rooms. The learner could then walk into the ‘concept of gravity’ room or into the ‘concept of free-fall with friction’ room. In each case, experiments, questions and other material would be encountered. As the learner makes this journey, there is a progression through concepts of increasing order.

Figure.2.



Here we invoke the spatial metaphor: Our IE rooms are constructed to contain concepts, relationships between concepts are built as passageways. As learners move through the IE rooms, they are effectively traversing the knowledge structures of the expert and may therefore be able to assimilate these structures since they are presented in an experienced spatial arrangement. The transformation from naïve to expert maps is progressive; at every stage it applies the observation of Ausubel who stressed the need to consider *a priori* knowledge in the learning process (Ausubel, 1968). Concept maps may change as the learner learns by: (i) addition of new concept nodes, (ii) pruning of incorrect concept nodes, (iii) addition of new links between concepts, (iv) pruning of incorrect links between concepts.

The Dynamics of Learning: Experiential Learning

Learning is a process, which implies the need for a temporal dimension in the IE. One may view learning as situated between the two poles of either having an ‘outcome’, or being an ‘activity’. Lewin saw learning as changing the psychological attributes of the learner, James and Dewey saw learning as generating ‘meaning’. In either case, learning implies movement, a dynamic. Watson sees learning as producing a change in behaviour. Kohler and the Gestalt psychologists see learning as an activity. Between these poles, resides a ‘middle ground’. Piaget sees learning as establishing a structured system, balanced in equilibrium. The experiential learning theories we invoke also sit in this middle ground, combining a learning dynamic with spatial knowledge structures. Yes it is the *dynamic* dimension of ELT which we find so appealing. Kolb proposes a four-stage cycle in his ELT (Kolb et al. 2000).

Kolb’s central idea is that learning involves both a formation of a representation of experience (which he calls ‘grasping’) and a transformation of that experience. He sees grasping as located

between two poles, one of *apprehension* corresponding to unquestioned experiences (e.g., walking through a forest), and one of *comprehension* where we produce meaningful symbols for our experiences. Comprehension turns the chaotic flow of sensory experiences into order which we can symbolise, communicate and discuss. Transformation of experience into knowledge defines the process of learning. Such transformation is continuous, iterative. This is emphasised by Lewin’s conception of learning as transforming desires and feelings obtained through experience into knowledge which informs purposeful action. Piaget also emphasises transformation in the development of the child from birth to the age of 16. Kolb sees transformation also as located between two poles; one is internal reflection and the other is active experimentation with the real world. This agrees with Piaget’s notion that *action* is the key to learning, that intelligence is shaped by experience, (which implies action). In the active process of learning, the learner grounds and extends his or her ideas and experiences obtained through contact with the external world through an internal reflection on these ideas and experiences. There is an outward movement of experience but an inward movement of reflection.

Kolb’s learning cycle captures this structure and dynamic. He places the two dimensions of grasping and transformation as axes on a graph (see Figure 3). Each axis is to be understood as representing a *dialectic* of opposing tensions, where this dialectic is resolved in the process of learning. Both Lewin and Dewey view learning as a dynamic and iterative process, moving in a clockwise attractor between the four poles on this graph.

We may conceive the learner to start at the top of this graph, in a state of *concrete experience*, which means an observation of the phenomena resulting from a particular experiment. Moving clockwise, the learner enters a state of *reflective observation*, which means collection of data associated with the experiment. Then, in a state of

abstract.conceptualisation. the learner will take the observation and the data and start to form a hypothesis which can explain these, through the invention (or discovery) of a conceptual basis. Finally in the state of *active. experimentation*. the learner will test this hypothesis through a modification of the experiment, e.g. by changing experimental parameters.

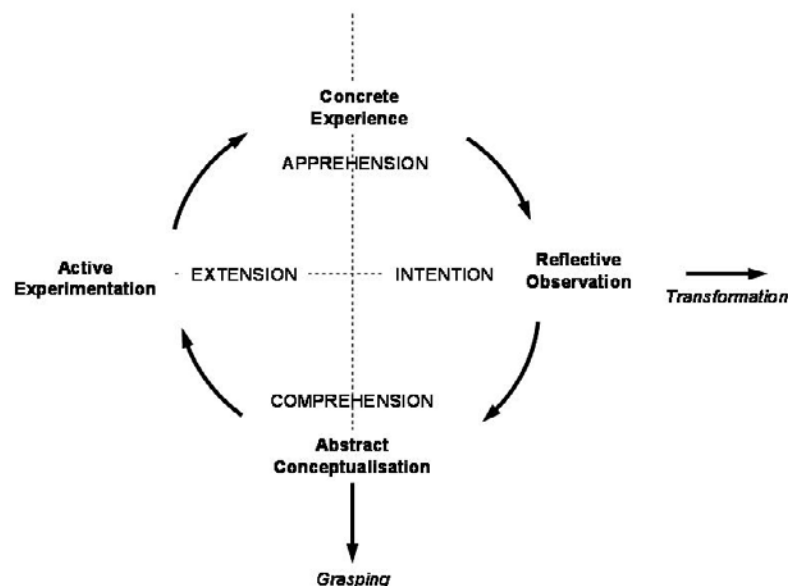
These stages are built into an IE as a group of four connected rooms. The global IE topology would therefore consist of a set of room clusters where each cluster discusses a particular concept, with each cluster providing four rooms as a metaphor of the four stages in Kolb's cycle. Taking our example of learning about gravity: (i) In the first room, a laboratory, the learner has a *concrete.experience*. through observation, e.g. of a falling object or of a projectile. (ii) In the second room, the learner is guided into a state of *reflective observation* by text panels, narrative or images which encourage him/her to decide on how to collect. (iii) The learner then moves into the third room of *abstract.conceptualization*. where text, narrative or conversation helps the learner relate their observations to the abstract concepts

of physics theory (such as gravity fields) and so construct individual hypotheses, and finally (iv) In a room of *active.experimentation*. where they test out their hypotheses by e.g. changing system parameters such as the strength of the gravity field or the mass of the falling objects. Moving between these rooms, guided by conversation or narrative (perhaps provided by an NPC), the learner hopefully will converge to an understanding of the particular concept. The guiding NPCs will support the iterative nature of this process by providing an increasingly detailed narrative. The NPCs are also programmed to help the learner to 'resolve the dialectic tensions' by posing questions and suggesting various actions.

Adaptive Learning

Since the epoch of 'Computer Based Learning' (CBL) there has been much interest in the generation of programmed learning materials which are tailored to the needs of the individual learner (Brusilovsky, 1999). Here the interaction and progress of the learner is monitored and is directed through the learning material accord-

Figure.3.



ing to individual needs. For example, hints and supporting examples would be presented when the system recognized that the learner was in difficulty. A recent classification of approaches to adaptation is found in Burgos and Specht (2006). We have used this classification to develop several adaptive IEs: (i) Learning-process components which are adaptable. Here we have constructed IEs containing doors which open into other rooms on successful completion of a test, or in response to requests for help. For example, doors leading to the study of gravity with friction remain locked until there is evidence that the study of gravity without friction is mastered. (ii) The learner model provides information useful for adaptation. We use a simple differential model which rates progress against targets, to provide adaptation through opening of doors to remedial or additional work, or to the next concept cluster. (iii) The system must gather information to direct adaptation in real time. We have successfully programmed a 'history' actor which records the activity of the learner, such as time spent in each room, the number of experiments attempted, the number of times an experiment is repeated, and the changes in parameters the learner has made. There is evidence that adaptation is facilitated by certain environments. Bereiter and Scadamalia (1993) make the distinction between first-order environments where adaptation is focussed on fixed goal conditions, and second order where each learner has to adapt to the progress of other learners. Our IEs are more aligned with first-order environments, where each learner is treated as an individual, even when working in a collaborating group.

Collaborative Learning

For a definition of collaborative learning we refer to Johnson and Johnson (2006), and also to Slavin (1997) who see collaborative learning as a dynamic process where individuals participate and where

knowledge is constructed through social and intellectual interaction with both peers and experts. Dillenbourg (1999) characterises four dimensions of collaborative environments: (i) the situation, (ii) the interactions (iii) learning mechanisms (iv) the effects. The situation refers to the mix of learners; collaboration is more likely in a fairly homogeneous ability group. Types of interaction include negotiation and instruction which are effected within our IEs through the use of real-time verbal communication. Collaborative learning mechanisms include, e.g., '*appropriation*' where the learner re-interprets his own action in the light of the ensuing actions of the other learners. During the 1990's there emerged a criticism of contemporary educational thinking arguing that the focus on the individual learner neglected the social and cultural aspects of learning (Vince 1998). It was at this time the social learning theory of Vygotsky (1978) was highlighted, (see Holman et al., 1997). This changed the focus of the individual's learning process, from one of learning as an individual from resources, to one of learning from resources within a communicating group, and ultimately to one of learning from peer perceptions. Computer-supported collaborative learning (CSCL) is emerging as an important type of computer mediated education following on from computer assisted instruction (CAI) and computer-based instruction (CBI) models. The tenet of CSCL is that learners' performance will improve through peer communication, reflection on choices made and shared activities. The underlying theory draws on elements of Piaget's social constructivism, Vygotsky's socio-cultural theory and situated cognition, (Wang et al. 2001). Cognitive theories were initially intended to model the individual's mental process, yet they now emphasise the socially distributed nature of cognition, (Norman, 1993). Distributed cognition is the process of sharing cognitive resources as an extension of individual resources and so to complete a task an individual would be unable to do. Such processes can be distributed between

learners or learners and machines. According to Norman, human cognitive resources have always been overestimated; the external world and fellow learners can increase these resources. Also, through social interaction, the learner is forced to see his or her conceptualisations from another point of view. Socio-cognitive *conflicts* have been shown to increase the learners' cognitive resources, (Pontecorvo and Paoletti, 1989), though it is unclear whether conflict is necessary to enable collaborative learning.

Such approaches must be borne in mind while constructing educational IEs. Working with our students in various classes, including 'OOP (Java) programming, IE/Game development, Modelling and Simulation, we have become aware of the power of teamwork in effective learning. Our students have produced ad-hoc collaborative groups which were neither required nor assessed. Within these groups, they have clearly displayed a strong desire to work in a 'distributed intelligence' mode. Their assessments reflect this in an honest and transparent manner.

Game engine technology provides collaboration for free: several learners may enter an IE synchronously over the internet. Each is equipped with a headset and a microphone which establishes real-time communications. Each individual learner is free to roam throughout the IE and have conversations with other learners and also with NPCs. Typically, collaborative learning will occur through conversation about a particular topic, e.g. a group of five students may observe and discuss an experiment in gravity; they negotiate a path through concept clusters, and so come to a shared understanding. This approach to collaboration requires a theory of conversation, which may inform how 'the spoken word' may be used within an IE between groups of learners, perhaps with an instructor, or with programmed NPCs. One central use of the spoken word is the provision of a narrative by an NPC who is programmed to guide the learner(s) through the concept clusters. This is the subject of the following subsections.

The Theory of Discourse

Verbal communication is an important aspect of collaboration. This was identified in the mapping in Table 1. Two approaches to crafting conversations are discourse and dialogue. Candlin gives a definition of 'discourse' as the use of socially-contextualized language (Candlin, 1997). Discourse is constructive and dynamic which has the effect of structuring learners' knowledge. Discourse allows the learners not only to talk and write about situations, but also to *act* within and upon those situations. This idea is familiar from Austin's speech act theory where communication may change the social situation (Austin 2006). Discourse is a linguistic, social and cognitive process; the interaction between speaker, listeners, utterance and context generates meaning (Thomas, 1995).

The defining characteristic of discourse is that it has a *goal* which may be set by the teacher. Discourse is structured to move towards this state. NPCs can be programmed to guide the learners' conversations, through posing questions, making suggestions and asserting directives. We have programmed NPCs to do all of this; they make use of recorded speech imported into the NPC code as 'wav' files. A first NPC has been programmed to support a dialogue with another NPC allowing conversations of constructor-defined length. A second NPC has been programmed to support conversations between groups of NPCs, again under the control of the IE developer,

Other theoreticians such as Grice suggest a communication model directed specifically at collaboration (Grice 2006). He identified several maxims that should be followed by participants in a true collaborative discourse; to be 'informative', 'truthful', 'relevant' and 'clear'. We have used these maxims in our IEs. The material should be 'informative' in that it contains breadth and depth of information suited to the learning context, it should be 'truthful' in that it is correct and does not mislead the learner. It should be 'relevant' fo-

cussing on the learning issues without distraction, and should be 'clear' in presenting information within a minimalist frame while maximizing information throughput. This suggests that the material should be strongly contextualized, e.g. learning about gravity in physics should be related to concrete experiences such as jumping of walls, the motion of tennis balls, as well as to more abstract concepts such as space-craft re-entry. Sperber and Wilson (1995), in their cognitive approach to communication, suggest that the relevance of information presented is increased by the degree of contextualization.

Another theory which may inform cooperative discourse is conversational analysis, which aims to understand conversations where each participant is given a 'turn to talk' (Hutchby and Wooffit, 1998). This structures the discourse (preventing multiple overlaying talk), and also allows an efficient post-event analysis of the discourse. We have implemented this structure within several IEs. This relies on an 'IE manager' which co-ordinates the interaction between the learners, allowing only one learner to have the focus of interaction input at any time. Conversational 'turn-taking' has been studied by Sacks, Schegloff & Jefferson, who suggest that discourse may be enhanced through a parallel process of directing gaze between the participants (Sacks et al., 1974). We have programmed learner avatars which can sense the locus of their gaze and respond appropriately, e.g. a piece of text or observing an experiment. This affordance is used in conjunction with the 'IE manager' where the learners indicate objects using their 'eye' crosshair rendered on the HUD, request the conversation channel and talk about that object. As well as making turn-taking more natural, these avatars have other uses, e.g., we can record and analyze how a learner reads textual information, (e.g. sequentially or scanned) or learners can pick up selected objects. In one IE, designed for Primary School literacy education, learners walk through rooms choosing words using the crosshair 'eye' and then drop these words

onto a 'notice board' to interactively construct sentences. The crosshair 'eye' provides a general and powerful interaction mechanism.

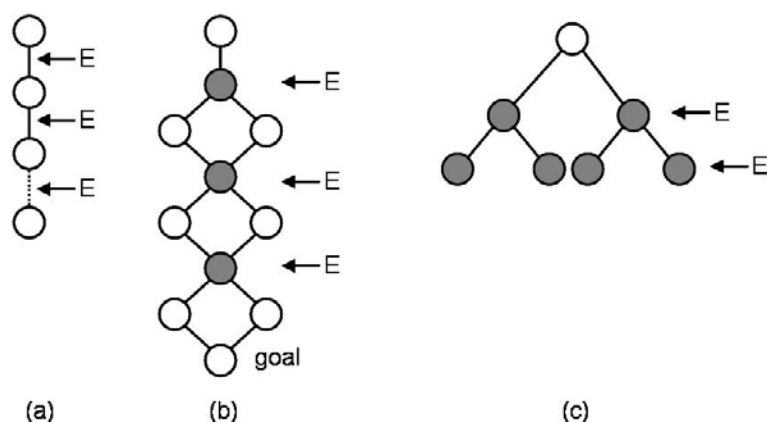
The above theories are *microscopic*, working at the level of individual sentences. A *macroscopic* theory is also required to structure entire conversations. Narrative theory can provide a suitable base. Narratives are a structured representation of desired events in temporal order; they provide a 'time-line' for the discourse, moving it from initial objectives to concluding goals.

A classic study of narrative has been made by Labov (1972) who defined several features which may be used to generate structured narratives. These are summarized by Ochs (1988), and here are related to a study of objects falling under gravity: (i) abstract, a summary of what is to be said. For example, we may construct the flowing narrative elements between two NPCs aimed to introduce collaborative experimenters to decide how to investigate the topic. E.g., "Let's discuss what happens when we throw an object", (ii) the orientation, "This is an example of motion of an object in gravity", (iii) complication, "The theory states that and predicts that" (iv) evaluation, "So we need to choose between the following experiments..." (v) resolution, "It seems a good idea to try this experiment first..." (vi) coda. "Now, you the experimenter may wish to follow our advice".

We have programmed several actors to support the various classes of conversation; (i) narrative, (ii) discourse and (iii) dialogue. These are illustrated schematically in Figure 4 which depicts the 'space' of conversation for the three classes.

This illustrates that narrative, discourse and dialogue provide a progressive increase in the information transfer in conversation. Discourse within an IE comprising NPCs, learners (LE) and the teacher (TE) may be classified as follows: LE-LE, LE-TE, NPC-NPC, NPC-LE. A further approach we have investigated to analyze LE-LE collaboration was the 'teamwork process model' suggested by Salas et al., (1992). This work identi-

Figure 4.



fies six skills necessary to support collaborative learning: (i) adaptability, (ii) coordination, (iii) decision making, (iv) interpersonal, (v) communication, (vi) leadership. These dimensions provide a means to analyze transcripts of LE-LE discourse. Within an IE we have used a selection of pre-defined messages constructed according to the above classification. During a collaborative activity with a group of five students, measures of collaboration were distilled from the number of each message-type observed. The largest number of observed messages were 'interpersonal', involving somewhat spurious chat unrelated to the learning materials. We accept this as beneficial, leading to a cohesion of the social group. Leadership messages appeared as the second most prominent communication; there was clearly a period of negotiation where one leader emerged. The distribution of messages changed with time; when the collaborative group had converged to a stable dynamic, 'communication' messages predominated, where learners (together with the 'leader') had gelled into a collaborative group. A similar study has been made by Chung et al. (1999).

While discourse theory provides generative and analytical tools to reflect on conversations, it is limited by the existence of a goal state. A similar goal state is implied in Vygotsky's socio-

cultural theory. The Russian Bakhtin, through his 'dialogic' theory, opens up a larger space to situate conversational analysis and construction, and so to escape the confines of this 'goal state'.

The Theory of Dialogic

Bakhtin's theory of the dialogic as mediating thought and learning, rests upon the need to take on board the perspective of all others involved in the learning process, rather than focus on goals. Dialogic theorises the process of shared inquiry through dialogue. Dialogic is essentially an epistemology. Meaning is revealed through dialogue, (Bakhtin, 1986). This is emphasised by Rommetveit (1992) and Linell (1998) who highlight three aspects of the dialogic: (i) Communicative acts are mutually dependent and conspire to connect past and future acts, (ii) These acts are also in dialogue with cultural and social contexts, (ii) Meaning itself is not to be discovered, but to be created within the dialogic. There is no reference to objects but rather an assertion of human perceptions of objects.

The principal characteristics of dialogic theory is that there is no final goal as with discourse theory, that dialogue exists *per se*. Dialogue generates more dialogue and so recursively increases the space of dialogue. Within an educational setting,

this expansion of space is a direct consequence of the learners' learning and induces more learning. Within the example of the study of objects falling under gravity, learners' dialogue may start around the concept of gravity. Since gravity concerns fields and force, the dialogue may branch into discussion of either fields or force.

Technological Implementations of the Dialogic

The use of technology in education should follow from a reflection on pedagogical principles. But this has not always been the case. Various approaches can be identified. The simplest is found perhaps within intelligent tutoring systems. Following Wegerif and Dawes (2004), insertion of programmed prompts such as "what if?", "why do you think that?" can stimulate reflection and open up the dialogic space. Such prompts may be elicited by NPCs or via programmed player avatars as suggested by Ligorio and Pugilese (2004). A second level of complexity may be found in the use of multi-modal assets where dialogue may emerge through engagement with both textual and non-textual representations of meaning. This serves a dual purpose; first, it is more inclusive, second it allows learners to reflect upon the communicative power of different modalities. Dialogue may be also inserted into narrative or discourse, providing opportunities for expansion of communication, (see Section 5 on topology). This difference is expected to emerge through learner-learner dialogue, but can also be instigated through NPCs who are programmed to introduce concepts against an alternative and so open up an expanding space of conversation.

Wegerif has proposed some design principles for dialogic IEs: (i) Address the issue of what it means to collaborate and promote the use of 'reflective dialogue'. (ii) Do not use 'taking turns' in dialogue, rather encourage prompting learners to talk together. (iii) Selection of alternatives rather than long typed input. (iv) There should be

a narrative which surrounds the learning issues. (v) Problems should be constructed to require distributed and not individual thinking. (vi) Dialogue should be scaffolded by images or symbols which can be pointed to or manipulated. (vii) No time constraints should be imposed, rather activities should be interspersed with moments for reflection. (Wegerif 2007). All these principles can be effected using IE technology such as images, sound and various modalities of interaction.

Walton has approached the dialogic from the point of view of argumentation. His approach is to set up a system of rules, and judge the ensuing dialogue against these rules. In his work *The New Dialectic* he asserts six fundamental types of dialogue: (i) persuasion, to resolve an issue, (ii) inquiry, to find and verify evidence, (iii) negotiation, to achieve a compromise, (iv) seeking information, to find or contribute information, (v) deliberation, to coordinate actions with intended outcomes, (vi) 'eristic', to verbally assault the perceived opponent (Walton 2000). Such rules can be easily programmed into the behaviour of NPCs which will in fact guide the learner-learner dialogue.

Rommteveit and Per Linell consider the epistemology of dialogic. Meaning is created within a dialogue, through the juxtaposition of the various learners' perspectives, where one true meaning emerges from a field of possible alternative interpretations. This, of course, is pure *existentialism*. In our context it emphasises that learners should not be seen as processors of information, but through engagement with metacognitive processes, (thinking about thinking) learners come to develop new skills to be used in new learning situations. This will result from learner-learner discourse or dialogue.

Other Aspects of Collaborative Conversation

We have emphasized the distinction between conversational discourse and dialogue yet there

are other conversations which do not fit into this mold. Conversation through writing has been highlighted by Graves (1983), where learners collaborate to draft, review and finalize written compositions. The 'Reciprocal Teaching' metaphor developed by Palincsar and Brown requires students to discuss and question each others' textual material. Discussion of text leads directly to cognitive growth. Deep conceptual understanding may result through the learner's activity of explaining one's conception to one's peers. This involves an individual commitment to personal understanding e.g., Brown and Palincsar (1989), whereby the inadequacies of the individual's perspective becomes informative. Dillenbourg (1999) speaks of a "space for misunderstanding" where learning may result from resolution of misunderstanding. Working within such a metaphorical space may be more efficient than a conversation free of ambiguity.

From a cognitive point of view, the process of explaining a problem to other learners deepens conceptual understanding since each individual learner is forced to commit to some ideas, explain their beliefs and reorganize their knowledge in the context of the collaborating group (Brown and Palincsar, 1989). Research has shown that the act of externalization of individual thought processes within a social context, so that the individual's processes become visible, where they can be imitated and examined, engages metacognitive processing. Monitoring of the individual's thought processes can lead to advancement of these processes.

Such monitoring can be explored in our IEs through a process of 'logging' critical student activity and their engagement, which provides a useful tool for examination of cognitive thinking and learning.

Dynamics of Collaborative Learning: Coupled Kolb Cycles

To capture the dynamics of collaborative learning we return to Kolb's learning cycle, as providing the

simplest dynamical system description of learning situated in a social context. Individuals' learning cycles become effectively interconnected, but the question arises as to how these may interconnect. Taking our proposed metaphorical structure as an interconnected network of concept clusters each containing a Kolb cycle, a naïve approach would be to assume that a group of five or so learners would march together in lockstep through this cycle, residing in each stage at the same time. However, this was not Kolb's intention. The idea behind the dual dialectic of (i) concrete experience – abstract conceptualisation, (ii) active experimentation – reflective observation was to identify individual learning styles where the individual learner would find a position along the dual poles and engage with these styles as individuals, (in our metaphor, this implies activities within one or more Kolb rooms). This suggests that while all collaborative learners may move through a particular Kolb cycle, they may do so with different phases, i.e., different learners may tardy in different Kolb rooms. This may lead to group fragmentation and re-crystallisation..

How to Design Collaborative IES

Collaborative systems are based on constructivist principles of learning. From the design perspective, Duffy and Cunningham's (1996) design framework is a good starting point. They propose seven design principles. (i) Construction of knowledge. Learning activities should enable students to direct their own learning, to be autonomous learners in order to construct their own knowledge. (ii) Multiple perspectives. IEs should contain learning experiences which place the individual learner beyond his own point of view. This can be done through conversations. (iii) The context. Learning materials and activities should be authentic; learners' thinking becomes aligned with actual practice (Honebein 1996). (iv) Mediated action. This refers to the tension between the IE used as a socio-cultural mediation tool, and as a means of

carrying out concrete actions (Wertsch, 1994). (v) Social dialogue. Learning is a social and discursive process which uses 'talk'. (vi) Socio-cultural learning. Learners do not learn as individuals but through initiation into the practices of a learning community (vii) Knowing how to know. This is the most important of Duffy and Cunningham's principles. It implies an increased awareness of the learner's psychological state and is realized through situations where the inadequacies of the learner's belief structures are revealed.

We relate our IE affordances to the above design framework: (i) Our IEs consist of a network of rooms and passages containing various resources to engage learners of various levels of ability and styles of learning. (ii) Like cubist art, our IEs contain experiential assets which provide multiple perspectives allowing various forms of engagement with the learning material. (iii) Our IEs are 'authentic' since they mirror processes and situations encountered within the real world, while asserting a simplification to remove extraneous factors or 'noise'. (iv) Our IEs relate the execution of individual physics experiments with the process of scientific peer-review. This is a characteristic of collaborative learning where the results of experiments are reviewed by the collaborating group, and decisions made on how to proceed through the IE. (v) Social dialogue is effected through the IE affordance of real-time conversation. (vi) This is a meta-level of social dialogue where learners converse in groups and with the instructor or programmed NPCs. (vii) This transcends all technological implementation and develops in each learner as a consequence of social dialogue, where the socially developed understanding is reflected back into the individual learner.

Dillenbourg emphasizes the idea that collaboration triggers various 'learning mechanisms'. Some mechanisms are already present in individual learning processes, such as induction and deduction, others such as disagreement, explanation and mutual regulation are specific to

collaboration. He suggests that the design of IEs should increase the chance that these interactions will occur. Our interpretation of Dillenbourg leads to the following design rules, posed as questions: (i) What is the structure of the collaborative group? Should the learners be homogeneous or heterogeneous in ability? What is a good group size? Research into these issues has revealed that the situation is complex; there are various interdependent factors. No clear guiding principle has emerged (Dillenbourg et al. 1995). (ii) What are the 'roles' of the individual learner within the group? Should these be assigned? Should an IE be crafted to assure 'conflicting' interactions which stimulate learning? Should learners be assigned roles even though these do not express their individual beliefs? (iii) How to scaffold by establishing rules of interaction, e.g., learners are required to communicate using pre-defined messages (Baker and Lund 1996). (iv) How to monitor and regulate interactions? This could be the 'facilitator' role of the teacher. Approaches to designing collaborative IEs have been frustrated by the lack of structure within the domain (Spiro et al. 1988). Slavin (1997) proposed four perspectives which may inform instructional design of collaborative IEs; motivational, social cohesion, developmental and cognitive elaboration. Social-constructivist theory informs us that meaning is constructed, in student workshops, through activities and talk. But this cannot occur unless we provide appropriate learning opportunities and also be sensitive to learning orientations, dispositions and motivations. Another aspect which is useful to inform construction of IEs is the closed-open group dichotomy. Within the closed group scenario, learners decide their learning objectives in advance, and so these objectives become *static*. On the other hand open-ended collaboration is grounded in a conversational dialogue where issues emerge from collaborative discussion. This reflects the discourse – dialogic dichotomy.

Metaphor

We have asserted the use of metaphor as well as direct correspondence through a common ontology, as providing a mapping between the affordances of computer game technology and the requirements of a contemporary pedagogy. In this section we review our use of metaphor and develop this in various dimensions. We have already encountered the use of a *spatial* metaphor in relating knowledge structures, to the topology of an IE. The power of the metaphor, as a design and analysis tool, lies in its establishment of a correspondence (loose or strong) between various domains of our human experiences in the physical world, and the virtual worlds we wish to create. The use of metaphor validates these IEs in the sense that it attributes *meaning* to the IE, through a link with the physical world and learners situated within that world. The power of the spatial metaphor has previously been identified by Lakoff (1987).

Metaphors of Space

In representing the physical world, an IE should not simply reproduce that world, but aim to allow the learner to produce a personal and meaningful interpretation of that world. This suggests condensing the complexity of real-world situations into a smaller space of interactions. As mentioned above in the case of physics experimentation, the IE provides the richness of real-world experimentation but in a confined context where factors extraneous to the object of study are eliminated. In other words ‘noise’ is eliminated.

Ben-Zvi and Sfard (2007) provide an interesting and challenging metaphor of a learning space. Ariadene, when attempting to release her beloved Daedalus from the Minotaur labyrinth, provided a thread which was intended to be followed without question. This corresponds to an *instructional* metaphor. This is a directed trajectory through space, aimed at a goal defined by the teacher of

the curriculum. Sfard highlights the restrictions of such an approach which is focused on one situation and one individual. Learning cannot be individually focused, it must be able to guide everyone through the labyrinth of knowledge and understanding.

We have produced several IEs where the instructor guides the learners through a web of concepts and activities; the instructor has been realized as both a human participant and as a programmed NPC providing a focusing narrative. Such IEs have been popular with learners since they provide a clear learning trajectory. It seems that learners feel the need for a clear pathway rather than a ‘garden of forking paths’.

The metaphor of a ‘shared learning space’ where knowledge and expertise may be pooled is important. Such a space takes on the role of a frame of reference for collaboration, and leads to development of IEs where collaboration may occur. Such a space should support principles of working together, trust, integrity and allow the possibility of “break-through” (Marshall, 1995).

Several of our physics IEs contain a combination of resources such as experiments, text-based materials and ‘experts’ in the form of programmed NPCs or even an expert instructor. Unlike the Kolb clusters, these spaces are not structured but are amorphous, intended to allow learners to discover how to collaborate outside the metaphorical classroom presented by the Kolb clusters.

White and Seigel (1984) make an interesting use of the metaphor of time and space in understanding the cognitive development of the learner. They situate the development of thought, from concrete to abstract, as a journey through space and time. As children grow up, their spatial experience increases, (they walk to school, they explore a city). At each stage of development, this increasing space provides cues informing their behaviour. Learning in space is natural. Spatial relationships within the physical world inform relationships between iconic symbols of

concepts. "A child who draws a map or makes a model transforms the world into an imitative symbolic code" (White and Seigel, 1984). Their learning becomes *situated* within physical space, and is transformed to the cognitive structures of their understanding.

The suggestion here is of a particular journey through physical space, the streets and buildings of a town. Making this journey involves choosing a subset of all possible routes, perhaps informed by personal choice. The associated metaphor is one of simplification, or reduction in the complexity of the situation, a single path is chosen from many. This may be used as a design principle for IEs, where learning rooms and pathways represent a simplification of real world phenomena, so that the learner is presented with a sufficient (but rich) learning experience.

We conclude that an IE learning space may be characterized by (i) a simplification of the complexities of real physical space where learning goals may be efficiently realized without distraction, (ii) a space where direction provided by the teacher may be emphasized but not prescribed, (iii) a context for collaboration, (iv) a path through space and time where the development of the learner may be realized and documented.

Embodiment

Various concerns relating to contemporary existence within *cyberspaces* (such as the Internet and 'Second Life') have been raised (Dreyfus, 2004). Dreyfus asserts that without a bodily engagement ('embodiment') with phenomena, we lose the ability to appreciate the *meaning* and *relevance* of these phenomena; there is no grounding to inform us of the validity of the information we retrieve. Dreyfus asserts that through a bodily engagement with phenomena we are able to attribute meaning to our experiences. This claim is also asserted by constructivist theoreticians; the absence of a real-world context prevents the

acquisition of meaning. This is supported by Dewey's theory that learning should be grounded in experience, Levin's theory that learning should be active and Piaget's theory that the interaction of person and environment affects intelligence. Embodied learning implies that IEs reflect the 'natural complexity' of the physical world where the learner distills understanding from this complexity (Spiro et al., 1988).

Embodiment is not equivalent to 'immersion' in a virtual world. It implies a deeper relationship between the learner and the IE, where the dynamics of the IE influence the learner, and where the actions of the learner change the substrate of the IE. The reciprocity of this relationship, in a generative sense, informs both the evolution of the learner and of the IE, an ecological process. Generation of information and appreciation of meaning are not defined *a priori*, but emerge through a human-substrate interaction.

A novel metaphor which relates the learner to the real world is 'cognitive apprenticeship' (Collins, 1991). Here, learners encounter knowledge in situations that foster invention and creativity. This metaphor employs different pedagogical tools than traditional instruction, such as modeling world-based processes, and expert activities. Through this modeling, learners become aware of how experts solve problems, how they generate solutions, and how they create new artifacts, such as knowledge. The learning processes here include *imitation* and *reification*. The cognitive apprenticeship metaphor is characterized by articulation, (making knowledge explicit) and exploration, (how to form and test hypotheses). This is reminiscent of the Bauhaus movement which combined high-theory and practice aimed at commercialization, a metaphor which is surely of importance to inform HE course development? Our discussion of embodiment (above), suggests that learning should be situated in the real physical world, society and culture. It has been suggested that the most effective learning is case-based,

i.e., involves a 'world-take'. Grounding learning within the skills-based world while creating an open space of academic reflection requires a sensitive mix of practical and academic learning. The corresponding metaphor is the 1920's Bauhaus movement in Germany which combined theoretical study with 'apprenticeship'.

Systems Thinking

Systems theory provides useful metaphors for informing the development of IEs. There are two poles to systems thinking. At one end is the theory of 'Hard Systems', (based upon a mathematical description of an underlying ontology), to 'Soft Systems', (based upon human perceptions of that ontology). There is a clear correlation here with Sfard's approach. In her acquisitional versus participatory metaphors, she makes exactly this distinction between hard and soft systems approaches.

In terms of learning and teaching, systems theory may be used as a metaphor to situate knowledge acquisition, and constructivist approaches to this goal. Systems theory considers 'open' and 'closed' systems, where the latter are defined by a consistent set of principles, which cannot respond to influences from outside the system. Open systems are constructed with dynamics able to respond to 'external' events such as human input. Traditional computer learning environments are closed, supported by goal-driven programs unable to cope with individual learning styles. The characteristics of open systems include (i) response to learners' needs, (ii) interactions initiated by the learners, (iii) providing a space which is intellectually and conceptually challenging. Such open IEs should reflect the complexities of the real world and not hide them. They should engage the learner with these complexities, through real-world case-based activities, and through collaboration to reflect on the nature of this context.

The Internet and Hyperlinks

Hypertext conforms to the principles of constructivist learning, since the use of hypertext to acquire knowledge engages the learner in constructivist processes (Jonassen & Wang 1993). Learners browse with existing knowledge structures in mind, providing an extensible context and eliciting learning. We propose that the topology of the Web, and the processes of navigation may act as a metaphor for the construction of IEs. Rooms within an IE are as to web-pages, passageways and teleporters are as to hyperlinks. There is a metaphorical equivalence of topology which results from the shared nonlinearity of hypertext and the IE. We suggest that educational IEs may be constructed according to the hypertext metaphor, where rooms (i.e. pages) containing associated information may be linked to others.

Emergent Properties

Emergence refers to experiences within an IE which have not been explicitly constructed. If the IE contains a large enough number of deterministic elements, unexpected behaviour may emerge, e.g., interactions between NPCs.

Sfard sees collaborative learning as following an emergent participation metaphor. Learning is not prescribed, rather it is about becoming a participant; the learner's knowledge emerges through practice, activity and discourse (Sfard, 1998). In this metaphor, meaning is never given, but is created. It emerges from dialogue between different perspectives; it is carved out from a space of a field of multiple interpretations (Bakhtin, 1986). Within the dynamic of the collaborative group, the metaphor of emergence is also realized in the context of structuring the group activity and the role of the participants within that group. Research has indicated some guiding principles, e.g., concerning the structure and induction of the group: Collaborative groups function best when an expert is asserted. Such structures may encourage

emergence, for example, the emergence of one learner playing the role of the teacher.

Students today are encouraged to choose their own learning trajectories rather than converge to a teacher-defined goal. Sfard describes this as a shift from the ‘acquisitional’ to the ‘participatory’ metaphor. Students no longer have a conversation with the world, but rather with others’ perceptions of the world, (Sfard, 2008). Here language is fundamental, since learning becomes a process of modifying and extending one’s capacity for discourse. Sfard goes on to posit that there are two levels of learning; the object-level and the meta-level, both of which are necessary for a learner to progress from novice to expert. At the object level, learners will discuss material within a provided linguistic field, e.g., in the study of gravity, learners will encounter experiments, textual descriptions and explanations. Within this linguistic field, they will be able to progress in learning and come to understand associated concepts. Since a field exists *a priori*, there is no need for a teacher to be present. However, the situation jumps dramatically when further material is introduced which requires a different linguistic field, e.g., the application of gravity, which normally causes downward acceleration, to hot-air balloons which rise upwards. This new linguistic field lies outside the learners’ experience, and therefore cannot be learned autonomously and so must be taught. This is a meta-level of learning where a new vocabulary must be introduced (by the teacher) in order to establish an expanded space of discourse. We have programmed NPCs which can facilitate jumping between linguistic fields. Typically, they introduce new vocabulary at the appropriate place in the IE topology such as at the point of introducing a higher-order concept.

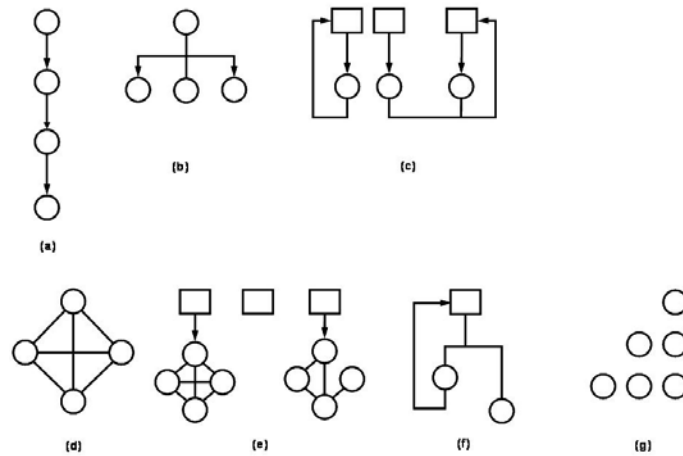
Topologies

We have so far used knowledge structures, Kolb cycles and adaptive learning principles to inform

the topological structure of an IE. In this section we consider topology in its own right; the design of IEs may be usefully informed by these, and other, topologies. An IE topology is defined as a set of ‘nodes’ connected by ‘arcs’. A node can be a single room, or a combination of nodes and arcs. An arc can be a passageway or a teleporter. These may be uni- or bidirectional; a passageway can be made unidirectional by use of a triggered door. An arc may be considered as ‘open’ or ‘closed’, its state being determined by some event, e.g., from a trigger pressed by the learner or induced from the learner’s state. We have identified several classes of composite nodes useful in designing IEs. A ‘grammar’ of topology may be considered where each node may contain another composite node, perhaps recursively. Some possible composite nodes are illustrated in Figure 5.

In (a) we have a simple linear sequence of nodes which may be used as a backbone for more complex topologies. Composite (b) shows the basic branch where particular arcs could be opened or closed providing the basis of choice. In (c) there is a menu of choices which return to the menu. This is useful at the highest level of the topology hierarchy. A hyperlinked structure is shown in (d) where all arcs are shown bidirectional and open, but in (e) the choice of links within a single hyperlinked structure is determined by the user. Here we have in mind that the learner actively reconfigures the IE according to personal choice. For example they may be asked to rate particular nodes, or to indicate which they find useful or not. In this way the learner constructs a personalized learning space. In (f) there is branching with dead ends; only certain choices lead to deeper investigation. The most complex topology is (g) where the user is able to interactively build the IE topology. This is simple to effect within an IE ‘control room’ where the learner is presented with a complete set of nodes with a description of learning activities contained within each node, where they select the desired nodes. A topology is built up ‘on the fly’, and the learner enters this personalized learning space.

Figure.5.



Having designed a base topology of nodes, a further design principle can then be invoked; this uses the metaphor of ‘overlays’. An ‘overlay’ comprises a subset of the base topology nodes and arcs which provides additional functionality. One example is the location of NPCs providing narrative, guiding the learner through the base topology. This includes introduction of new vocabulary to ‘jump’ into a larger linguistic field as discussed in Section 4.5. A further example could be the location of specific educational events, such as nodes of assessment or IE modification. Viewing the base technology in terms of overlays allows an additional design principle to be deployed.

CONCLUSION

In this chapter we have argued the need for a theoretical basis for the development of serious games for education and training derived from pedagogical principles and have given some examples of how technology and pedagogy may be related. We have grounded the processes of non-collaborative and collaborative learning in contemporary learning theories. The metaphor of ‘space and time’ has been introduced as both an analytic and generative methodology. The

virtual space of the IE, mirroring real physical space may be used as a metaphor for some third abstract space, such as knowledge structures expressed as concept maps. The virtual time within the IE, mirroring physical time, may be used as a metaphor for learning dynamics, such as expressed in experiential learning theory. Taken together, the ‘space-time’ metaphor provides a basis for understanding collaborative learning, where discourse and dialogue running through time are embedded in space and are able to capture the true socio-cultural aspects of learning. A distinction between three types of conversation, narrative, discourse and dialogue has been emphasised, since conversation is an important substrate for collaboration. We suggest that the concepts of ‘metaphor’ and ‘topology’, combined with pedagogical theory may usefully inform the creation of educational immersive environments.

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REFERENCES

- Austin, J. L. (2006). *How to do things with words*. In A. Jaworski & N. Coupland (Eds.), *The Discourse Reader*. London: Routledge.
- Ausubel, D. P. (1968). *Educational Psychology: A Cognitive View*. New York: Hold, Rinehart & Winston.
- Bakhtin, M. (1986). *Speech genres and other late essays*. Austin: University of Texas.
- Ben-Zvi, D., & Sfard, A. (2007). Ariadne's Thread, Daedalus' Wings, and the Learner's Autonomy. *Education and Didactics*, 1(3).
- Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves: and inquiry into the nature and implications of expertise*. Chicago and LaSalle, IL: Open Court.
- Brown, A. L., & Palincsar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. In L. Resnik (Ed.), *Knowing, learning and instructing: Essays in honour of Robert Glaser*. Hillsdale, NJ: Lawrence Erlbaum.
- Brusilovsky, P. (1999). Adaptive and Intelligent Technologies for Web-based Education, In C. Rollinger & C. Peylo (Eds.) *Kunstliche Intelligenz*. Special Issue on Intelligent Systems and Teaching.
- Burgos, D., & Specht, M. (2006). Adaptive e-learning methods and IMS Learning Design. *An integrated approach proceedings of ICALT2006*. Kerkrade, Holland.
- Candlin, C. N. (1997). General Editor's Preface. In B. L. Gunnarsson, P. Linell & B. Nordberg (Eds.), *The Construction of Professional Discourse*. London, Longman.
- Chung, G. K. W. K., O'Neil, H. F., & Herl, H. E. (1999). The use of computer-based collaborative knowledge mapping to measure team processes and team outcomes. *Computers in Human Behaviour*, 15.
- Collins, A., (1991). Cognitive apprenticeship and instructional technology. In L. Idol & B. F. Jones (Eds.) *Educational values and cognitive instructions: Implications for reform*. Hillsdale, NJ: Erlbaum.
- Dillenbourg, P. (1999). What do you mean by 'collaborative learning'. In P. Dillenbourg (Ed.), *Collaborative Learning: Cognitive and Computational Approaches*. Oxford: Elsevier.
- Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C (1995). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), *Learning in Humans and Machine: Towards an interdisciplinary learning science*. Oxford: Elsevier.
- Dreyfus, H. (2004). *A Phenomenology of Skill Acquisition as the basis for a Merleau-Pontian Non-representationalist Cognitive Science*. Retrieved from <http://socrates.berkeley.edu/~hdreyfus/html/papers.html> (January 2008).
- Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the design and delivery of instruction. In D. J. Jonassen (Ed.), *Handbook of Research for Educational Communications and Technology*. New York: Macmillan Library Reference USA.
- Graves, D. (1983). *Writing: Teachers and children at work*. Exeter, NH: Heinmann.
- Grice, H. P., (2006). Logic and Conversation, In A. Jaworski & N. Coupland (Eds.), *The Discourse Reader*. London: Routledge.
- Holman, D., Pavlica, K., & Thorpe, R. (1997). Rethinking Kolb's theory of experiential learning: The contribution of social constructivism and activity theory. *Management Learning*, 28.

- Honebein, P. (1996). Seven Goals for the design of constructivist learning environments. In B. Wilson, *Constructivist Learning Environments*. New York: Educational Technology Publications.
- Hutchby, I., & Wooffit, R. (1998). *Conversational Analysis*. Cambridge: Polity Press.
- Baker, M. J., & Lund, K. (1996). Flexibly structuring the interaction in a CSCL environment. In P. Brna, A. Paiva & J. Self (Eds.), *Proceedings of the European conference on Artificial intelligence in Education*. Lisbon, Portugal Sept-20-Oct 2.
- Johnson, D. W., & Johnson, F. P. (2006). *Joining Together: Group Theory and Group Skills*. Boston: Allyn & Bacon.
- Jonassen, D. H., & Wang, S. (1993). Acquiring Structural Knowledge from Semantically Structured Hypertext. *Journal of Computer-Based Instruction*, 20(1).
- Kinchin, I., & Alias, M. (2005). Exploiting variations on concept map morphology as a lesson-planning tool for trainee teachers in Higher Education. *Journal of In-service Education*, 31(3).
- Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2000). Experiential Learning Theory: Previous Research and New Directions. In R. J. Sternberg and L. F. Zhang (Eds.), *Perspectives on cognitive learning and thinking styles*. New Jersey: Lawrence Erlbaum.
- Kolb, D. A. (1984). *Experiential Learning. Experience as The Source of Learning and Development*. New Jersey: Prentice Hall.
- Labov, W. (1972). *Language in the Inner City*. Oxford, Blackwell.
- Lakoff, G. (1987). *Women, Fire and Dangerous Things: What Categories reveal about the Mind*. Chicago, IL, University of Chicago Press.
- Ligorio, M. B., & Pugliese, A. C. (2004). Self-positioning in a text-based virtual environment. *Identity: An International Journal of Theory and Research*, 4(4).
- Linell, P. (1998). *Approaching Dialogue: Talk, interaction and contexts in dialogical perspective*. Amsterdam, Benjamins.
- Marshall, E. M. (1995). The Collaborative Workspace. *Management Review*, 24.
- Norman, D. A. (1993). *Things that make us smart: Defending human attributes in the age of the machine*. New York: Addison-Wesley.
- Novak, J. D., & Musonda, D. (1991). A twelve-year longitudinal study of science concept learning. *American Educational Research Journal*, 28(1).
- Ochs, E. (1988). *Culture and Language Development: Language Acquisition and Language Development*. Cambridge: CUP.
- Pontecorco, C., & Paoletti, G. (1989). Computers, writing and metalinguistic abilities. *Rassegna Italiana di Linguistica Applicata*, 21(1-2).
- Price, C. B. (2008). Unreal PowerPoint: Immersing PowerPoint presentations in a Virtual Computer Game Engine World. *Journal Computers in Human Education*. (in press).
- Rommetveit, R. (1992). Outlines of a dialogically based socio-cognitive approach to human cognition and communication. In A. Wold (Ed.), *The dialogical alternative: Towards a theory of language and mind*. Oslo, Scandinavian Press.
- Sacks, H., Schegloff, E., & Jefferson, G. (1974). A simplest systematics for the pragmatization of turn-taking for conversation. *Language*, 50.
- Salas, E., Dickinson, T. L., Converse, S. A., & Tannenbaum, S. I. (1992). Toward an understanding of team performance and training. In R. W. Sweezy & E. Salas (Eds.), *Teams: Their training and performance*. Norwood, NJ: Ablex.
- Sfard, A. (2008). *Thinking as Communicating: Human development, the growth of discourses and mathematizing*. Cambridge, CUP.

- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2).
- Slavin, R. R. (1997). *Research on cooperative learning and achievement: a quarter century of research*. Paper presented at the annual Meeting of Pedagogical Psychology, Frankfurt, Germany Sept 1997.
- Sperber, D., & Wilson, D. (1995). *Relevance: Communication and Cognition*. Oxford, Blackwell.
- Spiro, R. J., Coulson, R. I., Feltovich, P. J., & Anderson, D. K. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structure domains. Technical Report 441. Champaign, IL. University of Illinois centre for the study of reading.
- Thomas, J. (1995). *Meaning in Interaction: An Introduction to Pragmatics*, London. Longman.
- Vince, R. (1998). Behind and beyond Kolb's learning cycle. *Journal of Management Education*, 22.
- Vygotsky, L. S. (1978) *Mind in Society: The development of higher psychological processes*. Cambridge, MA. Harvard University Press.
- Walton, D. (2000). The place of dialogue theory in logic, computer science and computer studies. *Synthese*, 123.
- Wang, X. C., Hinn, D. M., Kanfer, A. G. (2001). Potential of Computer-Supported Collaborative Learning for Learners with Different Learning Styles. *Journal of Research on Technology in Education*, 34(1).
- Wegerif, R., & Dawes, L. (2004). *Thinking and Learning with ICT: Raising Achievement in Primary Classrooms*. London: Routledge Falmer.
- Wegerif, R. (2007). *Dialogic Education and Technology: Expanding the Space of Learning*. New York: Springer-Verlag.
- Wertsch, J. (1994). The Primacy of mediated action in socio-cultural studies. *Mind, Culture and Activity*, 1.
- White, S. H., & Siegel, A. W. (1984). Cognitive Development in Time and Space. In B. Rogoff & J. Lave (Eds.) *Everyday Cognition: Its development in a social context*. London: Harvard University Press.

Section III

Evaluation

Chapter XIII

Towards a Development Approach to Serious Games

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ABSTRACT

This chapter reviews some of the key research supporting the use of serious games for training in work contexts. The review indicates why serious games should be used to support training requirements, and in particular identifies “attitudinal change” in training as a key objective for deployment of serious games demonstrators. The chapter outlines a development approach for serious games and how it is being evaluated. Demonstrating this, the chapter proposes a game-based learning approach that integrates the use of a “four-dimensional framework”, outlines some key games principles, presents tools and techniques for supporting data collection and analysis, and considers a six-stage development process. The approach is then outlined in relation to a serious game for clinical staff concerned with infection control in hospitals and ambulances, which is being developed in a current research and development project. Survey findings from the target user group are presented and the use of tools and techniques explained in the context of the development process. The chapter proposes areas for future work and concludes that it is essential to use a specific development approach for supporting consistent game design, evaluation and efficacy for particular user groups.

INTRODUCTION

The growing uptake of games and virtual world applications for supporting non-leisure purposes is leading to new studies which measure the efficacy of game-based applications, and compare the efficacy with face-to-face training approaches and other e-learning approaches¹. This chapter is part of this body of knowledge developing to support the most effective design, development, selection and use of game-based learning applications. Towards this end, the chapter will introduce an approach to serious games development that includes a consideration of learning specifically aimed at supporting the real strengths of game-based and immersive approaches to learning.

In previous studies undertaken by the authors, clear benefits of learning in immersive worlds and through 3D visualisations have been explored (e.g. de Freitas, 2006; de Freitas et al., 2006). These studies and meta-reviews have pointed to particular strengths of game forms as being: increased engagement and motivation of the learner, accelerated learning, better retention of learning over longer durations, and the promotion of attitudinal changes. It is the latter aspect that this chapter focuses upon, and the serious games development approach developed in the study out of experimental data emerging from the study aims to support or scaffold the most effective game-based approaches designed specifically to support attitudinal and behavioural changes.

That said it is clear that this is still a field at its beginnings and, as such, there is still a need to develop more tailored models, approaches and strategies to support the effective use of the forms. Therefore, it is important to position the work within the wider context of e-learning research as a whole, and with the study of pedagogic modelling in particular. This chapter then aims to provide a starting point for developers, designers, instructional designers, tutors and users aiming to engage with game-based learning in their practice. The chapter will provide a process for a game-based

approach to attitudinal change, in particular in work-based learning contexts that may be used in different contexts. The process relies upon the use of the four-dimensional framework (4DF) (de Freitas & Oliver, 2006). The framework is being used for a serious games demonstrator in production which aims to help change the attitude of healthcare workers with respect to infection control in hospitals. This latter example provides the detailed case study to illustrate how the serious games development approach and process work in practice.

The current debate on when a training simulation is a serious game or a serious game a training simulation will not be discussed here. The authors consider that in many cases, a particular serious game could be referred to as an immersive training simulation. It is possibly more useful to distinguish between training simulations and serious games by the level of adoption of the features that make a training solution more game-like (e.g. includes challenge, competition, reward, suspension of disbelief, etc) or more consistent with the definition of a simulation (e.g. based on a real-world model).

Attitudinal Instruction and Serious Games

Why should serious games – or game-based learning – be considered as a suitable learning media and learning method to support attitudinal change? In this section, we define what we mean by attitude and briefly discuss instructional design for attitude change. We will look at the research evidence that games can be effective at changing attitude and discuss the game characteristics that are relevant to attitude change.

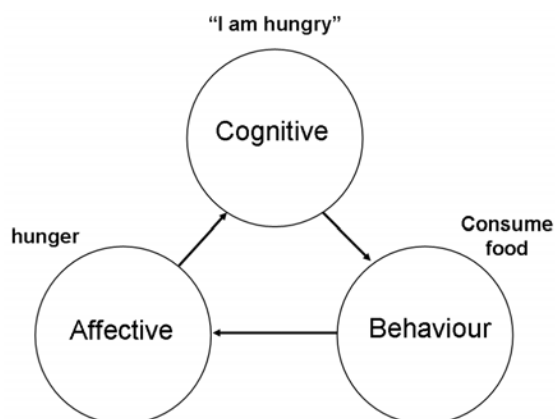
Attitudes are learned or established predispositions to respond to some object (Zimbardo & Leippe, 1991). They are evaluations of a person, behaviour, or event along a continuum of like-to-dislike. An attitude can be considered as contain-

ing affective, cognitive, and behavioural components. For example, a positive attitude towards a nutritional need could be described by a feeling of hunger that is closely followed by the thought that 'I am hungry, I should eat some food', that leads to the action of preparing and eating some food. Kamradt & Kamradt (1999) have created a useful representation of the components of an attitude (Figure 1).

Concern over the environment and particular social issues is raising the importance in the media and government of the need to change public attitude and behaviour. In early 2008, the media has discussed the undesirable attitudes of young people to drinking alcohol, the use of recyclable plastic bags, staff hygiene practice in hospitals, and the use of mobile phones in cars. Attitudes are not directly observable, but associated actions and behaviours may be observed (Bednar & Levie, 1993).

Due to the limits of space, it is not possible here to discuss the many psychological theories of attitude change. However, Simonson and Maushak (2001) from their own research, and a review of other studies, have defined six guidelines for effective design of attitude instruction which are worth consideration with respect to attitudinal change:

Figure.1..Components.of.an.attitude:.example.of.a.positive.attitude.to.a.nutritional.need



1. Learners react favourably to mediated instruction that is realistic, relevant to them, and technically stimulating.
2. Learners are persuaded, and react favourably, when mediated instruction includes the presentation of new information about the topic.
3. Learners are positively affected when persuasive messages are presented in as credible a manner as possible.
4. Learners who are involved in the planning, production, or delivery of mediated instruction are likely to react favourably to the instructional activity and to the message delivered.
5. Learners who participate in post-instructional discussions and critiques are likely to develop favourable attitudes toward the delivery method and content.
6. Learners who experience a purposeful emotional involvement or arousal during instruction are likely to change their attitudes in the direction advocated in a mediated message.

According to Simonson and Maushak, the more guidelines that are included, the better the chances of influencing attitude change. In addition to this, Smith and Ragan (2005) have derived three critical instructional conditions for attitude change from their review of attitude learning:

1. Demonstration of the desired behaviour by a respected role model.
2. Practice of the desired behaviour.
3. Provide reinforcement for the desired behaviour.

It seems reasonable to assume that any game-based learning intervention to help change attitude should take account of this research. We will return to these guidelines and instructional conditions for attitude change when we discuss our case study. Having provided a definition for

attitude and introduced guidelines for instructional design for attitude change, we will now attempt to answer the question posed at the start of this section. Why should serious games or game-based learning be considered as a suitable learning media and learning method to support attitudinal change?

Simonson and Maushak (2001), in their research of instructional technology, have found evidence that ‘mediated instruction does contribute to desired attitudinal outcomes in learners, especially when the instruction is designed specifically to produce certain attitudes or attitude changes’ (p1013). This research has also established that an important quality of effective attitudinal instruction is the creation of an aroused state in the learner through emotional and cognitive involvement. Successful leisure-based video games create just such a mental state in the player.

Research conducted over 30 years ago by Livingston (1970) found that school boys’ attitudes to the poor were significantly more favourable after playing a simulation game called *Ghetto* than before. Similarly, more recent research undertaken by Tumosa and colleagues (2006) claim that games are powerful instruments to change attitudes because they stimulate a desire to learn, and additional research demonstrates that games can be effective at helping change attitudes and behaviour. Furthermore, Hays has discovered empirical support for the claims that games improve learner motivation and interest. His desk research found some evidence indicating that learners’ attitudes about the subject matter could be changed through the use of a game, although he primarily is citing research from the 1980s (Hays, 2005). An example of this is the research by Williams (1980) that produced mixed findings on simulation games changing attitudes, though he does state that ‘simulation games possess the potential to modify attitudes’ (p193). His research suggested that identification with role may have more effect than choice of psychological method for attitude change, though he admitted that more research

was needed. Interestingly more recent research indicates similar findings (e.g. Francis, 2006a; 2006b). Francis, in his study, found that students’ control over identification was a significant accelerator for learning in game-based contexts. Another study by Williams and Williams (1987) involved 109 students randomly assigned to two experimental groups and one control group. The participants were required to read a short history of a fictitious conflict among four medieval nobles. Their research findings provided more evidence for the potential importance of role identification in game design for attitude change (Williams & Williams, 1987). Although in later research by Schumacher (1997), testing Williams’s hypothesis that greater role identification would lead to greater attitude change, the same findings were not replicated.

Interestingly, bearing in mind the importance of attitude change, particularly for effective training, Simonson and Maushak (2001) have found that there is a dearth of good instructional technology research on attitudes:

“It is obvious that attitude study is not an area of interest or importance in mainstream instructional technology research. Of the hundreds of studies published in the literature of educational communications since 1979, fewer than 5% examine attitude variables as a major area of interest.” (p996).

Our literature review of research involving serious games and attitude change that takes account of more recent research broadly has confirmed this finding.

Towards a Serious Game Development Approach

This section outlines a serious game development approach that has been developed in the course of the Serious Games – Engaging Training Solu-

tions (SG-ETS) research and development project. This project was co-funded by the Technology Strategy Board's Collaborative Research and Development programme and partly by SELEX Systems Integration (formerly VEGA Group PLC) and TruSim (a division of Blitz Games Studios), with academic partners from the Universities of Coventry and Birmingham. The work builds upon the four dimensional framework, standard development approaches used in games development, and systems development and instructional design approaches used by SELEX Systems Integration to inform effective e-learning approaches and evaluation methods.

Figure 2 represents a game-based learning development approach that is being used by the team for the serious game demonstrators. The approach combines the four-dimensional framework with a six-stage user-centred development process produced from a comparison of the design approaches used for games development, systems development and training design. Undertaken as part of the project, a literature review of game-based learning identified five game-based learning development principles which we used to assist us (a full database of related references is available at www.seriousgames.org.uk). These principles allowed us to form tools and techniques that were employed with the Triage Trainer demonstrator (the first demonstrator produced by the SG-ETS project) and are being used to pilot the development of the infection control game (the second demonstrator being produced by the SG-ETS project). The aims of the tools were to help us replicate the development process and assist us with evaluating the efficacy of the games. It is important to note that the approach posited here may be considered to be a specific instance of a more general approach to the development of any technology-based learning intervention, and, as such, builds upon the work of technology-enhanced learning approaches (Lockee et al., 2004).

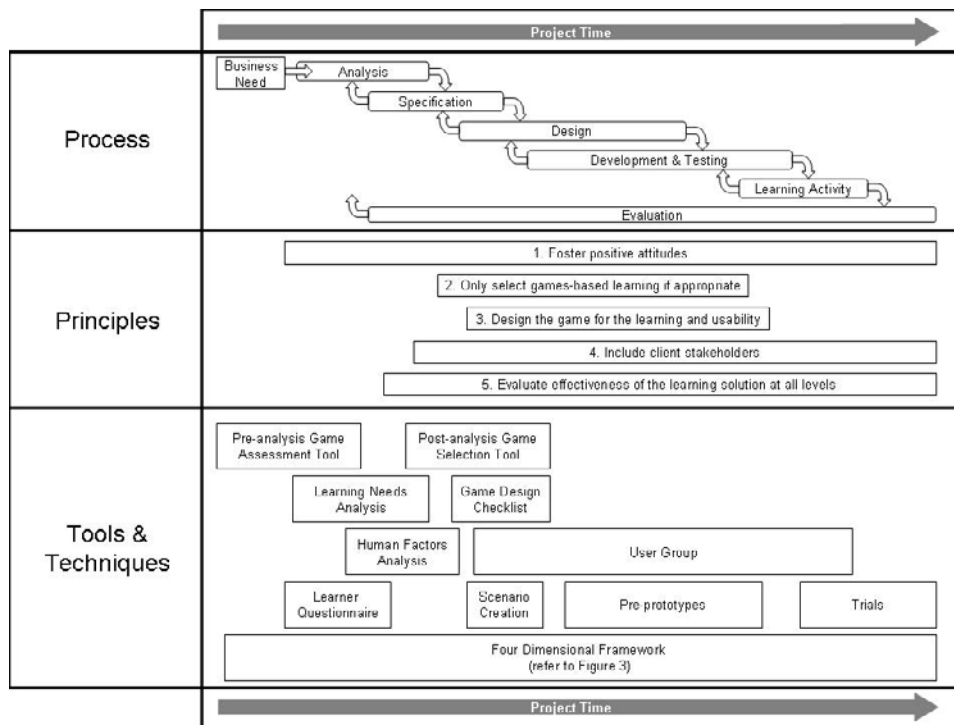
The game-based learning development approach will now be described in more detail and then it will be discussed in relation to the case study in the next section. The figure below provides a schema of the serious games development approach used. Here, project time is represented in the right-hand column of Figure 2 as running from left to right.

It is important to follow a game-based learning development approach for the simple reason that if a serious game, or any other learning intervention, works we want to be able to replicate it to increase the possibility of future successes. And if a game is less successful, we want to be able to identify the weakness in the process so that lessons can be learned. There are many different design and development processes currently used in the training industry. The development process that is illustrated in Figure 2 has been derived from a review of current instructional design and game-based learning approaches (e.g. Kirkley et al., 2005, de Freitas, 2006). It also relates to previous development and design experiences on the part of the team (e.g. de Freitas et al., 2006). The process adopted reflects the current trend towards a more user-centred approach and a highly iterative development process that involves early testing of design concepts with the users through the development of pre-prototypes (Kirjavainen et al., 2006). This reflects the commercial imperative to mitigate the risk of investing significant development effort that is not correctly aligned with the user requirements. The process is broken down into three areas: the processes of the design procedure, the principles guiding the development, and the tools and techniques used for implementing the learning and evaluating it.

The Processes

The process begins once a business need has been identified. The first stage is to conduct analysis of the business, the people, the processes and the local environment to better understand the

Figure.2..Game-based.learning.development.approach



user requirements. A solution is proposed in the Specification stage, where media, methods, time-scale and costs are identified. The evaluation strategy starts to be defined in parallel with the Specification stage. Once the client has authorised the project to proceed, the Design stage is where decisions are taken concerning the specifics of the solution. In a typical entertainment game development process, this stage might be referred to as the pre-production phase. The Design stage is where instructional designers and game developers need to collaborate closely to ensure that the game design satisfies the requirements for level of engagement and also achieves the learning objectives and other user requirements. Pre-prototypes are produced and exposed to a user group that provides feedback on elements of the design. The Development and Testing stage involves the production of the alpha and beta versions of the game and any required non-game learning material. Testing is ongoing as new features are

developed. Wherever possible, user trials should be an iterative process as continued feedback is invaluable to the success of the finished product. The Learning Activity stage is concerned with the launch and implementation of the solution into the business, and should commence well before the game is complete. Evaluation of the game-based learning solution is essential to determine whether the user requirements have been satisfied, to determine any need to make amendments, and to assess the effectiveness of the development process adopted.

The Principles

The key principles have been drawn from instructional theory and educational theory (e.g. Mayes & de Freitas, 2007), from game-based studies (e.g. Morris and Rollings, 2000), and from evaluation theory (e.g. Kirkpatrick, 1994). Notably, these principles are equally applicable to any technol-

ogy-based learning development project. The principles are fairly self-explanatory and further discussion of them will come when they are applied to the case study. There are several reasons for establishing such principles. Firstly, they help the development team keep in mind the key project success factors, thus minimising the risk of developing a serious game that fails to achieve the user requirements. Secondly, the principles imply the need for specific tools and techniques to satisfy each principle. These principles are dynamic and are being validated through the development of the serious game demonstrators and other game-based learning development projects. We would expect them to evolve over time from the analysis of effective and less effective serious game development projects. In *Figure.2*, the five principles are intended to indicate when they start to become relevant within the project development process.

To summarise these, the following five principles have been identified for developing effective game-based learning solution:

1. Foster positive attitudes to games-based learning
2. Only select games-based learning if the appropriate criteria are met
3. Design the game to be easy to learn, be appealing to all sections of the target audience, and relate directly to the high-level learning objectives
4. Within the project team, include client stakeholders, who become involved in the design and testing of the solution
5. Evaluate effectiveness of the learning solution for reaction, learning, change of job behaviour, satisfaction of organisational needs and return on investment

The last principle should be done for all training programmes. It is often not undertaken for a variety of reasons, but is included here because games are in their infancy, and evaluation is im-

portant to provide the necessary evidence of the efficacy of game-based learning.

The principle that states that games-based learning should only be selected if the appropriate criteria are met, cannot be satisfied without knowledge of factors that determine when it is appropriate to use a serious game. As part of the SG-ETS project, research has been conducted to determine these factors, and tools have been created to help in making the decision as to whether a game might be suitable. A tool has been developed to support a pre-analysis assessment of the applicability of a serious game to satisfy what is known about the user requirements at this stage. In *Figure.2*, this is referred to as the Pre-Analysis Game Assessment Tool. This tool is one example of a set of resources that support the effective development of serious games. *Figure.2* highlights other tools and techniques that will be described further in the context of the case study, but this is not a complete list of all the resources.

Tools and Techniques

To assist us with the process of developing serious games demonstrators, and to ensure that the process could be replicated, the team used a combination of available tools, frameworks and methods. One of these was the four-dimensional framework (4DF), a framework which was developed initially to support the selection and use of games in educational settings (de Freitas and Oliver 2006). For the purposes of the SG-ETS project, the team has extended the use of the 4DF to assist the development process of the serious game, which we believe needs to involve the active participation of the learner group. The aim of using this framework was to support the use of the game in practice most effectively, and also to enable the research team to evaluate of the efficacy of the game (de Freitas and Jarvis, 2007). The framework has also been used as a basis for analysing the user requirements most accurately.

The 4DF includes the need to consider context, representation, pedagogy and the learner as part of the design process. In particular, in advance of developing a serious game, it is recommended that a detailed learning analysis be produced that sufficiently covers the four perspectives.

The analysis of learning context relates to the need to consider the place where learning is taking place, to consider the resources available and to consider the disciplinary context. In this way, a picture can be produced that allows us to understand where the training is taking place (e.g. in the workplace, in school, in a university, at home), what the available resources are (e.g. access to laptops, mobiles, technical support), and what the subject and content of learning will be (e.g. English, maths, professional skills). This information is critical to matching the best solution to support effective training.

The role of the representation in game-based learning is also central to the efficacy of the serious game. This is because the way that the learner or the learning content is represented can either support or detract significantly from the learning objectives and aims. In accordance with any good practice of training and learning, it is critical to align the learning outcomes and objectives with the practices of learning (Biggs, 1999). The representational dimension of the model therefore, in relation to games, is complex in terms of application, and must include: consistency in the environment, adequate and regular feedback to the learner, and an evaluation of the correct level of immersion that supports flow in the learning process (Csikszentmihalyi, 1992). In addition, this dimension may be supported through narrative structures (e.g. quests), relevant levels of fidelity that do not detract from the immersion of the experience, and relevant levels of interactivity that facilitate learner control (e.g. Francis, 2006a; 2006b).

The third dimension that needs to be considered is the pedagogy used; in some cases this will be plural, and as in previous work it is important to

be aware that learning using instructivist, constructivist and situative modes together can be very effective (Mayes and de Freitas, 2007). In some way, this area is the most interesting as well as challenging as it is still relatively untested as to which pedagogical models work best with which contexts, representations and learner groups. For example, the research team decided to adopt a task-centred approach to develop the first serious games demonstrator (*Triage Trainer*) and that influenced the choice of an instructivist pedagogy for the game design and delivery. Preliminary trial results from the *Triage Trainer* game evaluation are showing significant performance improvement in some areas when compared to the control group that practised triage with the existing training method (results in publication). Results from the initial trials highlighted a potential issue with how feedback was being given that pointed to a lack of user involvement in the game design process; this was attended to by increasing the play levels of the serious game to ensure more regular feedback opportunities for the learners. This example shows that there are clearly indications that the pedagogies used to inform the design will have an impact upon the learning outcomes. But how far this can be controlled and supported, is a matter for ongoing consideration.

The fourth dimension of the framework relates to the learner and the learner groups. As outlined above, we assert that in order to maximise the efficacy of the serious game, it is essential to profile the learner accordingly. For our research, supporting the *Triage Trainer* and the infection control games, we conducted a survey to gather information for this dimension. In the infection control game, for example, the learning needs were established using a combination of different methods of data collection including qualitative interviews, repertory grid analysis and DIF analysis of the findings, and observations. Together, we were able to build up a detailed overview of the learner, and find ways to involve them in contributing to the study in more active ways.

The 4DF is represented in Figure 3.

Case Study: A Serious Game to Change Attitude to Infection Control

Together, the three aspects of the serious game development approach have informed the SG-ETS project. The aim of the study is to develop effective serious games applications for solving significant business needs. The team has already completed the evaluation of the first demonstrator, which was developed for supporting the training of clinical staff arriving at a major incident where casualties need to be prioritised (*Triage.Trainer*). The case study that we will detail in this chapter identifies the significant issue around hospital infections and outlines the development approach and methodology being used to develop a serious game for training clinical staff.

By way of background for the study, between 1993 and 2004 the rate of deaths from Staphylococcus aureus (S.aureus) infection in England and Wales increased annually. The rate of deaths involving Meticillin-Resistant Staphylococcus Aureus (MRSA) in males increased to 20 per million population in 2004, and in females the rate of deaths increased to 9 per million population. Most of the deaths involving S. aureus or MRSA were amongst older patients. Mortality rates in 2004

for deaths involving MRSA - in the 85 and over age group - were 546 and 258 deaths per million population for males and females respectively (UK: Office of National Statistics).

The SG-ETS research team has undertaken a significant study to investigate current training methods, and practices in hospitals and on ambulances. This has involved profiling the learner group and resulted in the creation of realistic scenarios that can be modelled into a serious game to support a blended learning solution. The analysis undertaken by the team identified the possible causes for nurses not adhering to policy at all times and one of main causes was the attitude of staff (paper to be published).

Application to Case Study

As part of the learner profiling, a Learner Questionnaire was developed to help profile the target audience and gather information about their game-playing habits and learning preferences. The application of this questionnaire to the target audience of healthcare workers revealed several interesting findings in the areas of computer anxiety, usage of computer games and preferred learning methods. The study surveyed clinical staff in two hospitals and one ambulance service in the north of England. 800 questionnaires were supplied for ward staff at the hospitals with a return rate of 18.5%. 300 questionnaires were distributed to the ambulance service with a slightly higher return rate of 25%.

As part of the study, the survey work aimed to build a profile of the level of ICT skills and competencies, profile levels of familiarity with using games, and identify the types of games used, and the learning preferences within the user group. This is important information to consider in determining that a game is a suitable learning method to use and in influencing the design of the game to ensure that it is easy to use for this learner group. 89% of the sample was female and 11% was male, reflecting the user group demographics.

Figure.3..Four-dimensional.framework

Four Dimensional Framework	
Learner Specifics Profile Role Competencies	Pedagogy Associative Cognitive Social/Situative
Representation Fidelity Interactivity Immersion	Context Environment Access to learning Supporting resources

Anxiety with using computers was much higher for females of all ages and highest with females over 40. Although this group uses computers both at home and at work, they tend to have limited experience with computer games. This group is generally enthusiastic about computers; however there is also anxiety about using them. On the other hand, males under the age of 30 tend to be confident computer users, experienced with computer games and are generally enthusiastic to using them for learning. However, they only represent 8% of the target audience.

Figure 4 illustrates the percentage of responses to the question as to whether the participants play computer games. The largest positive response came from males under the age of 30 (81%). This dropped to 26% for the female over-40 group. The frequency of game players is significantly affected by both age and gender.

The survey also gathered information on learning methods with the most popular being On-the-job (84%) and Tutor (68%). Figure 5 includes a breakdown of the preferred learning methods of females by age group.

The Learner Questionnaire has been a powerful tool for profiling target audiences, providing essential information to inform the Learner Specifics dimension of the 4DF. It is perhaps not a surprise that the largest group of our target audience, the female over 40, plays games less

often than other groups and reveals a greater level of anxiety to the use of computers. This is important information to consider in the design of the game, and provides further justification for actively involving representatives from the target audience in the design of the game at all stages. Principle 3 stresses the need for the game to be easy to learn and easy to use. This is particularly essential with a learner group that experiences some anxiety when thinking about playing a computer game.

The study adopted a participatory design approach to the game design and development. This meant going further than surveying the target audience, and the team adopted an inductive approach to data collection, supplementing survey data with the use of repertory grid analysis, semi-structured interviews, observations and focus group activities. The most appropriate methods to use for any learning needs analysis will depend on many factors, such as the business need and the organisational context. The purpose of the learning needs analysis and the human factors analysis is to establish the business and user requirements related to the dimensions of the 4DF. The analyses for the case study confirmed that inappropriate attitude is a key factor influencing behaviour that constitutes transgressions of infection control policy, such as not washing hands or using alcohol gel when required. Other training

Figure 4..Survey.responses.to.frequency.of.computer.game.play

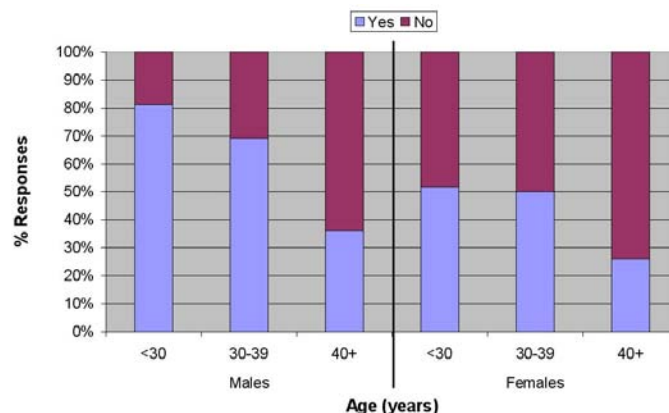
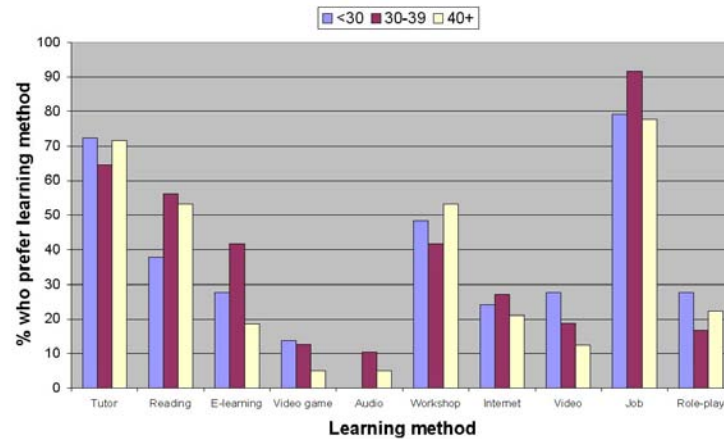


Figure.5..Learning.method.preferred.by.females.according.to.age.groups



issues were also identified such as problems giving feedback on observed transgressions, particularly to more senior staff.

The Pre-analysis Game Selection Assessment Tool has been mentioned already, and this is based on the following influencing factors about when a serious game may be appropriate:

- Large target audience
- Crucial subject matter (i.e. serious health, safety and financial consequences from poor performance)
- Target audience less motivated to learn subject matter (e.g. as a consequence of the perception that the subject matter is dull)
- Type of learning suited to game-based learning (e.g. decision making, attitude change, team-working skills...)
- Where practice is important for task proficiency

One of the assumptions made in this approach to game selection is that a game-based learning solution will typically be more expensive to produce than many alternative training media and methods, such as classroom instruction or e-learning. This explains the need for a large target audience to lower the unit cost to train each individual using

the game to a level comparable with other possible training media and methods. Another assumption is that a target audience less motivated to learn the subject matter may respond more favourably to the additional levels of engagement and immersion possible with game-based learning.

A Post-analysis Game Selection Tool has been developed to help in deciding whether a serious game is appropriate to satisfy any part of the identified learning need. There is currently a lack of research on when it is appropriate to use serious games. The SG-ETS project has as one of its main aims to address this deficiency. The Post-analysis Game Selection Tool requires as input the information gathered from a comprehensive analysis of the business problem. This tool is similar to many other media selection tools that have been developed to support more effective decision-making on the choice of training media and methods. The uniqueness of this tool is in its focus on the factors that make a serious game potentially more appropriate than other possible training media. Validation of the efficacy of the tool can only come from the evaluation of the success or failure of serious game projects that use this selection tool. A few of the questions in this spreadsheet-based tool that influence the decision to recommend a serious game are:

- How motivated is the target audience?
- How resistant is the target audience to games?
- What is the target audience's anxiety level towards computers?
- How important is decision-making in the learning?
- How important is practice to the learning?
- How available are resources/equipment for training?
- How high a fidelity representation is needed?

It should be evident that these questions could not be satisfactorily answered prior to the analysis. The Post-analysis Game Selection Tool was applied to the case study. The tool did recommend a serious game based on factors such as the large target audience, a learning goal of attitude change, motivational issues, and the health, safety and financial implications from poor performance.

The Specification stage for the case study involved the need for even closer collaboration between the instructional designers, game designers and the users. These stakeholders each have an important role to play in determining the most appropriate training solution. This involved daily communication to exchange information and to share ideas.

The rapid prototyping development approach involves working closely with the target user group, including working with a focus group at all stages of the design process. This has allowed us to replicate more closely the conditions experienced in the work environment of the clinical staff, and has led to changes in the interface design accordingly, to create consistency with the user groups' own experience in their environment. The approach is predicated upon the notion that the user will more readily use the game if it maps closely to their environment. The methods for supporting this have been standardised focus group activities, comparative tasking and discussion sessions. The approach is loosely based upon the

work of Allison Druin (Guha et al., 2004; Druin, 2002), where children are treated as designers of multimedia outputs. While their approach focused more upon creative processes for supporting more effective design, our approach has been to adopt game-play approaches, allowing the user group to interact with different interfaces and using the observations of this to influence game design, interface design and game selection.

A user group was formed of two infection control nurses and four nurses. It was thought that a larger user group would become more difficult to manage, and decision-making could be more protracted because of the increased risk of conflicting points of view. The two infection control nurses helped to define appropriate scenarios that represented high risks of transgression of infection control policy. The scenarios included the following:

- Patient vomits over bed
- Moving patient to an isolation room
- Giving a bed bath
- Changing a dressing

The previous analysis stage had also gathered information on the situations with the highest risk of cross-infection from policy transgression that was used to validate the choice of scenarios.

One of the main challenges at this stage of any game-based learning development project is managing the inherent complexity in the design decisions that need to be made. Questions that need to be answered involve the following:

- What camera viewpoint to adopt?
- What level of fidelity is necessary?
- Which platform?
- What is a realistic scope for the scenarios given the available resource?
- What is the role of the game within the learning intervention?
- What pedagogy should be adopted?
- What is the game concept?

Attitude change along the lines of established infection control policy was the learning goal of the game and was identified in the Specification stage. The decision to focus the game on an initial target audience of nurses was made without the need for too much discussion, because the analysis was confined mainly to this target audience. The other questions were not so easy to answer. The most appropriate answer to one question was often at variance with the most appropriate answer to another question.

For example, the camera viewpoint in the game is a critical design decision. The hospital observation had revealed the extent to which hygiene incidents could occur in one part of a ward and then, if unnoticed either by the individual concerned or his/her supervisor, potentially become part of a cumulative infection problem. This suggested that a third-person viewpoint would be required so that the player could see this effect. The research conducted on the importance of role identification for attitude change in game-based learning might suggest that a more intimate first-person viewpoint would be more appropriate. The initial user group workshop involved showing the users several different games with third and first person camera viewpoints. Several users gave the feedback that a high camera-angle made them feel 'uncomfortable' and 'queasy'. The eventual compromise decision that was agreed with the user group was to adopt a low camera angle in a third-person viewpoint. This decision will need to be tested as each scenario is incorporated into the game play to ensure that important actions and events in the game are not missed because they are out of view of the player. This example is just one of many design decisions that require the need to carefully weigh up conflicting information. Ultimately, it is the user group that represent the users who will be playing the game, so their perspective is the most important to consider.

A Game Design Checklist tool was developed to help manage the complexity in the design decisions by showing the relationships between factors

affecting the game design. This tool helped to prepare the stakeholders for the design meetings so that everyone started the meeting with the same level of understanding of the design issues and relevant information from the analyses and the user group input.

User group workshops were scheduled on a regular basis as critical design decisions needed to be made or tested. Pre-prototypes were used to expose design options to the users so they could be given the required feedback to the design team. Figure 6 and Figure 7 show examples of a pre-prototype visualisation of the ward used to obtain feedback on the required fidelity.

A short extract from the dialogue between a game designer and a member of the user group (Nurse A) illustrates the process:

Facilitator (Game Designer): These images show different levels of fidelity for the ward. How do you feel about this? Which do you prefer, and why?

Nurse A (User Group Member): I prefer the higher fidelity with the crumpled sheets the other image is too white ... not realistic ... beds too stark ... glaring in the eyes.

Figure. 6.. Pre-prototype. visualisation. of. ward. with low fidelity



Figure. 7..Pre-prototype.visualisation.of.ward.at.a higher fidelity



Each user group workshop has helped to refine the game design and ensure that the design remains aligned with the user requirements.

A challenge for the game design was to determine how best to implement the guidelines for instruction for attitudinal change (Simonson and Maushak, 2001). The user group is playing a key role in ensuring that the game is realistic, relevant to them, technically stimulating and credible. The user group (representing the learners) is also actively involved in the planning, production, and delivery of the serious game. The game should provide purposeful emotional involvement and arousal. The game will be delivered on a laptop computer and played in a staff room close to the ward. This information was obtained from the user group. The aim is for the game to be part of the Trust's organisational development programme with group discussion after playing the game (e.g. at the ward level). The one area that has been a challenge to incorporate into the game is the presentation of new information. The analysis showed that lack of knowledge of infection control policy was not a major issue.

The game concept that has been agreed with the user group involves a goal of the player performing everyday tasks whilst keeping infection at bay within a hospital ward environment by following best practice. From a learning perspective, the

game shows what effect actions, and inactions, can have on infection within a hospital ward. The objective of the game is to achieve as high a score as possible by completing tasks correctly without transgressing hygiene policies.

The evaluation strategy is critical to the success of the project and the game. Principle 5 states that the game-based learning solution should be evaluated for reaction, learning, change of job behaviour, satisfaction of organisational needs and return on investment (Kirkpatrick, 1994). The user group has helped determine what is measured relating to infection control on the ward and in the hospital that could be used in the trials (e.g. frequency of hand washing, monthly rates of MRSA and C. diff). Pre- and post-test questionnaires will measure any change in attitude of participants on the wards that play the game, compared to the participants on the wards that will form the control group.

From Serious Games Development Approach to an Exploratory Game-Based Learning Model for Attitudinal Change

The learning model that the authors are developing builds upon the experiential learning cycle proposed by Kolb (1984) and aims to extend the Kolb cycle to include exploration as a critical concept within the learning cycle of game-play (de Freitas & Neumann, 2008). Exploration aims to present the learner with the key aspect of being able to explore an environment freely, thereby allowing for greater learner control over identity, content and communications, a characteristic particularly associated with effective game-based learning (e.g. Francis, 2006 a,b). Exploration provides the additional dimension of the virtual environment, and exploratory learning therefore has a different emphasis than purely experience-based learning conditions.

The exploratory game-based learning model being developed as part of this project builds upon this work, and is testing the validity of exploratory learning as a distinct learning aspect of learning with games and simulations. Critically, argued for here is a new model for supporting effective learning and game design that may incorporate the processes, principles and tools and techniques outlined. The 4DF approach which considers the learner, the context, the representation and the pedagogic approaches taken, needs to be linked with the user-centred process model of development that adopts participatory design approaches. In this way, the central principles of game design and the tools and techniques for supporting the design process, including methodologies and data collection approaches used, can be integrated together.

Areas for Future Work and Conclusion

Preliminary findings emerging from the research are indicating that this serious games development approach is supporting effective learning design with serious games. We believe that further analysis of the study outcomes will serve to validate this approach. Future work for the team will focus upon refining and testing the model presented here. The aim is to contribute a body of evidence-based work that can forge serious games as a distinct academic discipline that draws from a range of methods and disciplines. The work has already begun but we have a lot more to do to begin to fill in the gaps in our knowledge. New approaches to the field may aim to capture more empirical evidence around identification, such as the role of learner authoring and the efficacy of using games for supporting behavioural changes.

To conclude: it is vital to use a specific development approach for supporting consistent serious game design, for evaluation and to ensure efficacy. It is important to involve users in the

design process to ensure the efficacy of the game. While learners may not use serious games in the ways we are accustomed to in e-learning systems, the critical aspect is the exploratory element of learning with games. We are working to try to understand this more fully, and the exploratory learning model we are evolving will be a key step along this path.

This study is revealing that the development of these tools and techniques is essential for serious game development due to high costs, and is also indicating the importance of flexibility in terms of scenario editing and development, allowing tutors and learners to create learning experiences more easily. The work emerging from this study will present developers, instructional designers and learners with the tools they need to develop immersive learning experiences, and the work is an important aspect for forming a distinct academic practice around serious games.

REFERENCES

- Bednar, A., & Levie, W. H. (1993). Attitude-change principles. In M. Fleming & W. H. Levie (Eds), *Instructional.message.design:Principles.from.the.behavioral.and.cognitive.sciences* (pp. 283-304). Englewood Cliffs, NJ: Educational Technology Publications.
- Biggs, J. (1999). *Teaching.for.Quality.Learning.at.University*. Buckingham. Society for research in Higher Education. Open University Press. See also <http://www.dmu.ac.uk/~jamesa/learning/solo.htm>. Last accessed 23rd March 2004.
- Csikszentmihalyi, M. (1992). *Flow..The.psychology.of.happiness*. London: Rider.
- de Freitas, S. (2006). *Learning.in.Immersive.Words..Bristol*. Joint Information Systems Committee. See: www.jisc.ac.uk_eli_outcomes.html
- de Freitas, S., & Jarvis, S. (2007). Serious Games – Engaging Training Solutions: A research and

- development project for supporting training needs. *British Journal of Educational Technology*, 38(3): 523-525.
- de Freitas, S., & Neumann, T. (2008). The use of 'exploratory learning' for supporting immersive learning in virtual environments. *Computers and Education*.
- de Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated? *Computers and Education, Special Issue*, 46(2006) 249-264.
- de Freitas, S., Savill-Smith, C., & Attewell, J. (2006). *Computer games and simulations for adult learning: case studies from practice*. London: Learning and Skills Research Centre.
- de Freitas, S., Harrison, I., Magoulas, G., Mee, A., Mohamad, F., Oliver, M., Papamarkos, G., & Poulouvassilis, A. (2006). The development of a system for supporting the lifelong learner. *British Journal of Educational Technology, Special Issue, Collaborative e-support for lifelong learning*, 37(6), 867-880.
- Druin, A. (2002). The Role of Children in the Design of New Technology. *Behaviour and Information Technology*, 21(1) 1-25.
- Francis, R. (2006a). *Towards a pedagogy for game-based learning*. Paper presented at JISC Online conference: Innovating with e-Learning 2006. 30th March. Available in Innovating e-Learning Practice - The proceedings of the JISC Online Conference: Innovating e-Learning 2006. Cheltenham. Direct Learn Services Ltd. Last retrieved online at: www.jisc.ac.uk/elp_conference06.html.
- Francis, R. (2006b). *Revolution: Learning about history through situated role play in a virtual environment*. Paper presented at the American Educational Research Association Conference, San Francisco.
- Guha, M. L., Druin, A., Chipman, G., Fails, J., Simms, S., & Farber, A. (2004). Mixing Ideas: A new technique for working with young children as design partners. In *Proceedings of Interaction, Design and Children (IDC'2004)*. College Park, MD: 35-42.
- Hays, R. T. (2005). The Effectiveness of Instructional Games: A Literature Review and Discussion. *NAVAIR Technical Report 2005-004*
- Kamradt, T. F., & Kamradt, E. J. (1999). Structured Design for Attitudinal Instruction. In C. M. Reigeluth (Ed.), *Instructional-Design Theories and Models: A New Paradigm of Instructional Theory, Volume II* (pp. 563- 590). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kirjavainen, A., Nousiainen, T., & Kankaanranta, M. (2006). *Prototyping in Educational Game Design*. Positioning paper for the CHI 2006 conference.
- Kirkley, S. E., Tomblin, S., & Kirkley, J. (2005). Instructional Design Authoring Support for the Development of Serious Games and Mixed Reality Training. *Presented at Interservice/Industry Training, Simulation and Education Conference*.
- Kirkpatrick, D. (1994). *Evaluating Training Programs*. The Four Levels: Berrett-Koehler
- Kolb, D. A. (1984). *Experiential Learning*. Englewood Cliffs, NJ: Prentice Hall.
- Livingston, S. A. (1970). *Simulation Games and Attitude Change: Attitudes Toward the Poor (Questionnaire Study I)*, Report No. 63. The John Hopkins University, Center for the Study of Social Organisation of Schools.
- Lockee, B., Moore, D., & Burton, J. (2004). Foundations of Programmed Instruction. In D. H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology, 2nd Edition* (pp 545-569). Mahwah, NJ: Lawrence Erlbaum Associates.

Mayes, T., & de Freitas, S. (2007). Learning and e-Learning: The role of theory. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy in the digital age*. London: Routledge.

Morris, D., & Rollings, A. (2000). *Game Architecture and Design*. New York: Coriolis Group

Schumacher, T. R. (1997). Simulation and attitude change: evolving the research model. *Proceedings of The Thirtieth Annual Hawaii International Conference on System Sciences* ISBN 0-8186-7862-3/97. IEEE

Simonson, M., & Maushak, N. (2001). Instructional technology and attitude change. In Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 984-1016). Mayway, NJ: Lawrence Erlbaum Associates

Smith, P. L., & Ragan, T. J. (2005). Chapter 14 Strategies for attitude learning. *Instructional Design*. Third edition, John Wiley & Sons.

Tumosa, N., & Morley, J. E. (2006). The Use of Games to Improve Patient Outcomes. *Gerontology & Geriatrics Education*, 26(4) 2006.

Williams, R. H. (1980). Attitude change and simulation games: The ability of a simulation game to change attitudes when structured in accordance with either the cognitive dissonance or incentive models of attitude change. *Simulation & Games*, 11(2), 177-196.

Williams, R. H., & Williams, S. A. (1987). Levels of Identification as a Predictor of Attitude Change. *Simulation & Games*, 18(4), 471-487.

Zimbardo, P. G., & Leippe, M. R. (1991). The psychology of attitude change and social influence. New York: McGraw-Hill.

ENDNOTE

- ¹ For example, one of the authors, Sara de Freitas is involved in one study that compares face-to-face with game-based learning: the Interactive Digital Media-funded Serious Games Exposed project (www.seriousgames.org.uk).

Chapter XIV

Current Practices in Serious Game Research: A Review from a Learning Outcomes Perspective

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ABSTRACT

Despite scant empirical substantiation, serious games are in widespread use. The authors review 28 studies with empirical data from a learning outcome perspective to outline the effectiveness of serious games (compared to other learning approaches and specific game features). They conclude that serious games potentially improve the acquisition of knowledge and cognitive skills. Moreover, they seem to be promising for the acquisition of fine-grained motor skills and to accomplish attitudinal change. However, not all game features increase the effectiveness of the game. To further advance game research, the chapter proposes recommendations including the alignment of learning outcome(s) and game type, the alignment of the game complexity and human cognitive processes, attention for cognitive and motivational processes, research on specific mitigating factors like gender on game effectiveness and, finally, developing new ways of assessing game effectiveness.

INTRODUCTION

The use of games in learning and instruction, often referred to as serious games, has been propagated by many researchers. Serious games are hypothesized to address both the cognitive and affective dimensions of learning (O'Neil, Wainess & Baker, 2005), to enable learners to adapt learning to their cognitive needs and to provide motivation for learning (Malone, 1981). However, reviews focusing on serious games have revealed little substantiation for these claims (Fletcher & Tobias, 2008; Kirriemuir & McFarlane, 2004; Leemkuil, de Jong & Ootes, 2000; O'Neil et al; Vogel et al., 2006).

This review focuses on the learning outcomes for two reasons. First, typically serious games aim at specific learning goals and consequently for specific learning outcomes as well. Therefore it seems obvious to conduct the review from this perspective. Secondly, many studies on serious games have focused particularly on cognitive learning outcomes: learning of knowledge and problem solving skills. Consequently, previous reviews have focused on particular types of learning outcomes and have neglected other types. We contend that a comprehensive taxonomy of learning outcomes will not only reveal in which situations serious games improve learning, but also uncover dimensions of learning that have been neglected thus far in reviews.

In the remainder of this chapter we first define games. Next, we present a taxonomy of learning outcomes. For each learning outcome we then review relevant studies and draw some conclusions. Finally, we present some directions for future research and draw a final conclusion.

What are Games?

A serious game is a computer based game with a primary purpose other than entertainment, ranging from anywhere between advertisements

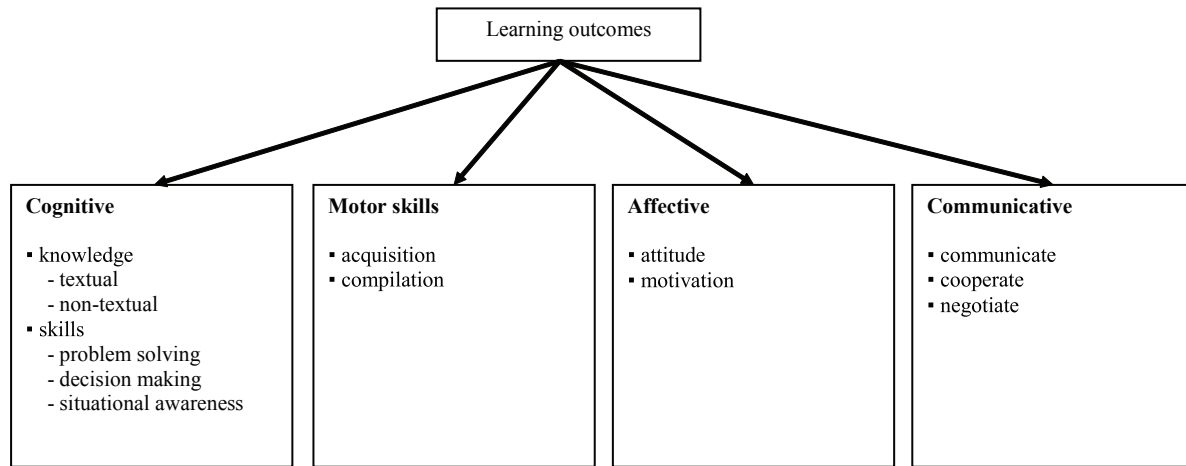
to military training exercises (Michael & Chen, 2005). Naturally in this review we will concern ourselves mainly with games that aim at the aforementioned learning outcomes. Many definitions exist that describe a game (cf. Garriss, Ahlers & Driskell, 2002; Vogel et al., 2006), but mostly a definition along the following lines is chosen: that it is *goal-directed*, a *competitive activity* (against the computer, another player, or oneself) and conducted within a framework of *agreed rules* (Lindley, 2004). In addition, games constantly provide *feedback* to enable players to monitor their progress towards the goal (Prensky, 2001).

A Taxonomy of Learning Outcomes in Serious Games

There are many classifications of learning outcomes. Traditionally, researchers have focused on the cognitive dimension of learning outcomes (Bloom, 1956; Gagné, 1977). Others have included affect-oriented objectives such as appreciation (Krathwohl, Bloom & Masia, 1964). More recent, other classifications have emerged identifying factors such as collaboration/teamwork, communication and self-regulation as potential outcomes of learning (Baker & Mayer, 1999). An interesting classification of learning outcomes has been provided by Kraiger, Ford and Salas (1993), who distinguish between cognitive outcomes (e.g., problem solving), skill-based outcomes concerning the development of technical or motor skills, and affective outcomes including attitude and motivation. Drawing from the two latter classification schemes, we propose a taxonomy consisting of four categories of learning outcomes: cognitive, motor skills, affective and communicative. Figure 1 presents an overview of these learning outcomes and their constituent parts.

Cognitive learning outcomes can be divided into knowledge and cognitive skills. Knowledge refers to encoded knowledge reflecting both text-oriented (e.g., verbal knowledge) and non

Figure 1..A taxonomy of learning outcomes



text-oriented knowledge (e.g., knowledge in the form of an image). Several types of encoded knowledge can be discerned such as declarative (explicit knowledge of facts) and procedural (knowledge of how to perform a task). A cognitive skill pertains to more complex cognitive processes. In problem solving, for example, learners have to apply knowledge and rules to solve new problems. In complex and dynamic situations people are sometimes forced to make decisions under time-pressure. Such decision making skills require situational awareness, that is, the ability to attend to and perceive the relevant information in a situation, comprehend this information and predict how the situation may develop (O'Brien & O'Hare, 2007).

The second type of learning outcome, learning *motor skills*, involves several stages. Initially a learner has to acquire the skill by making a transition from declarative knowledge to procedural knowledge. In subsequent stages the learner practices the motor behavior and in this way compiles the behavior, that is, make the motor behavior faster, less error-prone and independent of verbal rehearsal.

With *affective learning outcomes* we can differentiate two subtypes. To start with, learning may focus on a change in the attitude of the learner.

Attitudes refer to internal states that influence the choices or actions of an individual (Gagné, 1977). This may pertain to a change from a negative to a positive learning attitude towards (subjects at) school, but also to a change in behavior that is exhibited in daily live (e.g., driving cautiously) or for therapeutic purposes (e.g., overcoming fear of spiders). The second subtype, motivation, is a prerequisite for learning to commence. Motivation reflects the willingness to pay attention to learning material and to spent cognitive resources to process information.

The last type comprises *communicative learning outcomes*. Although collaborative learning is claimed to lead to a deeper level of understanding and long term retention of the learned material, it also emphasizes the opportunities for developing social and communication skills, and building social relationships and group cohesion (Kreijns, Kirschner & Jochems, 2003). In environments where teams have to work together on tasks that go beyond the capabilities of one individual (e.g., firefighters, cockpit crews), the training of communication and collaboration skills can be the primary purpose of an instructional intervention.

In general the performance of (complex) tasks will involve different types of learning outcomes. For example, learning to drive may comprise

knowledge (e.g., traffic rules), motor skills (e.g., changing gears) and attitudinal change (e.g., driving cautiously). This example also illustrates that the learning outcomes are sometimes hierarchical: before the changing gears motor skill can be performed the procedural knowledge has to be learned.

The Review

For the purpose of this review we searched several databases (PsychINFO, ERIC) with terms including 'game-based learning', 'PC games', 'video game', 'computer video game', 'serious games', 'educational games', 'simulation games', 'virtual environments', 'virtual reality'. If necessary these terms were combined with 'learning', 'instruction' and 'training'. In addition, we consulted the proceedings of relevant conferences (CHI, AERA and so forth) with the same terms. The review was conducted in Summer 2008 and covered the last 10 years. Studies were only considered when empirical data were available. Table 1 classifies the serious game studies in the taxonomy of learning outcomes. We classified each study according to the learning outcome that the research was primarily aimed at.

First we discuss the relevant studies for each type of learning outcome. We discuss studies that compare serious games with other instructional methods as well as studies that investigate the effectiveness of specific game features.

Cognitive Learning Outcomes

Encoded Knowledge

First, studies comparing a game group with a control group are discussed. In the multi-user virtual environment *River City* two gaming groups (with a focus on respectively 'learning-by-doing' and modeling) were compared with a control condition (Dede, Clarke, Ketelhut, Nelson & Bowman,

2005). The task for all participants was to discover why residents of a virtual town were getting ill. In this process they learned about biology. The results showed that the two gaming groups gained more biology content knowledge than the control group. In learning about electromagnetism Squire, Barnett, Grant and Higginbotham (2004) compared learners engaging in the *Supercharged* game with a group engaging in guided inquiry. The game places students in a three dimensional environment where they must navigate a spaceship by controlling the electric charge of the ship. Learners in the *Supercharged* game performed better on knowledge than guided inquiry learners. In training Navy electronic technicians, Parchman, Ellis, Christinaz and Vogel (2000) found that trainees engaging in an adventure game (*King's Quest V*-based) in which they had to visit a series of compartments in a battleship and perform exercises, were outperformed by trainees who received a computer-based practice-and-drill or an enhanced computer-based instruction on a posttest measuring knowledge of definitions. However, no differences were found on knowledge of symbols. In the domain of biology the game *Metalloman* was compared with a hypertext and a text instruction group in knowledge on physiology concepts (Wong et al., 2007). It was observed that the game and the hypertext group yielded higher learning gains than the text instruction group.

The effectiveness of the game features for relevance of information, interactivity, instructional guidelines, level of stress, game task and game type have been investigated as well. In the game *America's Army* people learn about the values and history of the army. A study with military academy recruits revealed that information that was relevant for the task was better recalled than non-relevant information (Belanich, Sibley & Orvis, 2004). Regarding the game feature for interactivity Wong et al. (2007) surprisingly found that an interactive version of *Metalloman* yielded no higher learning gains than a non-interactive version of the game. In *KMQuest*, learners run a commercial organi-

Table 1. Classification of studies in the taxonomy of learning outcomes

Learning outcome	Study	Game	Domain	Results	Effect
Cognition					
Knowledge					
	<u>Game vs. control group</u>				
	Dede et al. (2005)	River City	Biology	Game > Text	+
	Squire et al. (2004)	Supercharged	Science	Game > Guided inquiry	+
	Parchman et al. (2000)	King's Quest V	Electronics	Game < Computer-based	+/-
	Wong et al. (2007)	Metalloman	Biology	Game and Hypertext > Text	+
	<u>Game features</u>				
	Belanich et al. (2004)	America's Army	Military	Relevant knowledge better recalled	+
	Wong et al. (2007)	Metalloman	Biology	Interactivity has no effect	-
	Leemkuil (2006)	KMQuest	Economy	Instructional support not effective	-
	Morris et al. (2004)	DeltaForce	Military	Stress level has no effect on recall	-
	Virvou et al. (2004)	VR Engage	Geography	Game mission more effective	+
	Beale et al. (2007)	Re-Mission	Medicine	Game type has an effect	+
Cognitive skills					
	<u>Game vs. control group</u>				
	Barab et al. (2006)	QuestAtlantis	Writing	Game > Traditional	+
	Dede et al. (2005)	River City	Biology	Game > Text	+/-
	Nullmeyer et al. (2006)	Unknown	CRM	Game > Control	+/-
	Parchman et al. (2000)	King's Quest V	Electronics	Computer-based > Game = Text	+/-
	Ke et al. (2007)	Astra Eagle	Math	Game > No game	+
	<u>Game features</u>				
	Leemkuil (2006)	KMQuest	Economy	Instructional support not effective	-
	Nelson (2007)	River City	Biology	Guidance not effective	+/-
	Morris et al. (2004)	Delta Force	Military	High stress yields better mission success	+
	Feng et al. (2007)	MoH, Balance	Spatial Cogn.	Action game yields better spatial cognition	+
Motor skills					
	<u>Game effect</u>				
	Rosenberg et al. (2005)	Top Spin	Surgery	Game experience has no effect	+/-
	Waxberg et al. (2005)	Goldeneye	Surgery	Game experience has no effect	+/-
	Enochsson et al. (2004)	Unknown	Surgery	Game experience yields better performance	+

continued on following page

Table.1..continued

	Grantcharov et al. (2003)	Unknown	Surgery	Game experience yields better performance	+
	Rosser et al. (2007)	Silent Scope	Surgery	Game experience yields better performance	+
Learning outcome	Study	Game	Domain	Results	Effect
Affective					
Attitude					
	<u>Game effect</u>				
	Bouchard et al. (2006)	Half-Life	Phobia	Reduction of fear of spiders	+
	Walshe et al. (2003)	London Racer	Phobia	Reduction on fear of driving	+
	Ke et al. (2007)	Astra Eagle	Math	Cooperative game > Competitive/ No game	+
	<u>Game features</u>				
	Backlund et al. (2007)	Unknown	Driving	Safe driving behavior	+
	Fischer et al. (2007)	Burnout/Fifa	Driving	Race gamers less cautious than non race gamers	+
Motivation					
	<u>Game vs. control group</u>				
	Dede et al. (2005)	River City	Biology	Game > traditional	+
	Parchman et al. (2000)	King's Quest V	Electronics	Enhanced = Game > Drill-practice = Text	+/-
	Tuzun et al. (2008)	Quest Atlantis	Geography	Intrinsic: Game > traditional Extrinsic: Game < Traditional	+
Communicative					
	<u>Game vs. control group</u>				
	Branninck et al. (2005)	Asteroids	CRM	PC based simulator > Game + Exercises	+
	Nullmeyer et al. (2006)	unknown	CRM	Game = Control	-
	<u>Game features</u>				
	Nova et al. (2003)	Spaceminers	Science	task performance better with awareness tool	+
	Galimberti et al. (2001)	DOOM II	Maze	Collaboration: Immersion = nonim- mersion	+/-

Note: .+ = .an.effect.(positive.or.negative).is.reported,.- = .no.effect.is.reported,.. +/- = .results.are.inconclusive

zation in which they have to make decisions in order to make the organization more efficient. Leemkuil (2006) investigated several variations of the game feature for instructional guidelines

(advice vs. no advice, extra assignments vs. no extra assignments, advice with hints vs. advice without hints vs. no advice), however, no difference on the knowledge learning outcome was

found in a transfer test that was administered after the training in KMQuest. In a training with the game *DeltaForce*, no effect of the game feature for level of stress was found on recall of knowledge of military tactics content (e.g., use of equipment) between trainees who were exposed to either a low or a high level of stress (Morris, Hancock & Shirkey, 2004). In geography Virvou, Katsionis and Manos (2005) investigated the effect of the game feature for game task. For this purpose they compared a group engaging in a 3D virtual reality game (based on *Doom*) with a group working in a hypertext environment. Both groups differed in the fact that the virtual reality group had a game task, that is, they had to navigate through a virtual 3D world with the explicit mission to find the missing pages of the 'book of wisdom'. The game group yielded higher learning gains than the hypertext group. Closely related to the game task is the type of game that is used. In the game *Re-Mission* young people engage in missions in 3-D virtual bodies of cancer patients and learn about the mechanisms underlying cancer. Participants engaging in *Re-Mission* showed larger knowledge gains than participants who received a commercial adventure game (Beale, Kato, Marin-Bowling, Guthrie & Cole, 2007).

The fact that three out of four studies report higher performance for groups learning with games provides some evidence that the new generation of serious games support the acquisition of knowledge. The effectiveness of specific game features is mixed. The game features for relevance of information, game task and game type ameliorate the acquisition of knowledge, whereas the game features for level of stress, instructional guidelines, and interactivity failed to have an impact on learning.

Cognitive Skills

First, we describe studies comparing a game group with a control group. In the multi-user environment *Quest Atlantis* (QA) learners travel to virtual worlds and engage in educational activi-

ties (quests). It was used by Barab, Warren and Ingram-Goble (2006) to compare the performance in writing skills of a group receiving traditional instruction with a group working as an investigative reporter for the local newspaper in QA. In writing tasks similar to the tasks performed during instruction the QA group showed significantly more improvement. In the aforementioned *River City* environment cognitive skills were measured in two ways: with open-ended questions and with a letter to the mayor in which the participants discussed their hypothesis, the results and the interpretations. Interestingly only a difference in favor of the game groups was found when the cognitive skills were measured by the letter to the mayor (Dede et al., 2005). In the military, games have been used to investigate the effect on learning specific cognitive skills during a flight mission such as task management, decision making, and assessing the situation. In the training of cockpit crews, commonly known as crew resource management (CRM), the comparison of a group training on a PC-based simulator and a control group revealed that the former group performed better on task management and situational awareness, but not on other cognitive skills, such as decision making and planning (Nullmeyer, Spiker, Golas, Logan & Clemons, 2006). Problematic in this study was that no information was provided with respect to the training in the control condition. In the aforementioned training of Navy electronic technicians, Parchman et al. (2000) found that the two computer-based groups performed better on the application of principles than the game and classical instruction groups. For the application of rules no differences between the groups were found. Finally, Ke and Grabowski (2007) compared two game groups (students were either assigned to a cooperative or competitive version of the game *ASTRA Eagle*) with a no game group on the acquisition of mathematical problem solving skills. It was found that both game groups outperformed the no game group on mathematical skills.

Other researchers have studied the effect of the game features for instructional guidelines, level of stress and game type. Leemkuil (2006) varied the guideline advice (advice vs. no advice and advice with hints vs. advice without hints vs. no advice) in the *KMQuest* environment, but found no differences in a transfer task that was administered after the learning phase in *KMQuest*. Nelson (2007) used *River City* to investigate whether guidance would improve science inquiry and hypothesis formation skills. It appeared that groups with either extensive or moderate guidance did not use this guidance and consequently did not gain a better command of these cognitive skills than a group without such guidance. However, further analyses revealed higher learning gains for learners who did use the provided guidance. Also the effect of extra assignments was studied in the *KMQuest* learning environment, but no differences were found on the transfer task that was administered afterwards (Leemkuil, 2006). The game feature for level of stress was investigated in the game *Delta Force* in which the participants had to engage in an arctic mission that required cognitive skills. The trainees in the group with a high level of stress during training were more successful in completing the mission than trainees who were exposed to a low level of stress (Morris et al., 2004). Finally, the impact of the game feature for game type was investigated by comparing the effect of an action game (*Medal of Honor: Pacific Assault*) with a non action game (*Balance*) on spatial cognition (Feng, Spence & Pratt, 2007). It was found that only the action game enhanced spatial cognition. Interestingly, they also found that the initial superiority of males over females in spatial cognition was much reduced after working with the action game.

Although four out of five studies substantiate the claim that serious games are more effective in training cognitive skills than traditional instructional methods, the results in the *River City* study also pose the question how cognitive skills should be assessed. The contextualized type of

learning that takes place in serious games may not be detected by traditional measurements, but all the more with alternative measurements (i.e., essays). Also for learning cognitive skills the game feature for instructional guidelines failed to be effective.

Motor Skill Learning Outcomes

Much research has focused on the effect of video game experience on screen-mediated surgery skills (i.e., the surgeon operates via a monitor). Researchers have compared groups that practiced with games with groups that did not practice with games (Rosenberg, Landsittel & Averch, 2005; Waxberg, Schwaitzberg & Cao, 2005). These studies did not show that video game experience yielded better surgery skills. For instance, in laparoscopic surgery Waxberg et al. (2005) hypothesized that practicing with the video game *James Bond. 007: Goldeneye* for a week would lead to better performance on several tasks on a surgery skills trainer. The results showed that this was true for some tasks, but that the no-game group performed better on other tasks.

Other researchers have correlated video game experience with surgery skills and reported that video game experience predicted surgery performance (Enochsson et al., 2004; Grantcharov, Bardram, Funch-Jensen & Rosenberg, 2003; Rosser et al., 2007). Rosser et al. (2007), for instance, showed that surgeons with video games experience made less errors and showed faster completion times in a learning environment for laparoscopic surgery. Moreover, the video games skills of these surgeons, demonstrated during three different video games, appeared to be significant predictors of laparoscopic surgery skills.

The results in the domain of surgery are still inconclusive: whereas experimental designs fail to show a beneficial effect, correlation studies seem to confirm the predictive power of game experience. Given the ample evidence indicating that experience in video games enhances

the ability for visual search (e.g., Castel, Pratt & Drummond, 2005; Green & Bavelier, 2003, 2006) and dual-tasking (Satyen & Ohtsuka, 2001), we believe that the use of serious games is promising in learning fine-grid motor skills that require excellent hand-eye coordination.

Affective Learning Outcomes

Attitude

Increasingly, virtual reality systems are used to support people in desensitizing a large range of fears and phobias by allowing them to confront frightening situations without the danger of possible (physical) harm. Since these systems are rather expensive, researchers have investigated whether realistic games can be used for this purpose as well. Their focus was on the effect of games on attitude and not the comparison of a game therapy with a traditional therapy. Bouchard, Côte, St-Jacques, Robillard and Renaud (2006) designed a therapy requiring participants with fear of spiders to engage in a *Half-Life* based environment where they were increasingly exposed to spiders. Before the treatment, the majority stayed 2 metres from a bowl with spiders. After the treatment the majority was able to stand next to the bowl. A similar positive effect was obtained with participants who were diagnosed as having an accident phobia. Before and after the intervention comprising a 12 hours program of game racing (e.g., *London Racer*) they were assessed with several ratings such as distress and severity of fear of driving. It was found that the participants showed posttest reductions on all measures (Walshe, Lewis, Kim, O'Sullivan & Wiederhold, 2003).

The effectiveness of serious games on attitudinal change towards school topics was investigated in the aforementioned study of Ke and Grabowski (2007), which revealed that students engaging in a cooperative game developed a more positive attitude towards mathematics than students who engaged in a competitive game or in paper-and-

pencil lessons. This effect was stronger for socio-economically disadvantaged students.

Regarding attitudinal change the effect of the features game task and game type have been studied. In a simulator environment for training driving skills a group receiving a game task (i.e., they had to follow an ambulance without losing sight of it) was compared with a group without such game task. It was found that the group with the game task showed safer traffic behavior on dimensions such as looking in rearview windows and lane changing than the group without a game task (Backlund, Engström, Johanneson & Lebram, 2007). The effect of the feature game type on attitudinal change was investigated in a series of experiments conducted by Fischer, Kubitzki, Guter and Frey (2007). They found that participants who played race games (e.g., *Burnout*) exhibited a less cautious driving behavior in terms of risk-taking and excitement than participants who played neutral games (e.g., *Fifa*, 2005). Apparently, not only is engaging in a game task important, but so is the game type in which the task is performed.

Tentatively it can be concluded that serious games facilitate attitudinal change. Game features, such as a game task and the game type also have an impact on attitude. The findings of both race games studies also confirm that individual characteristics should be taken into account when using serious games for attitudinal change. The traumatized participants in the Walshe et al. (2003) study benefitted from the race game and became less fearful for driving, whereas the non-traumatized participants in the Fisher et al. (2007) study became more reckless drivers after engaging in the race game.

Motivation

Previous reviews have claimed that serious games motivate players to continue and subsequently it is alleged that this feature can be useful for the purpose of learning (cf. Garriss et al., 2002), but recent research on motivation is scant. Dede et al.

(2005) argued that the large drop in absentee rate (50%) during learning in *River City* environment may have indicated an increased engagement during the implementation of River City. However, the absentee rate for the traditional instruction group was not reported. In the aforementioned training of military cadets in the Parchman et al. study (2000) a motivation questionnaire based on Keller's ARCS model was used to compare trainees' motivation in the four groups (a game group, classical instruction, and computer-based practice-and-drill or enhanced instruction). Although the game group participants were more attentive to the contents than the classical instruction and computer-based practice-and-drill group, no differences were observed between the game and computer-based enhanced instruction groups. A qualification of the motivational aspects of games comes from Tuzun, Yilmaz Soylu, Karakus, Inal and Kizilkaya (2008) who compared a game group (*Quest Atlantis*) with traditional school learning on intrinsic and extrinsic motivation. They found some evidence that students in the game group were more intrinsically motivated, whereas students in the traditional school setting were more extrinsically motivated.

In short, no recent *convincing* evidence was found for the assumed motivational pull of serious games. Given the popularity of playing games among adolescents, it seems obvious that games are motivating. It is not clear to what extent this pertains to serious games. In *Quest Atlantis*, for example, Lim, Nonis and Hedberg (2006) reported that learners were less motivated than the researchers had expected. It is remarkable that characteristics of games such as immersion and interactivity that are considered motivating in entertainment games, refrained students in *Quest Atlantis* from full engagement in the learning task. This indicates that a better understanding is required about the underlying motivational processes in serious games. We will return to this issue in the Discussion section at the end of the chapter.

Communicative Learning Outcomes

In training communicative skills of cockpit crews (CRM training), Brannick, Prince and Salas (2005) compared the communication skills of trainees receiving CRM-simulator training with a group receiving group exercises and video games (*Asteroids*). The CRM-simulator group showed better communicative skills than the group with exercises and video games in an assessment task requiring the trainees to contact the air traffic controller (ATC) in order to obtain the information that was deliberately omitted by the ATC. However, these results were not confirmed in a similar study comparing a PC-based simulator and a control group (Nullmeyer et al., 2006), although a problem with this study was that it did not report what kind of training the control group received.

The impact of a game feature called the awareness tool was investigated in the game *SpaceMiners* where dyads have to collect minerals located in asteroids by launching drones and bring them to a space station. The players can use tools to manipulate the direction of the drone, but they have to negotiate where to position these tools in space. An awareness tool helps players to understand the activities of other players in the game. It appeared that pairs with an awareness tool outperformed pairs without an awareness tool in collecting minerals (Nova, Dillenbourg, Wehrle, Goslin & Bourquin, 2003). The game feature for level of immersion was investigated in the game *DOOM II* in which dyads had to collaborate in order to find their way through a virtual maze. It appeared that the quality of collaboration in the immersive (head-mounted display) and the nonimmersive (monitor) conditions was comparable, with the exception that the immersive group took more time to complete the task (Galimberti, Ignazi, Vercesi, & Riva, 2001).

Research investigating the effect of serious games on communicative skills is still undeveloped. Recently, massive multiplayer online games

(MMOGs) have become very popular. These MMOGs (e.g., World of Warcraft) are graphical 3D videogames allowing players, by means of self-created digital characters or ‘avatars’, to interact with the game world and with other players’ avatars as well. Research on interaction and collaboration in these games is very limited. There is some research on social interaction in these MMOGs, but these studies focus on the characteristics of game players (e.g., Seay, Jerome, Lee & Kraut, 2004). Hopefully, the increasing popularity of MMOGs will become an encouragement for more research into the impact of online gaming on communicative skills.

Discussion: Future Research Directions

It should be noted that the number of studies is too low to make definite conclusions. In order to substantiate the claims regarding the learning potential of serious games more research is required and, even more important, data and results have to be reported. We recommend five directions for follow-on research that may further advance learning with serious games.

1. Alignment of Game Type and Learning Outcome

First, the mixed results of this review pose the question whether the appropriate game design was selected for obtaining the specified learning outcome(s). As different game types can elicit very different cognitive and affective responses in the player (e.g., Ravaja et al., 2004), designers of serious games should carefully consider the implications of the game design on the possible learning outcomes. For this reason, we propose a framework that categorizes the games according to their level of cognitive and affective complexity (CALC). Most taxonomies that have been introduced (cf. Lindley, 2003; Björk, Lundgren,

& Holopainen, 2003) approach the categorization from a design standpoint. As our review approached the research from a user-centered viewpoint, namely the learning outcomes, we also propose a more user-centered framework for the categorization of games (Figure 2).

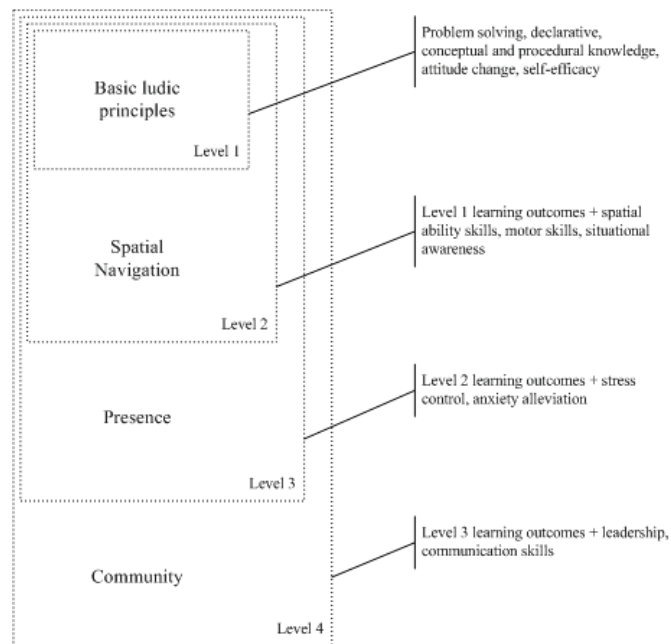
The scale we currently propose consists of four different *layers*, although in the future more differentiation is possible. Furthermore, a *level* of cognitive and affective complexity is defined as the corresponding layer together with the previous underlying layers. As increasing levels of complexity open up new possibilities for training while maintaining those of previous levels, the levels are said to work cumulatively in possible learning outcomes.

The first level comprises games that are textual or symbolic in outlook often with simple and explicit mechanics. In cognitive terms, players have to create a mental model of the game rules and consequences of the actions they perform. At this basic level, games can be used to train problem solving skills, decision making and teach verbal and conceptual knowledge.

The second level comprises games that are situated in a spatial environment. Here spatial dimensions have to be interpreted and the spatial interrelationships between different objects are thus added to the mental model constructed in the first layer. Some basic situational awareness can be trained with these kinds of games, for instance in assessing the distance and route to the nearest exit in case of fire, as well as hand-eye coordination and motor skills.

A layer on top of this is the presence layer, where players not only have to navigate a virtual world, but strongly feel that they are a person immersed in this world. This feeling of ‘presence’ opens up a range of affective responses that could be part of a training exercise, for example stress control or anxiety alleviation. Different presentation types generate different degrees of presence (Nunez & Blake, 2003), but First Person 3D games are probably best suited.

Figure.2..Cognitive.and.affective.level.of.complexity.(CALC)



Lastly, because the feeling of being in an environment opens up possibilities for social interactions with other beings inside the virtual world, and these virtual communities add to the complexity of the game, multiplayer or MMO games make up the top level on our cognitive and affective complexity scale. These games can be used to study and train a person's social skills in a group or large scale community setting.

As all taxonomies trying to cope with the highly diffuse area of games, it is not perfect; a 3D game with no social interaction may be more perceptually rich, and therefore cognitively demanding, than a text based multi-user dungeon. However, while tentative, we maintain that it can provide a guideline for choosing the right game design to achieve the desired learning goals; situational awareness may not transfer well when trained with a 2D game, while overly complex designs may compromise the learning outcomes that can also be achieved with simpler games.

2. The Role of Human Cognitive Architecture

The second recommendation pertains to the question how to (further) optimize the effectiveness of serious games. As this review has shown game features can be manipulated to improve the effectiveness of the serious game. In Table 2 an overview is presented of the game features that were discussed in four types of learning outcomes. It shows that the investigated instructional guidelines failed to increase the effectiveness of the serious game. In other cases the effectiveness was only increased for one type of learning outcome, but not for another learning outcome.

Playing a serious game is a complex task, even when an appropriate design was chosen for the intended learning outcomes: Players have to visually attend different locations on the screen, coordinate this with mouse or joystick movement, interpret verbal cues, and solve problems that occur during the game play. We contend that the effectiveness of a game feature is contingent on the ability of

designers to align the complexity of the serious game with the limitations of human processing capacity. From a cognitive theory perspective it can be argued that without support novice game players can easily become overwhelmed by all the information that has to be processed. For example, a relevant game task may limit the amount of irrelevant information that the player has to

process. In this way cognitive capacity can be effectively used for processing information that fosters learning from the serious game.

It would be interesting to see whether instructional guidelines that have been successful in learning from animations pertain to the design of serious games as well (cf. Wouters, Tabbers & Paas, 2007). Potential instructional guidelines

Table.2..Overview.of.results.by.game.feature.

Game feature	Description	Study	Results	Effect
Awareness tool	Helping player understanding activities of other players	Nova et al. (2003)	An awareness tool yields higher task performance than no awareness tool	+
Game task	A specific task or mission is involved or not	Virvou et al. (2005) Backlund et al. (2007)	The task/mission has a positive effect on knowledge or attitude	+
Game type	The specific game type that is involved (e.g., an action game or not)	Feng et al. (2007) Fischer et al. (2007) Beale et al. (2007)	Game type causes cognitive processes to occur or not	+
Instructional Guidelines				
Advice/Guidance	Advice or guidance with or without hints is offered	Leemkuil (2006) Nelson (2007)	Advice or guidance have no effect without additional support	–
Assignments	Extra assignments (tasks) are implemented or not	Leemkuil (2006)	Extra assignments have no effect	–
Interaction	Game allows choices of the player or not	Wong et al. (2007)	Interaction has no effect	–
Level of immersion	Effect of head-mounted display vs. monitor	Galimberti et al. (2001)	No effect, except immersion took more time for the task	+/-
Level of stress	A high or low level of stress is brought into the game	Morris et al. (2004)	The level of stress has a positive effect on cognitive skills, but no effect on knowledge	+/-
Relevance	The information is relevant or not for the game	Belanich et al. (2004)	Relevant information has a positive effect	+

Note: +. = .an.effect.(positive.or.negative).is.reported,.–. = .no.effect.is.reported,..

+/- = .results.are.inconclusive

that may reduce information overload in serious games include pacing (i.e., regulating the speed of information presentation), focusing attention and activating relevant domain knowledge (e.g., by providing knowledge gaps). The challenge for designers would be to implement these instructional guidelines without losing the power of attraction that games have.

The purpose of these guidelines is to enable learners to engage in cognitive processes that contribute to learning. However, little is known about the types of cognitive processes that occur during serious gaming. Therefore we recommend more research be carried out that extends the understanding of effective and ineffective cognitive processes in learning with serious games. For example, cognitive theories consider the use of trial-and-error methods in learning how to solve problems to generate ineffective cognitive processes. It would be valuable to see under which conditions such ineffective cognitive processes occur. One of these conditions, the game structure, was investigated by Pillay (2002) who observed that linear cause-and-effect oriented games yielded a trial-and-error problem solving behavior in the game, whereas adventure games encouraged more inferential and proactive thinking. Apart from the implication for cognitive processes, the Pillay study also emphasizes the importance of the structure of serious games.

3. The Role of Mitigating Factors

The third recommendation is related to the lack of understanding on factors that mitigate the effect of serious games on learning, and three factors in particular. The first factor pertains to the gender of learners. Some researchers have reported notable differences in results between male and female participants. For example, in the *River City* study Nelson (2007) found girls to be more effective in the use of guidance and Feng et al. (2007) reported that on spatial cognition female

students benefitted more from action games than male students.

The second factor concerns training time. If it is true that players immerse themselves in games and consequently spend more time on the task, then the question arises whether the higher performance can be ascribed to the extra time spent on the task in the game or to the characteristics of the games that support learning.

The last mediating factor to be discussed is age. One of the central findings in cognitive aging research is that the efficiency of working memory deteriorates with aging. This may be particular relevant for complex serious games. Elderly learners may have problems with discerning between relevant and irrelevant information in the game or their processing speed can not keep up with the progress in the game. Without instructional support, a serious game that may be effective for young learners may be ineffective for elderly learners.

4. Understanding Motivation(al) Processes

The fourth recommendation concerns the assumed motivational impact of games. Apart from theoretical accounts of game characteristics that motivate players to sustain playing a game, we also need a better understanding of the psychological mechanisms underlying these motivation processes. Of particular note for this type of study are those conducted by Ryan, Rigby and Przybylski (2006). Drawing from self-determination theory, they hypothesized that perceived autonomy (i.e., feeling uncontrolled when pursuing an activity) and competence (i.e., a need for challenge and feelings of effectance) would enhance motivation to play games. In the studies participants played games like *Super Mario 64*, *Zelda* and *A. Bugs Life*. The results showed that experiences of competence and autonomy while playing accounted for gaming motivation and enjoyment. Another promising avenue of research is the

relation between ‘flow’ and learning from serious games. Flow has been described as such an extent of involvement in a task that nothing else seems to matter (Garris et al., 2002). Although it is undeniable that players fully engage in popular games and forget the real world around them, it is still unclear how such full engagement relates to learning. With this focus research may begin to establish links between game features, motivational processes, and learning outcomes.

5. Assessment of Learning Outcomes

The final recommendation concerns the validity of the learning outcomes, that is, did the assessment test that was used really measure the learning outcome that was aimed at? Dede et al. (2005) demonstrated a better command of cognitive skills for a game group when measured with an evaluation letter to the mayor, but not with traditional test items. Most serious games are situated in specific contexts that may yield learning outcomes that are contextualized as well. Assessment methods that take the context of learning into account (e.g., an evaluation letter to the mayor) may reveal differences in performance that would be undisclosed with traditional assessment methods.

An additional argument for reconsidering the traditional assessment methods follows from the results of Belanich et al. (2004) who found that items with visual information were better recalled than written information. Video games are highly visual and may favor the acquisition of visually encoded knowledge. In that case visually-oriented assessment may reveal learning of knowledge that would probably not have been found with a text-based assessment method.

Another promising direction for assessment in serious games comes from a study by Day, Arthur and Gettman (2001) who measured the learning of complex skills with the game *Space Fortress* by assessing the knowledge structures that the players constructed. In knowledge structures the

information is mentally organized in concepts, the features that define them and the relationships between the concepts. It appeared that the degree of similarity between the knowledge structures of trainees and those of experts was correlated with complex skill acquisition and a good predictor of skill retention and transfer. Altogether, future research on the effectiveness of serious games should also consider other techniques to measure learning.

CONCLUSION

We gave an outline of the current practices in serious games research by reviewing 28 studies with empirical data from the perspective of learning outcomes. We discerned cognitive, motor skills, affective and communicative learning outcomes. In general, serious games seem to be effective when it comes to cognitive learning outcomes. Serious games for training motor skills and attitudinal change is promising. Finally, little recent substantiation was found for the effectiveness on motivation and communicative learning outcomes. With respect to the effectiveness of game features, especially, the implementation of the investigated instructional guidelines did not improve learning. Although the number of studies is too low to make definite conclusions, the review provides an indication of the current practices. We believe that serious games are promising, but that more research is required that should also consider the alignment of learning outcomes and game type, the limited cognitive capacity, specific mitigating factors (e.g., gender), motivational processes and new assessment methods.

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REFERENCES

- Backlund, P., Engström, H., Johannesson, M., & Lebram, M. (2007). Games and traffic safety – an experimental study in a game-based simulation environment. *Proceedings of the International Conference Information Visualization*, 11, 908–916.
- Baker, E. L., & Mayer, R. E. (1999). Computer-based assessment of problem solving. *Computers in Human Behavior*, 15, 269–282.
- Barab, S., Warren S., & Ingram-Goble, A. (2006, April). *Academic play space: Designing games for education*. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.
- Beale, I. L., Kato, P. M., Marin-Bowling, V. M., Guthrie, N., & Cole, S. W. (2007). Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer. *Journal of Adolescent Health*, 41, 263–270.
- Belanich, J., Sibley, D. E., & Orvis, K. L. (2004). *Instructional characteristics and motivational features of a PC-based game* (Research Report No. 1822). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Björk, S., Lundgren, S., & Holopainen, J. (2003). Game Design Patterns. In M. Copier and J. Raessens (Eds.), *Proceedings of the Level Up: Digital Games Research Conference*. Utrecht, The Netherlands.
- Bloom, B. (1956). *Taxonomy of educational objectives: The cognitive domain*. New York: Donald McKay.
- Bouchard, S., Côte, S., St-Jacques, J., Robillard, G., & Renaud, P. (2006). Effectiveness of virtual reality exposure in the treatment of arachnophobia using 3D games. *Technology and Health Care*, 14, 19–27.
- Brannick, M. T., Prince, C., & Salas, E. (2005). Can PC-based systems enhance teamwork in the cockpit? *The International Journal of Aviation Psychology*, 15, 173–187.
- Castel, A. D., Pratt, J., & Drummond, E. (2005). The effects of action video game experience on the time course of inhibition of return and the efficiency of visual search. *Acta Psychologica*, 119, 217–230.
- Day, E. A., Arthur Jr., W., & Gettman, D. (2001). Knowledge structures and the acquisition of a complex skill. *Journal of Applied Psychology*, 86, 1022–1033.
- Dede, C., Clarke, J., Ketelhut, D. J., Nelson, B., & Bowman, C. (2005, April). *Students' motivation and learning of science in a multi-user virtual environment*. Paper presented at the meeting of the American Educational Research Association, Montréal, Quebec.
- Enochsson, L., Isaksson, B., Tour, R., Kjellin, A., Hedman, L., Wredmark, T., & Tsai-Felländer, L. (2004). Visuospatial skills and computer game experience influence the performance of virtual endoscopy. *Journal of Gastrointestinal Surgery*, 8, 874–880.
- Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological Science*, 18, 850–855.
- Fischer, P., Kubitzki, J., Guter, S., & Frey, D. (2007). Virtual driving and risk taking: Do racing games increase risk-taking cognitions, affect, and behaviors? *Journal of Experimental Psychology: Applied*, 13, 22–31.

- Fletcher, J.D., & Tobias, S. (2008). *What research has to say (thus far) about designing computer games for learning*. Paper presented at the American Educational Research Association, New York, NY.
- Gagné, R. M. (1977). *The conditions of learning*. New York: Holt, Rinehart & Winston.
- Galimberti, C., Ignazi, S., Vercesi, P., & Riva, G. (2001). Communication and cooperation in networked environments: An Experimental Analysis. *CyberPsychology & Behavior*, 4, 131–146.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33, 441–467.
- Grantcharov, T. P., Bardram, L., Funch-Jensen, P., & Rosenberg, J. (2003). Impact of hand dominance, gender, and experience with computer games on performance in virtual reality laparoscopy. *Surgical Endoscopy*, 17, 1082–1085.
- Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, 423, 534–537.
- Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology: Human Perception and Performance*, 32, 1465–1478.
- Ke, F., & Grabowski, B. (2007). Gameplay for maths learning: cooperative or not? *British Journal of Educational Technology*, 38, 249–259.
- Kirriemuir, J., & McFarlane, A. (2004). Literature review in games and learning (Futurelab Series Report 8). Retrieved March 17, 2008 from Futurelab Website http://www.nestafuturelab.org/research/reviews/08_01.htm.
- Kraiger, K., Ford, J. K., & Salas, E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology*, 78, 311–328.
- Krathwohl, D. R., Bloom, B. S., & Masia, B. B. (1964). *Taxonomy of educational objectives: The classification of educational goals*. White Plains, NY: Longman.
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior*, 19, 335–353.
- Leemkuil, H. (2006). *Is it all in the game? Learner support in an educational knowledge management simulation game*. Unpublished doctoral thesis. University of Twente, Enschede, The Netherlands.
- Leemkuil, H., de Jong, T., & Ootes, S. (2000). *Review of educational use of games and simulations* (IST-1999-13078 Deliverable D1). University of Twente, Enschede, The Netherlands.
- Lim, C. P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multiuser virtual environment: engaging students in Science lessons. *British Journal of Educational Technology*, 37, 211–231.
- Lindley, C.A. (2003). *Game Taxonomies: A High Level Framework for Game Analysis and Design*. Retrieved March 17, 2008 from Gamasutra Website. http://www.gamasutra.com/features/20031003/lindley_01.shtml.
- Lindley, C.A. (2004). Narrative, game play, and alternative time structures for virtual environments. In S. Göbel, U. Spierling, A. Hoffman, I. Iurgel, O. Schneider, J. Dechau & A. Feix (Eds.), *Lecture Notes in Computer Science: Vol. 3105. Technologies for Interactive Digital Storytelling and Entertainment*. (pp. 183–194). Heidelberg: Springer Berlin.
- Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 4, 333–369.

- Michael, D., & Chen, S. (2006). *Serious.games.: Games.that.educate,.train,.and.inform..* Boston, MA.: Thomson Course Technology.
- Morris, C. S., Hancock, P. A., & Shirkey, E. C. (2004). Motivational effects of adding context relevant stress in PC-based game training. *Military. Psychology*, *16*, 135–147.
- Nelson, B. C. (2007). Exploring the use of individualized reflective guidance in an educational multiuser virtual environment. *Journal.of.Science. Education.and.Technology*, *16*, 83–97.
- Nova, N., Dillenbourg, P., Wehrle, T., Goslin, J., & Bourquin, Y. (2003). The impacts of awareness tools on mutual modelling in a collaborative video-game. In J. Favela & D. Decouchant (Eds.), *Lecture.Notes.in.Computer.Science:.Vol...2806.. Groupware.Design,Implementation,and.Use* (pp. 99–108). Heidelberg: Springer Berlin.
- Nullmeyer, R. T., Spiker, V. A., Golas, K. C., Logan R. C., & Clemons, L. (2006, December). *The effectiveness.of.a.PC.based.C-130.crew.resource. management.aircrew.device*. Paper presented at the meeting of the Interservice/Industry training, simulation, and Education Conference, Orlando, FL.
- Nunez, D. & Blake, E. (2003). A direct comparison of presence levels in text-based and graphics-based virtual environments. *Proceedings. of. the. 2nd. international.Conference.on.Computer.Graphics,. Virtual.Reality,. Visualisation.and.Interaction.in. Africa*, 53-56.
- O'Brien, K. S., & O'Hare, D. (2007). Situational awareness ability and cognitive skills training in a complex real-world task. *Ergonomics*, *50*, 1064–1091.
- O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: Evidence from the computer games literature. *The. Curriculum.Journal*, *16*, 455–474.
- Parchman, S. W., Ellis, J. A., Christinaz, D., & Vogel, M. (2000). An evaluation of three computer-based instructional strategies in basic electricity and electronics training. *Military. Psychology*, *12*, 73–87.
- Pillay, H. (2002). An investigation of cognitive processes engaged in by recreational computer game players: Implications for skills of the future. *Journal.of.Research.on.Technology.in. Education*, *34*, 336–350.
- Prensky, M. (2001). *Digital.Game-Based.Learning*. New York: McGraw-Hill.
- Ravaja, N., Salminen, M., Holopainen, J., Saari, T., Laarni, J., & Järvinen, A. (2004). Emotional response patterns and sense of presence during video games: Potential criterion variables for game design. *Proceedings.of.the.Third.Nordic. Conference. on. Human-Computer. interaction*, 339–347.
- Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation. and.Emotion*, *30*, 347–363.
- Rosenberg, B. H., Landsittel, D., & Averch, T. D. (2005). Can video games be used to predict or improve laparoscopic skills? *Journal.of.Endourology*, *19*, 372–376.
- Rosser, J. C., Lynch, P. J., Cuddihy, L., Gentile, D. A., Klonsky, J., & Merrell, R. (2007). The impact of video games on training surgeons in the 21st century. *Archives.of.Surgery*, *142*, 181–186.
- Satyen, L., & Ohtsuka, K. (2001). Strategies to develop divided attention skills through video game training. In D. Harris (Ed.), *Engineering. psychology. and. cognitive. ergonomics*, *6*, 191 – 199. Aldershot, UK: Ashgate.
- Seay, A. F., Jerome, W. J., Lee, K. S., & Kraut, R. E. (2004). *Project.massive:.A.study.of.online. gaming.communities*. Extended abstracts of the

- Conference on Human Factors in Computing Systems (pp. 1421-1424), Vienna, Austria.
- Squire, K., Barnett, B., Grant, J. M., & Higginbotham, T. (2004). Electromagnetism Supercharged! Learning physics with digital simulation games. *Proceedings of the international conference on Learning sciences*, 6, 513–520.
- Tuzun, H., Yilmaz Soylu, M., Karakus, T., Inal Y., & Kizilkaya, G. (2008, March). *The effects of computer games on primary school students' achievements and motivation in geography learning*. Paper presented at the meeting of the American Educational Research Association, New York, New York.
- Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational Technology & Society*, 8(2), 54–65.
- Vogel, J. J., Vogel, D.S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. *Journal of Educational Computing Research*, 34, 229–243.
- Walshe, D. G., Lewis, E. J., Kim, S. I., O'Sullivan, K., & Wiederhold, B. K. (2003). Exploring the use of computer games and virtual reality in exposure therapy for fear of driving following a motor vehicle accident. *CyberPsychology & Behavior*, 6, 329–334.
- Waxberg, S. L., Schwaitzberg, S. D., & Cao, C. G. L. (2005). Effects of videogame experience on laparoscopic skill acquisition. *Proceedings of the Human Factors and Ergonomics Society*, 49, 1047–1051.
- Wong, W. L., Shen, C., Nocera, L., Carriazo, E., Tang, F., Bugga, S., & Narayanan, H. (2007). Serious video game effectiveness. *Proceedings of the international conference on Advances in computer entertainment technology*, 49–55.
- Wouters, P., Tabbers, H. K., & Paas, F. (2007). Interactivity in video-based models. *Educational Psychology Review*, 27, 327–342.

Chapter XV

Towards the Development of a Games–Based Learning Evaluation Framework

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ABSTRACT

The field of games-based learning (GBL) has a dearth of empirical evidence supporting the validity of the approach (Connolly, Stansfield, & Hainey, 2007a; de Freitas, 2006). One primary reason for this is a distinct lack of frameworks for GBL evaluation. The literature has a wealth of articles suggesting ways that GBL can be evaluated against particular criteria with various experimental designs and analytical techniques. Based on a review of existing frameworks applicable to GBL and an extensive literature search to identify measurements that have been taken in relevant studies, this chapter will provide general guidelines to focus researchers on particular categories of evaluation, individual measurements, experimental designs and texts in the literature that have some form of empirical evidence or framework relevant to researchers evaluating GBL environments particularly focusing on learner performance. A new evaluation framework will be presented based on the compilation of all the particular areas and analytical measurements found in the literature.

INTRODUCTION

One of the primary concerns associated with the GBL literature is the dearth of empirical evidence supporting the validity of the approach (Connolly, Stansfield, & Hainey, 2007a; de Freitas, 2006). O'Neil *et.al.* (2005) believe that an essential element missing is the ability to properly evaluate games for education and training purposes. If games are not properly evaluated and concrete empirical evidence is not obtained in individual learning scenarios that can produce generalisable results, then the potential of games in learning can always be dismissed as unsubstantiated optimism. In the O'Neil study, a large amount of literature was collected and analysed from the PsycINFO, EducationAbs, and SocialSciAbs information systems. Out of several thousand articles, 19 met the specified criteria for inclusion and had some kind of empirical information that was either qualitative, quantitative or both. The literature was then viewed through Kirkpatrick's four levels for evaluating training and the augmented CRESST model. The majority of the studies reviewed analysed performance on game measurements. Other studies included observation of military tactics used, observation, time to complete the game, transfer test of position location, flight performance and a variety of questionnaires including exit, stress and motivation questionnaires.

The review of empirical evidence on the benefit of games and simulations for educational purposes is a recurring theme in the literature and can be traced even further back. For example, Randel, Morris, Wetzel, and Whitehill (1992) examined 68 studies from 1963 comparing simulations/games approaches and conventional instruction in direct relation to student performance. Some of the following main discoveries were made:

- 38 (56%) of the studies found no difference; 22 (32%) of the studies found a difference that favoured simulations/games; 5 (7%) of studies favoured simulations/games

however control was questionable; 3 (5%) found differences that favoured conventional instruction.

- With regards to retention simulations/games induced greater retention over time than conventional techniques.
- With regards to interest, out of 14 (21%) studies, 12 (86%) showed a greater interest in games and simulations over conventional approaches.

Although lack of empirical evidence supporting GBL is not a new issue, the growing popularity of computer games in conjunction with recent advances in games and hardware technology, the emergence of virtual worlds and massively multiplayer online games (MMOGs), reinforces the need for a flexible evaluation framework that can be used by Evaluation researchers. This chapter presents such an evaluation framework.

In the next section, we examine previous research and, in particular, discuss the types of evaluation that can be used and their applicability and importance in the field of GBL. We also examine previous evaluation frameworks that have been presented in the literature that could be applicable to GBL and follow that with the results of an extensive literature review to identify studies that performed some form of evaluation and attempted to take appropriate measurements through various experimental designs particularly focusing on learner performance. On the basis of these reviews, we then present a flexible framework for GBL evaluation from a pedagogical perspective. In the final section we discuss future validation of the new framework.

PREVIOUS RESEARCH

Evaluation

Ainsworth (2003) divides evaluation into two main types: evaluation to inform design encompassing

cognitive walkthrough, heuristic evaluation and formative evaluation and evaluation to assess an end product or determine the best use for that product, encompassing summative evaluation. As we discuss shortly, we found very few academic articles in the GBL literature that actually addressed formative evaluation and even less that addressed summative evaluation. According to Ainsworth the most important general questions of evaluation are:

- What is to be done with the information collected?
- What are the appropriate forms of measurement?
- What is the most appropriate experimental design?
- What is an appropriate form of comparison?
- What is an appropriate context?

Formative Evaluation

Ogle (2002) states that formative evaluation is “*a systematic and empirical process although rarely a scientific one*”. Citing Tessmer (1993), Ogle highlights that instructional designers generally carry out formative evaluations as they have intimate knowledge of the material and are also the most qualified to put comments made to productive use. One advantage of formative evaluation is that it also allows evaluation of the instruments of evaluation. For example, evaluation of a prototype GBL application may be performed a number of times in different contexts and learners can assist in highlighting any ambiguity or weaknesses in the instruments of evaluation, such as ambiguous questions in a questionnaire. This allows the experiment to be revised and improved each time to gather more productive results. There are several variations of formative evaluation, however the main ones are as follows:

- *Expert.Reviews* – Conducted very early on in the evaluation process and is particularly focused on instructional content, technical quality or accuracy. The primary goal is to get expert reviewers to highlight things that are not right and offer correctional advice.
- *One-To-One.Evaluations* – Designed for the developer to work with a number of potential learners from the intended user base, primarily to assess the learners’ reaction to content and assess particular indicators of performance. Discussion techniques and questions should be used at this stage to obtain information.
- *Small. Group. Evaluations* – Conducted using small groups in which the instructor interacts with the learners in the same type of environmental context as the intervention will be used. The main goal is to refine the instruction by the collection of descriptive and quantitative feedback.
- *Field.trials.* – Also known as field-tests or beta tests, field trials are designed to see if the changes made from the small group evaluation were effective and whether the intervention can be used in the intended context. It consists of the instructor acting as an observer while the intervention is used with a larger group (e.g. 20 - 40 learners) in a “*situated.evaluation*”.

Braden (1992) believes that a primary weakness of instructional design models is that a formative evaluation is performed at the end, if at all, and should be performed during the entire process and be consistently iterative.

Summative Evaluation

Ainsworth (2003) points out that the aim of summative evaluation is to assess an end product and as a result this type of evaluation is usually performed by external evaluators. The two main types of summative evaluation identified by

Harpel (1978) are: research-oriented and management-oriented. Research-oriented summative evaluations are to validate and improve programs. Management-oriented summative evaluations are to assess cost and whether the programs did what they were supposed to do.

Problems Evaluating GBL

Dondi and Moretti (2007) identify two general and very important issues associated with evaluation of GBL:

- Producing a general framework of evaluation is difficult unless it is abstract. This is primarily because the evaluation processes are inextricably linked to the main goal of the evaluation, which leads to the question of “what exactly is being evaluated about the GBL intervention?”
- It is difficult to distinguish between single aspects of the GBL environment and holistic aspects related to “*the processes of analytical measurement/evaluation*”. If the evaluation is more holistic and attempts to take everything into account then it is more likely that the evaluation will be general, not particularly detailed or rigorous, leading to other methods being required to establish quality standards. If the evaluation is based on single aspects then the holistic view of the GBL intervention cannot be taken into account. To overcome this problem it is clear that prioritization of particular evaluation areas is required, which leads to the question of “what is the most important objective that the GBL intervention must achieve?”

Approaching the concept of evaluation of GBL from a pedagogical perspective assists in refining the process. The literature review presented shortly shows that there is no general method of evaluation for GBL or simulations. When evaluation does take place the most common

method appears to be surveying the participants and certainly the majority of GBL evaluations encountered in the research literature has some form of survey as an evaluation instrument. The largest disadvantage of this is that surveys are sensitive to weak methodological design and can be influenced by particular wording and exogenous factors (Saari, Johnson, McLaughlin, & Zimmerle, 1988).

Previous Evaluation Frameworks and Models

When developing an evaluation framework for GBL, it seems logical to design the framework from a pedagogical perspective as the entire ideology of GBL is using games/simulations to motivate and engage learners, resulting in more effective learning even at a supplementary level. There are very few evaluation frameworks in the literature that specifically address the effectiveness of GBL from this perspective and ask questions such as: Does the GBL environment increase knowledge acquisition? Does it improve learner performance? Does it assist in the formation of metacognitive strategies? The majority of available frameworks are focused on either e-Learning or commercial games such as World of Warcraft.

Two examples of these frameworks are based on Nielsen's Heuristic Evaluation developed in 1990 (Nielsen & Molich, 1990). Heuristic Evaluation consists of ten recommended heuristics and is supposed to be performed by a small team of evaluators. It is a Human Computer Interaction (HCI) technique that focuses on finding interface usability problems and has been extended with additional heuristics to encompass website specific criteria. The technique has also been expanded and developed to produce a framework for web-based learning (Ssemugabi & de Villiers, 2007) and a framework for heuristic evaluation of Massively Multi-player On-Line Role Playing Games (MMORPGs) (Song & Lee, 2007). One of the main difficulties associated with frameworks

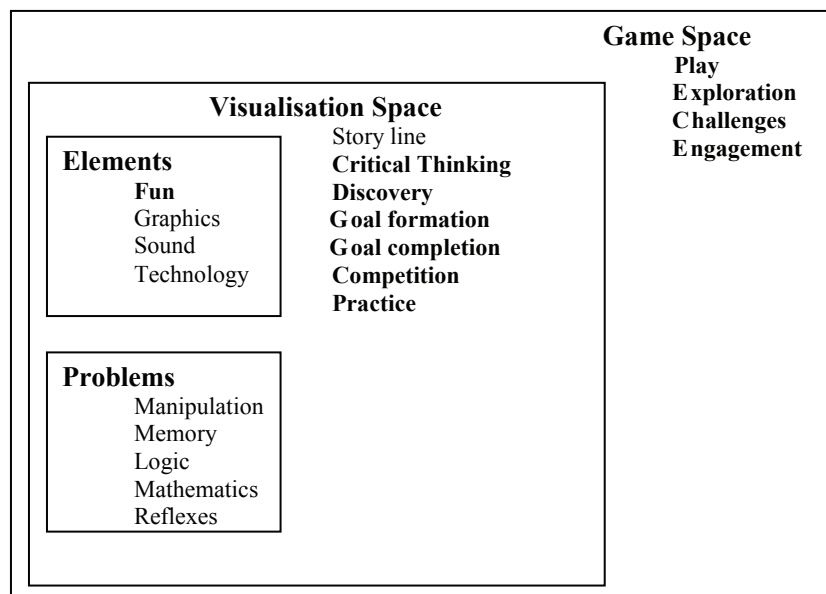
developed from Heuristic Evaluation is that the quality of a Heuristic Evaluation is dependent on the knowledge of the expert reviewer. By extending frameworks to encompass web-based learning and MMORPGs, suitable reviewers would have to have sufficient knowledge of HCI and games to perform a high-quality evaluation. In addition, from a GBL perspective the main difficulty is that these frameworks do not specifically focus on pedagogy.

Tan, Ling, and Ting.(2007) reviewed four GBL frameworks and models including: the design framework for edutainment environments, the adopted interaction cycle for games, the engaging multimedia design model for children and the game object model. According to their results one framework significantly addressed pedagogy and game design: the game object model developed to allow identification of suitable game elements to be supported by valid pedagogical elements (Amory, Naicker, Vincent, & Adams,. 1999). The game object model (GOM) has been further developed using theoretical constructs and developments in the literature to become the game object model version II framework (GOM II) (Amory, 2006).

This particular framework can be used from both a game design perspective and an evaluation perspective. The original GOM (Figure 1) has several spaces:

- *Game.Space* – Embodies all of the components. Components are represented by a square and contain different discrete interfaces that can be either abstract or concrete. The interfaces are displayed within the component. The components are either free standing or part of other components. The inner components inherit all of the outer components interfaces and inner components interfaces are concrete where as the outer components interfaces are more abstract. The interfaces have been listed in this model from the most important to the least important. The game space component encompasses all of the other components and has the following interfaces: play, exploration, challenges and engagement.
- *Visualisation.Space* – This component encompasses the elements and problems components and has the following interfaces:

Figure.1..Adapted.from.the.game.object.model.(GOM).(1999)



story line, critical thinking, discovery, goal formation, goal completion, competition and practice.

- *Elements* – This component has the following interfaces: fun, graphics, sound and technology.
- *Problems* – This component has the following interfaces: manipulation, memory, logic, mathematics and reflexes.
- *Abstract.interfaces* – Promote educational objectives and appear in the diagram in bold. They are the following: fun, critical thinking, discovery, goal formation, goal completion, competition, practise, play, exploration, challenges, and engagement.
- *Concrete.interfaces* – Enable the realization of the educational objectives. They are the following: graphics, sound, technology, manipulation, memory, logic, mathematics, reflexes and story line.

The GOM II is divided up into several inter-related interfaces and consists of a number of complex objects developed from contemporary practices and educational theories. The GOM II is a far richer model and one of the main developments is the introduction of a new *social.space* to support the development of on-line communities. The study describes the model as an “*idiosyncratic,. homological,. inclusive. ideology. and. represents. one. of. many. ways. of. seeing. educational. computer. game. development. . Therefore. the. model. should. be. viewed. as. a. means. of. structuring. discussions. and. could. easily. be. reconceived. to. suit. different. ,. or. alternative. viewpoints. .*”

Kirkpatrick’s four level framework (1994) (Figure 2), takes pedagogy into account. It was originally developed in 1994 as a framework for evaluating training but it has also been proposed for the evaluation of business simulations as educational tools (Schumann, Anderson, Scott, & Lawton, 2001).

The CRESST model of learning (Figure 3) is composed of five families of cognitive demands

and can be used in a motivational learning view for the evaluation of games and simulations (Baker & Mayer, 1999). Each family in the CRESST model is composed of a task that can be used as a skeletal design for testing and instruction. The CRESST model is divided into content specific and content independent variables. Content specific variables include: content understanding and problem solving. Content independent variables include: collaboration/teamwork, communication and self-regulation.

Dondi and Moretti (2007) reviewed Uni-Game (Games-based Learning for Universities and Life Long Learning) and SIG-Glue (Special Interest Group for Game-based Learning in Universities and Lifelong Learning), two projects funded by the European Commission. This led to the development of a ‘classification of games by learning purposes’ and an ‘evaluation framework for assessing games’. The evaluation framework takes into account that “*a. learning. game. should. be. a. ‘good. game’. through. which. the. player. will. achieve. the. stated. learning. objectives*” and covers both pedagogical and technical criteria (Table 1). A reduced version is provided to give an illustration of the content with a focus on the pedagogy, context and evaluation criteria sections:

A further framework specifically for games and simulations that addresses pedagogy is the Four Dimensional Framework (FDF) (de Freitas & Oliver, 2006). The FDF is “*designed. to. aid. tutors. selecting. and. using. games. in. their. practice. . The. framework. includes: context, learner specification, , pedagogy. used. and. representation. as. four. key. aspects. for. selecting. the. correct. game. for. use. in. learning. practice*” (de Freitas, 2006). The FDF is displayed in Figure 4. The four dimensions are not designed to be considered in isolation but all dimensions should be considered as a collective whole. The first dimension of the FDF focuses on context with macro-level factors such as political, economic and historical and micro-level factors such as specific tool, resources and general availability. Context is a highly important factor that

Figure.2..Adapted.from.Kirkpatrick's.four.levels.for.evaluating.training.(1994)

Level 1: REACTION	This level assesses how learners feel about participation in a learning experience. It is an evaluation of learner satisfaction measuring “ <i>how.those.participating.in.the.program.react.to.it</i> ”. Kirkpatrick highlights that positive reaction to a training program does not necessarily indicate or ensure that learning will take place, however a negative reaction will almost certainly lead to learning not taking place. General methods of collecting learner reaction data are, for example, satisfaction questionnaires.
Level 2: LEARNING	Kirkpatrick describes this level as “ <i>the.extent.to.which.participants.change.attitudes,.improve.knowledge,.and/or.increase.skill.as.a.result.of.attending.the.program</i> ”. Learning is measured by quantifying the differences in attitudes, increase in knowledge and the increase in skills. The measurements are typically taken within the context of a training session as dictated by the learning outcomes. Campbell and Stanley (1963) note that the best experimental methodology for establishing whether learning has taken place is a pre-test, post-test, experimental, control group methodology.
Level 3: BEHAVIOUR	This level assesses whether the learners are actually applying what they have learned within the training session in their working environment. Kirkpatrick (1998) describes behaviour as “ <i>the.degree.to.which.learners.have.changed.their.behaviour.outside.of.the.learning.environment.because.of.their.participation.in.the.learning.activities</i> ”. Behaviour can be measured by surveying individuals who have the opportunity to observe the behaviour of the learners in different settings to rate the extent to which the attitudes, knowledge and skills are utilized.
Level 4: RESULTS	This level measures the final benefits to the company. Kirkpatrick defines it as “ <i>final.results.that.occurred.because.the.participant.attended.the.program</i> ”. The final results can be in relation to a number of attributes such as increased profit, increased turnover, decrease in number and severity of accidents.

Figure.3..Adapted.from.Baker.and.Mayer's.CRESST.model.of.learning:families.of.cognitive.demands.(1999)

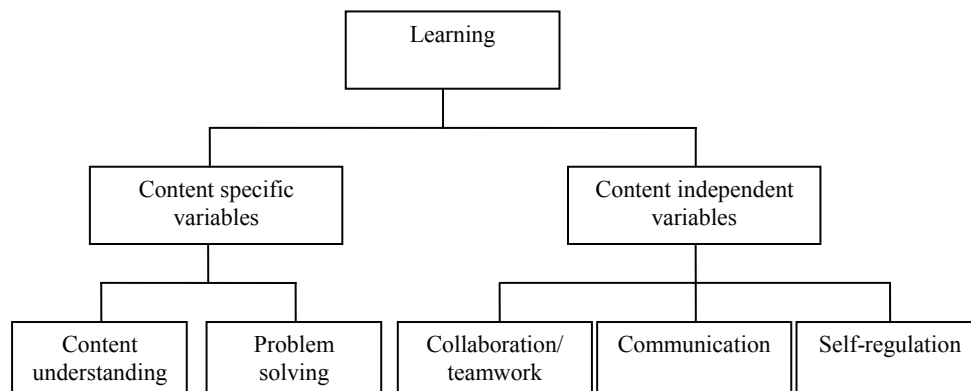


Table.1..SIG-Glue.quality.criteria.framework

Target groups and prerequisites identification
Learning objectives
Clearly defined objectives
Correspondence of established objectives and objectives that can be reached using the game
Context of usage
Clear instructions
Context suggestions
Coherence with the targeted context
Didactic strategy
Indications of average play time
Incentives and support to motivation
...
Coherence of the social and collaborative activity with objectives
Communication and media
Clear, user-friendly tone and language
Quality of the interaction
Coherence between media used and established objectives of target group
Evaluation
Clear identification of evaluation criteria and procedures
Adequate number and distribution of evaluation activity, during the game and at the end
Type of evaluation activity proposed
Quality of the feedback of the evaluation
Relevance of evaluation activity and consistency with the objectives and/or the contents
Supporting the reflective process

can enable or impede learning depending on difficulty of delivery. The second dimension of the FDF focuses on particular learner or learner group attributes such as learner level, learning styles, preferences, background and age. Research has indicated that different game types can be used to acquire or learn different skills; for example simulations are good for teaching tactical and strategic planning (Dempsey, Haynes, Lucassen, & Casey, 2002). The third dimension of the FDF focuses on the “*internal.representational.world. or. diegesis. –. of. the. game. or. simulation*” and covers immersion and fidelity, presentation mode and the interactivity. de Freitas and Oliver (2006) emphasise that this is a particularly important dimension of the framework as it highlights the distinction between immersion in the game and the critical reflection process that takes place out with the game. The fourth dimension of the FDF focuses on the learning processes during informal and formal curricula based learning. It is designed to promote reflection of the practitioners in terms

of frameworks, models, methods and theories used to support learning practice. The dimension supports differentiated learning provided by the availability of e-Content, e-Assessment and new software tools by considering how learning content is personalised and embedded.

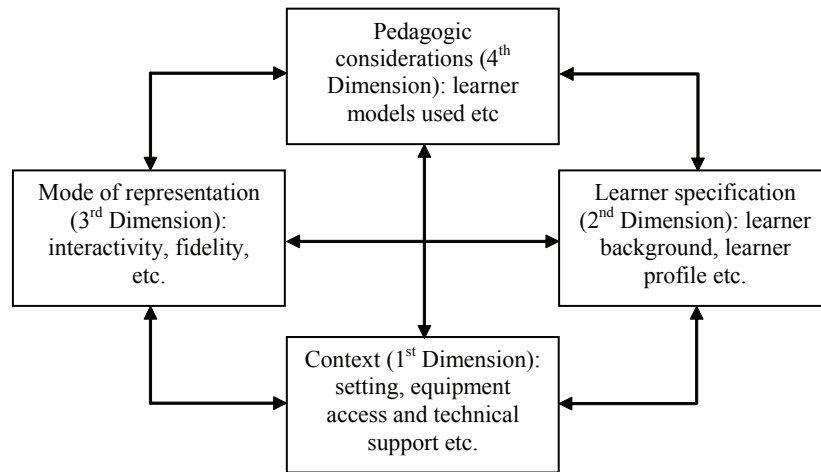
Literature Search

This section presents the literature search that was carried out in the Summer of 2008 to identify previous evaluation approaches for games-based learning.

Method Used to Collect Data

An extensive literature search was performed by reviewing various electronic databases including: ACM, ABIINFORM Global Database, Academic Search Premier, ScienceDirect, Blackwell Synergy, EBSCO (consisting of Psychology and

Figure.4..Adapted from the four dimensional framework. (de.Freitas.&.Oliver.2006)



Behavioural Science, PsycINFO, SocINDEX, Library, Information Science and Technology Abstracts, CINAHL), ERIC, IngentaConnect, Infotrac (Expanded Academic ASAP) and Emerald. All relevant Simulation & Gaming journal papers from 1996 were also extracted and assimilated into the final results. The following detailed search terms were used:

("computer.games".OR."video.games".OR."serious.games".OR."simulation.games".OR."games-based.learning".OR."MMOG".OR."MMORPG".OR."MUD".OR."online.games").AND.("education".OR."learning").AND."evaluation".

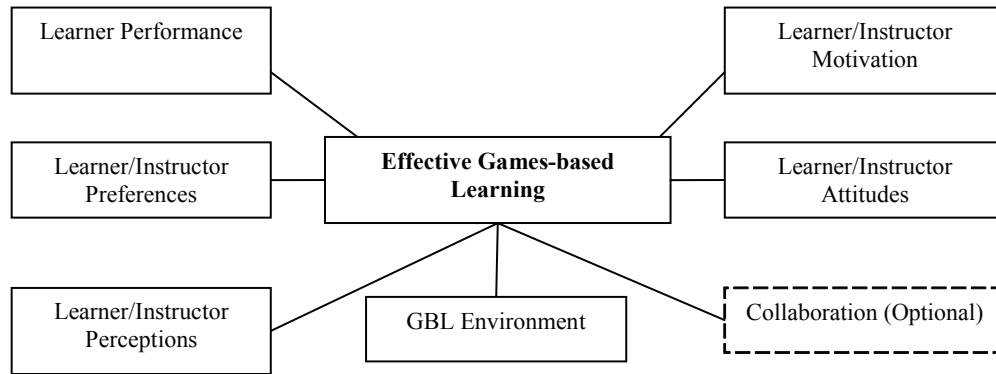
Approximately 10,000 articles were returned, but only 77 were considered appropriate to our primary research criteria, namely evaluation frameworks and evaluation of games-based learning. The literature search results have helped identify particular measurements existing in the literature and have been instrumental in constructing the GBL evaluation framework presented in the next section.

Towards an Evaluation Framework for GBL

This section presents a compiled evaluation framework for GBL based on the key measurements we identified in the literature search. The previous frameworks reviewed were highly instrumental in attempting to make sure there were no omissions and also assisted in the categorisation process. The only direct similarity is the concept that the categories do not necessarily have to be considered in isolation like the FDF. The highest abstraction of the framework is displayed in Figure 5.

The purpose of the framework is to identify what can potentially be evaluated in a GBL application. The literature review identified existing frameworks of evaluation and the particular attributes that researchers have attempted to measure during a GBL environment or simulation intervention. Drawing on the frameworks in the existing literature and particular identified measurements, GBL can be evaluated in terms of learner performance, learner/academic motivation, learner/academic perceptions, learner/academic preferences, the GBL environment itself

Figure.5...Evaluation.framework.for.effective.games-based.learning



and collaboration between players where appropriate. Like the Four Dimensional Framework (de Freitas & Oliver, 2006) presented earlier, the categories do not necessarily have to be viewed in isolation but as a collective whole depending on what is to be evaluated. This is the greatest direct similarity between the new framework and frameworks identified above. The framework can be used in both a developmental sense to inform design during the implementation and embedding of a GBL application into curricula in a formative evaluation sense and also points to examples of individual analytical measurements already present in the literature for focusing on an evaluation at the end of development in a summative evaluation sense.

Learner Performance

This category encompasses pedagogy from the perspective of the learner and evaluates aspects of learner performance. Considering that a GBL intervention can be used in both educational institutions and industrial settings the word ‘learner’ is meant to encompass the two settings or indeed any setting in general. The category is primarily concerned with whether there is an improvement in the performance of the learner as a result of the intervention. The improvements are of course inextricably connected to the learning outcomes

of the GBL intervention and can be: improvement in knowledge acquisition (procedural, declarative, general), the formation of metacognitive strategies, and improvement in the formation of skills etc.

Learner/Instructor Motivation

This category is primarily concerned with the particular motivations of the learner for using the intervention, the learner level of interest in participating in the intervention, participation over a prolonged period of time and determining what particular motivations are the most important (Connolly, Boyle, & Hainey, 2006; Connolly, Boyle, & Hainey, 2007b). Are the learners participating extrinsically or intrinsically (Deci & Ryan, 1991)? What particular features of the GBL environment or simulation are the most interesting? Are the learners distracted in anyway? Are the learners willing to use the GBL environment or simulation more than once? When considering Kirkpatrick’s four levels for evaluating the effectiveness of business simulations in particular curricula it is important to identify the motivations that not only apply to the learner but also to the instructor. Therefore, it may be important to identify what motivates the instructors to attempt to assimilate a GBL approach into their curricula.

Learner/Instructor Perceptions

This category mainly encompasses perceptions associated with the learners such as their perception of the overview of time within a game or simulation, how real the game is and its correspondence with reality, for example whether the GBL intervention represents a holistic view of a particular organisation or process, perception of game complexity, advice quality and level of self reported proficiency at playing games. The category also encompasses the learners' perception of how the GBL intervention can assist them and whether confusion is experienced. The instructor would also have similar perceptions depending on their particular involvement. If the instructor was simply incorporating content into the GBL intervention or simulation then their perceptions may be more important in terms of whether the intervention is fitting well into the particular context. Perceptions are once again extremely dependent on the learning outcomes and what particular perceptions are considered important in the evaluation criteria.

Learner/Instructor Attitudes

This category is mainly concerned with learner and instructor attitudes towards various elements that may alter the effectiveness of the GBL intervention. These elements include: learner attitudes towards the taught subject, learner attitudes towards games (Connolly, Boyle, & Hailey, 2007b), instructor attitudes towards the incorporation of games into the curricula, learner attitudes towards particular game elements such as likeability, sounds, colours, interface, feedback usefulness for learning the subject area and accomplishing the learning outcomes. Attitudes may have to be collected as negative attitudes towards games and the subject area may substantially reduce effective GBL. It may also be the case that an intervention may alter the attitudes towards

games and the subject so attitude data could be collected afterwards.

Learner/Instructor Preferences

This category considers learner and instructor preferences during a GBL intervention. Learners like to learn in different ways and have different learning styles (Kolb, 1984) therefore different learners will have different preferences. This category could include: learner preference for media when teaching the material, preference of conventional or GBL training, preference and utilization of particular game features, most preferred positive and negative aspects of the game and preference for different competitive modes (Yu, Chang, Luit, & Chan, 2002). For an instructor, this category could include when to introduce the GBL intervention in their particular course or whether they prefer to teach with the GBL intervention.

Collaboration

The GBL evaluation framework is designed to be a set of general guidelines for conducting an evaluation of a GBL intervention. The framework has a particular emphasis on pedagogy, as learning is the most important goal. The framework can be customised to particular requirements that are generally optional depending on what particular analytical measurement is necessary to be indicative of effective GBL. Collaboration is optional depending on whether the game is played on an individual level, cooperative group level, competitive group level or multiple cooperative groups competing against each other. It may very well be the case that collaboration does not require evaluation. If collaboration is to be evaluated, the main ways are through achievement of learning outcomes or particular goals, log files monitoring interaction, mapping team aspects to learner comments, measuring the regularity and

level of collaboration and learner group reflection essays.

GBL Environment

This category encompasses all aspects that could potentially be evaluated about the GBL environment. It is the most complicated of all categories as it can be divided into the following five identified subcategories from the literature: virtual environment, scaffolding, usability, level of social presence and deployment. In terms of the actual virtual environment itself the evaluation criteria may be the following: validating the background environment and characters including virtual agent expressiveness (Dugdale, Pallamin, & Pavard, 2006), evaluation of factors with regards to environmental alteration, advice importance within the environment, the context of the environment in terms of real-world decision making support and general game difficulty.

Scaffolding refers to the advice and resources within the environment to support the learner in completing their learning outcomes. Scaffolding can be evaluated through monitoring of appropriate realism, feedback, learner perception of the quality of advice, an expert review of the quality of advice and monitoring of the utilisation of resources and advice. Usability can be analysed by looking at particular task completion times, average task completion times, the ease of the task, the number of errors made while performing a task and the ranking of the tasks by the learners.

Usability can also be evaluated through conversation analysis, correlation of the learner demographics to the susceptibility of the problem that is to be overcome by the GBL intervention. In particular relation to developing a GBL intervention, player reactions to initial and incremental prototypes in an iterative fashion may be monitored to evaluate increased and decreased usability aspects. Level of social presence is to do with the immersion and interaction in the game world. It can be monitored by looking at

relationship frequencies, player evaluation of game character personalities, attitude and mood statements towards characters and events in the game indicating a social presence.

Deployment is intended to encompass the most effective method of incorporation of the GBL application into the educational context and can also mean the preference of different gaming conditions; i.e. particular format of delivery in a technical sense and also with regards to embedding the GBL environment into the curriculum.

Measurements Encountered Specifically Associated with the Learner Performance Category

Each category in the evaluation framework can be extended and has measurements associated with it. The GBL environment category has already been explored in a previous study (Connolly, Stansfield, & Hainey, 2008). Due to the complexity of the framework this study will primarily focus on measurements associated with the learner performance category, which is based on cognition and divided into knowledge and skills (Wouters, van der Speck, & van Oostendorp, in press). All measurements associated with it are displayed in Table 2.

Conclusions and Future Directions

This chapter has highlighted the requirement for empirical evaluation evidence in the GBL literature and presented a new GBL evaluation framework to help researchers evaluate GBL applications. The learner performance category of the framework has been explored in detail in this chapter (the GBL environment category has been reviewed Connolly, Stansfield, and Hainey, (2008)). The chapter has highlighted that there is a missing link between recognised methods of

Table.2..Learner.performance.category.measurements

Learning outcome	Area	Game	Study	Methodology	Measurements	Results
Cognition						
Knowledge						
	Knowledge Management	KMQuest	Christoph, Sandberg, & Wielinga (2005)	Experimental/control group + pre-test/post-test + survey for metacognitive strategy formation.	Knowledge gained. Metacognitive strategies	The total increase of groups with and without the task model were: declarative knowledge increase - (pre-test 0.51 (SD 0.11), post-test 0.62 (SD 0.10)). Procedural knowledge increase - (pre-test 0.49 (SD 0.13) post-test 0.62 (SD 0.09)). Effect of task value model on learning outcomes was inconclusive. Metacognition was inconclusive.
	Knowledge Management	KMQuest	Christoph (2007)	Three studies were performed. Two experimental + pre-test/post-test + survey for metacognitive strategy formation studies. One Experimental/control group + pre-test/post-test + survey for metacognitive strategy formation.	Knowledge gain. Comparison of metacognitive strategy formation in relation to knowledge gain.	The total increase of the groups without a task value model were: declarative knowledge increase - (pre-test 0.51 (SD 0.11), post-test 0.64 (SD 0.10)). Procedural knowledge increase - (pre-test 0.49 (SD 0.13) post-test 0.62 (SD 0.09)). General procedural increase - (pre-test 0.51 (SD 0.13) post-test 0.59 (SD 0.09)). Specific procedural increase - (pre-test 0.48 (SD 0.16) post-test 0.63 (SD 0.13)). Very little relationship between self reported metacognition and learning measures.
	Knowledge Management	KMQuest	Leemkuil & de Hoog (2005), Leemkuil (2005)	Three studies were performed. One experimental group + pre-test/post-test + additional transfer test (a homework assignment with 10 marks associated with it). One experimental/control group pre-test/post-test + additional transfer test (a homework assignment with 10 marks associated with it). One experimental/control group pre-test/post-test.	The importance of advice within the game. Explicit and implicit knowledge items.	Experimental group knowledge increase. Implicit knowledge increase - (pre-test 3.48 (SD 1.59), post-test 4.14 (SD 1.36)). Explicit knowledge increase - (pre-test 6.83 (SD 2.36), post-test 8.93 (SD 1.98)). Advice within the game was ineffective.

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	Cancer knowledge	Re-Mission	Beale, Kato, Marin-Bowling, Guthrie, & Cole (2007)	Experimental/control group + pre-test/post-test + long term follow up post-test conducted 3 months after intervention.	Factors associated with knowledge gain.	Increase in cancer related knowledge in both groups but higher in Re-Mission group. Sustained heightened knowledge scores over time.
	Project Management	Incredible Manager	Dantas, Barros, & Werner (2004)	Experimental group + pre-test/post-test.	Knowledge acquisition. Interest in subject. Interest in GBL.	100% of participants say that learning occurred. 87% say interest in the subject was increased.
	Food safety	The Food Detectives Fight BAC	Chamberlin (2003)	Experimental group + pre-test/post-test + review of transcripts.	Knowledge gained	Qualitative results - the majority of participants displayed knowledge gain in interviews.
	Malaria/Parasitic education	Parasite and Mosquito Game	Lennon (2006)	Experimental participant + post-test.	Knowledge gained.	Inconclusive.
	Architectural energy efficiency	Architectural energy efficiency game	Cowan (2007)	Two experimental groups and one control group + pre-test/post-test. The post-test was conducted one month after the intervention.	Knowledge gained.	Participants in gaming group were more consistently successful in improving.
	Breast Cancer - Medicine	Breast Cancer Detective	Roubidoux, Chapman, & Pontek (2002)	Two experimental groups + post-test survey.	Previous existing knowledge. Acceptability evaluation.	Inconclusive knowledge gain - acceptability survey indicated that images used in the game contributed to educational value.
	Chemistry and Science	Not specified - Computer - Animated Instruction	Talib, Matthews, & Secombe (2005)	Experimental/control group + pre-test/post-test.	Knowledge gain in high and low level achievers. Conceptual change.	Greater level of knowledge gain for those students exposed to constructivist animations Mean = 13.6, (SD 3.63) as opposed to traditional techniques Mean = 10.2 (SD 3.90). Heightened conceptual change for high and low levels.
	Knowledge Management	Chief Knowledge Officer	Chua (2005)	Experimental group + pre-test/post-test.	Knowledge gain.	Positive effect on knowledge gain.
	Business	LEARN	Größler, Maier, & Milling (2000)	Three experimental groups/control group + pre-test/post-test.	Knowledge gain. Effectiveness of transparency (structural help).	Knowledge gain significant in experimental groups. Transparency (structural help) beginning to be effective.

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	Internet Peering	The Peering Game	Komisarczuk & Welch (2007)	Experimental group + individual self reflection essays + team essays + post-test survey.	Knowledge gain. Team essays and individual essays.	Achieved a positive learning experience in general. No control group was used as the game was designed to reinforce concepts from the lectures and introduce new information. The game was reported to reinforce concepts however new information was not successfully introduced.
	Electromagnetism – Physics	Super-charged!	Squire, Barnett, Grant, & Higginbotham.(2004)	Experimental/control group + pre-test/post-test.	Learning in games-based learning environments.	Experimental group outperformed control group in conceptual exam. Experimental change = 1.2 (SD 0.20). Control change = 0.6 (SD 0.27).
	Civil Engineering	Internal Force Master	Ebner & Holzinger (2007)	Experimental/control group + pre-test/post-test. Online evaluation running concurrently.	If the game leads to similar or equal learning results as traditional methods. If playing the game voluntarily feels similar to incidental learning. Disadvantages for learners.	The game leads to at least similar learning as traditional methods. Post-test playing students (Mean = 4.03, SD 1.026). Post-test non-playing students (Mean = 3.82, SD 1.18). Game feels like incidental learning with 98% of students playing at least once more.
	Fire Safety/Street Walking Safety	Fire World and Street Walking World	Coles, Strickland, Padgett, & Bellmoff (2007)	Two experimental groups/control group + pre-test/post-test. Each experimental group was given the tests for both conditions to act as control group for the other.	Standard ability score. Comparison of correct responses of different groups on knowledge at different points. Verbal responses.	Knowledge gain. At Time 1 (immediately after the intervention), the mean number of correct responses was 3.75 of a possible 4 (SD 0.68) for the fire condition and 3.20 (SD 1.14) for the street condition. At Time 2 (one week post), the mean number of correct responses was 3.38 (SD 1.15) for fire and 3.20 (SD 1.26) for street.
	Anti-phishing education	Anti-phishing Phil	Sheng <i>et.al.</i> (2007)	Game group/existing material group/tutorial group + pre-test/post-test.	Measurement of correctness before and after the intervention. Total correctness of test groups.	Participants in the game condition performed better. Existing training material group (pre-test = 0.66, post-test = 0.74), tutorial group (pre-test = 0.65, post-test = 0.80), Game (pre-test = 0.69, post-test = 0.87).
	Software Development	SimSE	Oh & Van der Hoek (2005)	Experimental group + post-test survey.	If the game teaches software engineering processes.	On a scale of 1-5 (1-not at all and 5-definitely), the average rating of the perception of the game teaching new process knowledge was 2.5. On a scale of 1-5 (1-not at all and 5-very much so), the average rating for whether the participants believe that the game teaches software engineering was 3.6.

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			Shaw & Dermoudy (2005)	Experimental group + post-test survey.	If the games teaches software development.	67% of respondents perceive the game as being able to teach software development lifecycles.
	Biology	SimJavaSP	Wong <i>et al.</i> (2007)	Four experimental groups + post-test survey for usability.	Effects of interactivity and media richness on learning.	No significant knowledge gain.
	Mathematics	ASTRA EAGLE	Ke & Grabowski (2007)	Two experimental groups (cooperative condition and competitive condition)/one control group + two pre-tests/post tests. One associated with performance and another associated with attitudes towards the subject area.	Cooperative game play would increase math performance.	Results from a post hoc pair-wise comparison on the adjusted post-test means indicated no significant difference in math performance between cooperative and competitive conditions. Adjusted mean of cooperative condition = 61.2. Adjusted mean of competitive condition = 59.9. Both conditions performed significantly higher than the control group. Adjusted means for the control group condition = 55.3.
	Biology	River City	Dede, Clarke, Ketelhut, Nelson, & Bowman (2005)	Two experimental groups (guided social constructivist group (GSC) and expert modeling and coaching group (EMC))/control group + two pre-tests/post-tests. One for understanding of content and one for attitudes.	Efficacy of test subject. Understanding and content knowledge.	Increase in Biology knowledge in test group by 32% – 35%. 17% increase in control group. Inquiry content results improved more in the control group than the other two experimental groups. Control group increased by 20%. Guided social constructivist group increased by 18% and the expert modeling and coaching group increased by 16%.
	Geography	VR Engage	Virvou, Katsionis, & Manos (2005)	Two studies performed. Two experimental groups/two control groups + two pre-tests/post-tests	Improvement in mistakes made in relation to different levels of academic performance (poor, mediocre, good).	Consistent improvement in the percentage of mistakes made. For students of previously poor academic performance the experimental group = 48.97% (SD 10.94), the control group = 31.57% (SD 7.72). For students of previously mediocre academic performance the experimental group = 38.50% (SD 10.06), the control group = 31.64% (SD 5.08). For students of previously good academic performance the experimental group = 33.80% (SD 9.66), the control group = 32.84% (SD 9.67).

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	Biology	River City	Nelson (2007)	Two experimental groups (one with moderate guidance and one with extensive guidance)/one control group + pre-test/post-test.	Knowledge gain with different levels of guidance No Guidance, Extensive Guidance, and Moderate Guidance.	Knowledge gain, however advice was ineffective. Moderate Guidance group show predicted gain of 0.45. The No Guidance group had a gain of 0.14 and the Extensive Guidance had a gain of 0.13 which is identical to the control group.
	Biology - genetics/epidemics	Virus and Live Long and Prosper (LLAP)	Klopfer <i>et.al.</i> (2004)	Four experimental groups: one tags for LLAP, one palms for LLAP, one tags for Virus and Live, and one palms for Live and Live + two pre-tests/post-tests. One for knowledge and one for attitudes.	Self-assessment of learning about content, technology, experimental design and whether the participants believed that the technology positively impacted learning.	Participants rated their learning of content (mean = 3.64), technology (mean = 3.72) and experimental design (mean = 3.64) highly. They expressed strong agreement (mean = 3.95) with the statement that the technology positively impacted their learning.
	Childhood violence prevention	Invasion of the Fuzzles	Fontana & Beckerman (2004)	Experimental/control group + pre-test/post-test.	Learner knowledge towards human behaviour and conflict resolution strategies.	Significant change was not recorded for most of the areas of human behaviour and conflict resolution in relation to knowledge.
	Mathematics	ASTRA EAGLE	Ke (2006)	Three experimental groups (individualistic, competitive and cooperative) + pre-test/post-test for performance and attitudes.	Knowledge gain with different goal structures: cooperative, competitive and individualistic.	There was no significant effect of gaming goals structures. Adjusted post-test means for each group are: Individualistic = 60.5, competitive = 59.2 and cooperative = 60.7.
Skills						
	Knowledge Management	Chief Knowledge Officer	Chua (2005)	Experimental group + pre-test/post-test.	Skill acquisition. Attitude.	Inconclusive.

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	Process Management	Containers Adrift	Mayer, Bockstael-Blok, & Valentin (2004)	Experimental group + post-test.	Ability to drawing a visual representation, negotiating parameters, build and running a simulation model and assessing design performance.	The tool was actively used and positive observations were made.
	Project Management	Incredible Manager	Dantas, Barros, & Werner (2004), Dantas, Barros, & Werner (2005)	Experimental + pre-test/post-test.	Project Management skills.	Skills gained. 100% of participants believed that the game in crease their project management skills.
	Mathematics	Zombie Division	Baker, Hadgood, Ainsworth, & Corbett. (2007)	Experimental + pre-test/post-test.	Learner fluency. Learner change in exercising a skill overtime.	Inconclusive.
	Mathematics	SKILLS ARENA	Shin <i>et al.</i> (2006)	Two experimental groups, one handheld game group and a delayed group tested 10 weeks after the intervention + two pre-tests/post-tests. One for math skills the other for attitudes towards the subject area.	Mathematical skill acquisition.	The handheld game group outperformed those in the card game group. Handheld group - pre-test mean = 37.06 (SD 14.31), post-test mean = 44.71 (SD 12.62). Card game group - pre-test mean = 37.05 (SD 15.58), post-test mean = 39.95 (SD 17.00)

evaluation and the GBL literature with the majority of studies surveying participants with very little mention of formative or summative evaluation methodologies.

Future work and validation of the evaluation framework will firstly include a pilot study evaluation of a software development game designed to teach requirements collection and analysis at tertiary education level (Connolly, Stansfield, and Hailey, 2007a). Other categories of the framework will be refined and investigated in depth next as we have primarily focused on the learner performance category of the framework in this study. The framework will also be made available to researchers who are developing and evaluating GBL interventions for the purposes of refinement and also to assess the broader question of whether the framework was beneficial in directing their research interests.

REFERENCES

- Ainsworth, S. (2003). Evaluation Methods for Learning Environments. Amsterdam. *A tutorial for the 11th International Conference on Artificial Intelligence Education*. Retrieved March 28, 2008, from <http://www.psychology.nottingham.ac.uk/staff/Shaaron.Ainsworth/Evaluationtutorial.ppt>
- Amory, A., Naicker, K., Vincent, J., & Adams, C. (1999). The use of computer games as an educational tool: 1. Identification of appropriate game types and game elements. *British Journal of Educational Technology*, 30, 311-322.
- Amory, A. (2006). Game object model version II: A theoretical framework for educational game development. *Educational Technology Research and Development*, 55(1), 51-77.
- Baker, S. J., d. Hadgood, J., Ainsworth, S. E., & Corbett, A. T. (2007). Modeling the Acquisition of Fluent Skill in Educational Action Games. *Proceedings of User Modeling*, 17-26.
- Baker, E. L. & Mayer, T. E. (1999). Computer-based assessment of problem solving. *Computers in Human Behavior*, 15, 269-282.
- Beale, I. L., Kato, P. M., Marin-Bowling, V. M., Guthrie, N., & Cole, S. W. (2007). Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer. *Journal of Adolescent Health*, 41, 263-270.
- Braden, R. A. (1992). Formative evaluation: A revised descriptive theory and a prescriptive model. Paper presented at the *Association for Educational Communications and Technology (AECT)*.
- Campbell, D. T., & Stanley, J.C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally.
- Chamberlin, B. (2003). *Creating entertaining games with educational content: case studies of user experiences with the children's website, food detectives fight bac!* A dissertation presented to the faculty at the Curry school of education, University of Virginia In partial fulfillment of the requirements for the degree doctor of philosophy May 2003.
- Chua, A. Y. K. (2005). The design and implementation of a simulation game for teaching knowledge management. *Journal of American Society for Information Science and Technology*, 56(11), 120-1216.
- Christoph, L., Sandberg, J., & Wielinga, B. (2005). Added value of task models and use of metacognitive skills on learning. In *12th International Conference on Artificial Intelligence in Education (AIED.2005)*, 774-776.
- Christoph, N. (2007). *The role of metacognitive skills in learning to solve problems*. PhD Thesis submitted to the University of Amsterdam. Retrieved 28th November, 2007 from <http://dare.uva.nl/document/22568>

- Coles, C. D., Strickland, D. C., Padgett, L., & Bellmoff, L. (2007). Games that “work”: Using computer games to teach alcohol-affected children about fire and street safety. *Research in Developmental Disabilities: A Multidisciplinary Journal*, 28(5), 518–530.
- Connolly, T.M., Stansfield, M.H., & Hainey, T. (2008). Development of a general framework for evaluating games-based learning. *Second European Conference on Games – Based Learning*. The Hotel Silken Diagonal Barcelona, Barcelona, Spain 16-17 October 2008
- Connolly, T. M., Stansfield, M. H., & Hainey, T.. (2007a). An application of games-based learning within software engineering. *British Journal of Educational Technology*, 38(3), 416-428.
- Connolly, T. M., Boyle, E., & Hainey, T. (2007b). A survey of students’ motivations for playing computer games. *First European Conference on Games – Based Learning*, 25 – 26 October 2007, Paisley, Scotland.
- Connolly, T. M., Boyle, E., & Hainey, T. (2006). Can computer games motivate next generation learners? A survey of students’ reasons for playing computer games. *10th International Conference of Motivation*, 28-30 September 2006, University of Koblenz-Landau, Germany
- Cowan, D. J. (2007). Assessment of a computer game for teaching architectural energy efficiency. *Journal of Advanced Technology for Learning*, 4(4).
- Dantas, A. R., Barros, M. O., & Werner, C. (2005). Simulation Models Applied to Game-Based Training for Software Project Managers. In *Process Simulation and Modeling Workshop (ProSim)*, St Louis, USA, May 2005, 110–116.
- Dantas, A. R., Barros M. O., & Werner, C. (2004) A simulation-based game for project management experiential learning. In F. Naurer & G. Ruhe (Eds.), *Sixteenth International Conference on Software Engineering and Knowledge Engineering (SEKE;04)*. Alberta, Canada, June 2003, 19–24.
- Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska symposium on motivation*, 38. *Perspectives on motivation* (pp. 237-288). Lincoln, NE: University of Nebraska Press.
- Dede, C., Clarke, J., Ketelhut, D. J., Nelson, B., & Bowman, C. (2005, April). *Students’ motivation and learning of science in a multi-user virtual environment*. Paper presented at the meeting of the American Educational Research Association, Montréal, Quebec.
- de Freitas, S. (2006). Learning in Immersive Worlds. *Joint Information Systems Committee*.
- de Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated. *Computers & Education*, 46(3), 249–264.
- Dempsey, J. V., Haynes, L. L., Lucassen, B. A., & Casey, M. S. (2002). Forty simple computer games and what they could mean to educators. *Simulation & Gaming*, 33(2), 157-168.
- Dondi, C., & Moretti, M., (2007). A methodological proposal for learning games selection and quality assessment. *British Journal of Educational Technology*, 38(3) 502–512.
- Dugdale, J., Pallamin, N., & Pavard, B. (2006). An assessment of a mixed reality environment: Toward an ethnomethodological approach. *Simulation & Gaming*, 37(2), 226–244.
- Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers & Education*, 49, 873–890.
- Fontana, L., & Beckerman, A. (2004). Childhood Violence Prevention Education Using Video

- Games. *Information Technology in Childhood Education Annual*, (pp. 49–62).
- Größler, A., Maier, F. H., & Milling, P. M. (2000). Enhancing learning capabilities by providing transparency in business simulators. *Simulation & Gaming*, 31(2), 257–278.
- Harpel, R. L. (1978). Evaluating from a management perspective.. *New Directions for Student Services*, (1), 19–33.
- Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: cooperative or not? *British Journal of Educational Technology*, 38, 249–259.
- Ke, F. (2006). Classroom goal structures for educational math game application.. In *Proceedings of the 7th International Conference on Learning Sciences ICLS '06*, Publisher: International Society of Learning Sciences.
- Kirkpatrick, D. L. (1994). *Evaluating training programs: the four levels*. San Francisco, CA, Berrett-Koehler.
- Kirkpatrick, D. L. (1998). *Evaluating training programs: the four levels (2nd Ed.)*. San Francisco, CA, Berrett-Koehler.
- Klopfer, E., Yoon, S., & Rivas, L. (2004). Comparative analysis of Palm and wearable computers for Participatory Simulations. Blackwell Publishing Ltd 2004 *Journal of Computer Assisted Learning*, 20, 347–359
- Kolb, D. (1984). *Experiential Learning*. New Jersey, Prentice-Hall Inc.
- Komisarczuk, P., & Welch, I. (2007). Web based board game for teaching aspects of internet engineering. ACTA/IASTED, *International Journal of Advanced Technology for Learning on Games-based Learning*, 4(4).
- Leemkuil, H. (2005). *Is it all in the game? Learner support in an educational knowledge management simulation game*. Unpublished doctoral thesis. University of Twente, Enschede, The Netherlands.
- Leemkuil, H., & de Hoog, R. (2005). Is support really necessary within educational games? In C. Conati & S. Ramachandran (Eds). 18-22 July 2005, Amsterdam, Netherlands. *Workshop on educational games as intelligent learning environments, 12th International Conference on Artificial Intelligence in Education (AIDE 05)* (pp. 21–31).
- Lennon, J. L. (2006). Debriefings of web-based malaria games. *Simulation & Gaming*, 37(3), 350–356.
- Mayer, I. S., Bockstael-Blok, W., & Valentin, C. (2004). A building block approach to simulation: an evaluation using containers adrift, *Simulation & Gaming*, 35(1), 29–52.
- Nelson, B. C. (2007). Exploring the use of individualized reflective guidance in an educational multiuser virtual environment. *Journal of Science Education and Technology*, 16, 83–97.
- Nielsen, J., & Molich, R. (1990) Heuristic evaluation of user interfaces. Seattle, WA 1-5 April. In *Proceedings of the ACM. HI'90. Conf.*, (pp. 249-256).
- Ogle, G. J. (2002). *Towards a Formative Evaluation Tool*. PhD Thesis submitted to Virginia Polytechnic Institute and State University. Retrieved March 28 2007, from <http://scholar.lib.vt.edu/theses/available/etd-04262002-161146/unrestricted/etd.pdf>
- Oh Navarro, E., & Van der Hoek, A. (2005). Design and Evaluation of an Educational Software Process Simulation Environment and Associated Model. In *Proceedings of the Eighteenth Conference on Software Engineering Education and Training*, Ottawa, Canada.
- O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: evidence

- from the computer games literature. *The Curriculum.Journal*, 16(4), December 2005.
- Randel, J. M., Morris, B. A., Wetzel, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes a review of research. *Simulation.& Gaming*, 23(3), 261–276.
- Roubidoux, M. A., Chapman, C. M., & Piontek, M. E. (2002). Development and evaluation of an interactive web-based breast imaging game for medical students. *Academic. Radiology*, 9, 1169–1178.
- Saari, L. M., Johnson, T. R., McLaughlin, S. D., & Zimmerle, D. M. (1988). A survey of management training and education practices in US companies. *Personnel.Psychology*, 41, 731–743.
- Schumann, P. L., Anderson, P. H., Scott, T. W., & Lawton, L. (2001). A framework for evaluating simulations as educational tools. *Developments. in.Business.Simulations.and.Experiential.Learning*, 28.
- Shaw, K., & Dermoudy, J. (2005). Engendering an empathy for software engineering. In *Proceedings. of.the.7th.Australasian.Conference.on.Computing.Education.-. Volume.42.ACE. '05*.
- Shin, N., Norris, C., & Soloway, E. (2006). Effects of Handheld Games on Students Learning in Mathematics. June 2006, *Proceedings.of.the. 7th.international.conference.on.learning.science. ICLS. '06*, Publisher: International Society of the Learning Sciences.
- Sheng, S., Magnien, B., Kumaragurg, P., Acquisiti, A., Cranor, L. F., Hong, J., & Nunge, E. (2007). Anti-Phishing Phil: The Design and Evaluation of a Game That Teaches People Not to Fall for Phish. *Proceedings. of. the. 3rd. symposium. on. Usable. privacy.and.security.SOUPS. '07*. ACM Press.
- Song, S., & Lee, J. (2007). *Key factors of heuristic. evaluation. for. game. design. : Towards. massively. multi-player. online. role-playing. game*. Unpublished manuscript.
- Squire, K., Barnett, B., Grant, J. M., & Higginbotham, T. (2004). Electromagnetism Supercharged! Learning physics with digital simulation games. *Proceedings. of. the. international. conference. on. Learning. science*, 6, 513–520.
- Ssemugabi, S., & de Villiers, R. (2007). A comparative study of two usability evaluation methods using a web-based e-learning application. Fish River Sun, Sunshine Coast, South Africa. *Proceedings.of.the.2007.annual.research.conference. of.the.South.African.institute.of.computer.scientists. and.information.technologists.on.IT.research.in. developing.countries*, 2 - 3 October 2007.
- Talib, O., Matthews, R., & Secombe, M. (2005). Constructivist Animations for Conceptual Change: An Effective Instructional Strategy in Understanding Complex, Abstract and Dynamic Science Concepts. *Malaysian.Online.Journal.of. Instructional.Technology.(MOJIT)*, 2(3) 78–87.
- Tan, P-H., Ling, S-W., & Ting, C-Y (2007) Adaptive digital game-based learning framework. *Proceedings.of.the.2nd.international.conference. on.Digital.interactive.media.in.entertainment.and. arts*. Perth, Western Australia.
- Tessmer, M. (1993). *Planning. and. conducting. formative.evaluations*. London: Kogan Page.
- Yu, F. Y., Chang, L. J, Luit, Y. H., & Chan, T. W. (2002). Learning preferences towards computerized competitive modes. *Journal. of. Computer. Assisted.Learning*, 18, 341– 350.
- Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational. Technology.&.Society*, 8(2), 64–65.
- Wong, W. L., Shen, C., Nocera, L., Carriazo, E., Tang, F., Bugga, S., & Narayanan, H. (2007). Serious video game effectiveness. *Proceedings.of. the.international.conference.on.Advances.in.computer.entertainment.technology*, (pp. 49–55).

Wouters, P., van der Speck, E., & van Oostendorp, H. (in press) Current practices in serious game research: A review from a learning outcomes

perspective.. In T. M. Connolly, M. Stansfield, E. Boyle (Eds.), *Games-Based. Learning. Advancements.for.Multisensory.Human.Computer.Interfaces.:Techniques.and.Effective.Practices.* Hershey PA: IGI Global.

Chapter XVI

Games–Based Learning in the Classroom and How it can Work!

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ABSTRACT

Based on real-world experiences using a variety of digital games, this chapter presents a guide for teachers on how to use games-based learning in the classroom. Beginning with a theoretical overview of the change in learning styles and the growing digital divide, the impact that games have had on young people will be discussed. The limitations faced and ways to overcome these to create effective pedagogical experiences when using games will follow. The second half of this chapter aims to provide a practical guide for teachers wishing to integrate games into their classrooms, beginning with an overview of the changing role of the teacher, moving onto preparation guidelines, before finally discussing assessment and practical implementations.

INTRODUCTION

Throughout the years there have been significant paradigm shifts in learning practices and recently there has been a move from behaviorist reinforcement to knowledge regarding how the ways in which we think and feel affect our ability to learn. Despite these changes much of mainstream education is still based on behaviorist principles and external rewards, rather than a concern with individual cognitions.

The current trend towards a more constructivist (Vygotsky, 1969) approach, whereby the individual is responsible for his or her own learning, accomplished through individual experience and coaching, combined with the increasing presence of technology in the modern day classroom is resulting in a rift in the level of knowledge and understanding of these technologies between student and teacher. Games are just one example of how this rift has manifested itself.

Games are intrinsically constructivist; the player or learner has to traverse a world where they are the centre of the learning experience, constantly constructing new knowledge and understanding, in order to progress. Refocusing towards this learner centric experience reduces the need for the traditional pedagogical methodology of the 'Sage on the Stage' and 'Tell and Test', such as King (1993 pp 30) who describes the teacher as the focus of the classroom, 'the individual who has the knowledge and transmits that knowledge to the students, who simply memorize the information and later reproduce it on an exam-often without even thinking about it'.

The move towards constructivism and learner centered technology, has resulted in the challenge of bridging this rift and ensuring those who deliver education are comfortable with this approach – and the crux of the matter, they are unlikely to be avid gamers. To many this may sound like 'Mission Impossible' but that is far from the truth. What teachers need is advice on how to navigate through this maze to emerge on the other side with an understanding of how games can be used effectively in education.

In recent years there has been a phenomenal increase in interest in games in the classroom. Several papers funded by Government Bodies have been published, mainly concerned with Commercial off the Shelf games (COTS) such as the report by McFarlane and Kirriemuir (2003) on the 'Use of Computer and Video Games in the Classroom', together with the Federation of American Scientist report 'Harnessing the power of video games for learning' (2005). Both reports concluded that the use of games as teaching tools can have positive results for teachers and students.

Despite this research and the growing body of evidence pointing towards the positive impact of games, there is still a belief that games have a negative influence on young people. A recent report by the British Board of Film Classification (2007) claimed that they are violent, time consum-

ing, take hours and hours to complete and that they reduce players' social interaction skills.

However people have learnt from games for thousands of years and from my experience working with schools, students and teachers over the past 5 years with several games-based learning tools, this chapter presents the lessons learned from integrating games into the classroom and school environment, aiming to move towards best practice for current and future design and implementation.

How Times Have Changed

There are many aspects of good pedagogy, such as the impact of motivation, cognitive engagement, overload and attention span that are not given the consideration they deserve in traditional teaching methods of drill and skill and tell and test. For example pupils are required to pay attention and absorb the information presented to them for up to and even exceeding 50 minutes at a time, no matter the content or delivery style. These and other aspects are important factors, which with the proper consideration are beginning to bring about a new and innovative method of learning.

Many educators use methodologies that were used when they were at school; their attitude is 'it worked for me, it will work for them'. However this methodology may not be appealing to young people, who are used to instant access, and possess the ability for 'parallel processing'. The result when faced with traditional teaching is that they simply turn off. This is not to say that they have short attention spans - just think of the number of hours they spend trying to solve puzzles and explore new worlds in video games. A recent Entertainment Software Association (ESA) report (2007) estimated that on average, young people spend around 7 hours per week, using games.

An examination of the skills acquired from video games has revealed some interesting results. Today, it seems, young people are very good at multi-tasking and it is claimed that they have a

wider span of attention than ever before (Greenfield, 1994). They live in a rich and engaging world where, to quote Prensky (2001), they have to 'power down' when they go to school. Greenfield goes as far as suggesting that digital media have altered our cognitive and social development, and that the skills learnt using video games are much more complicated than simple hand-eye coordination, as previously believed, and include increased problem solving, and pattern identification utilizing trial and error approaches.

Greenfield and others go on to suggest that the way young people process information has changed: they process information in parallel for example they can watch a news presenter, read the news ticker at the top of the screen, and do their homework, or they can text and talk to their friends simultaneously. Interactive technology and multimedia are a commonplace addition to their world. However, this world is not familiar to some educators. In her work Greenfield concluded that there is a new generation with unique cognitive skills; she called them the 'Games Generation'. Prensky calls them Digital Natives.

Background: What is Games-Based Learning?

The overall objective of Serious Games covers everything from education and training to raising social awareness, and it acts as a catch-all term for using games technology for non entertainment purposes. However Games-Based Learning is specifically designed to transfer knowledge to the player through interaction with objects, characters or environments. In essence what differentiates Games-Based Learning from the overarching group of Serious Games is that there is a defined learning outcome. 'They are designed in order to balance the subject matter with the gameplay and the ability of the player to retain and apply said subject matter to the real world.' (Prensky, 2001).

Part of creating effective teaching tools involves understanding what works and doesn't work for the learner. We have seen that learners and their preferences have changed, and some of the psychological reasons Games-Based Learning works and appeals to young people are outlined below.

Malone and Lepper (1987) comment that games are intrinsically motivating, that they are enjoyable and stimulate natural curiosity as a game has many levels of interest. This engagement can benefit education but it is important to embed the game within a structured course so as not to lose initial interest and curiosity.

Games include natural goals for players, for example, finish this level, collect 100 gems, or win the race. Goals allow people to plan for experiences and feel good about their achievements. These achievements in turn provide 'Ego Gratification' (Gee, 2003), where the individual is rewarded for their accomplishments in the form of new levels or abilities which in turn reveal new opportunities.

Games-based learning incorporates 'Stealth Learning', whereby the individual is learning unwittingly through their play and motivation to continue playing is found through gaining rewards as explained above (Gee, 2003). Players learn about the games' tactics and strategies through experimentation and trial and error with the game world. Imagine what could be achieved if this trial and error was related to Physics or a Language: pupils would be motivated to keep trying different permutations to progress onto the next level of the game, gradually building up a picture of the subject matter through their own experimentation. In order to learn we must be aware of what we did wrong and what we did right. The need for reflection is vital for any form of learning or improvement in any walk of life. Games arouse natural reflection in their users, the individual needs to understand what works and what doesn't in order to progress through the game.

Traditionally in school the class needs to move at the pace of the slowest learner. However games support individualized learning and generally allow each player to learn at their own pace. Some innovative games have the capacity to adapt to the ability of an individual, providing a smooth learning curve to keep players in the state of flow. Csikszentmihalyi (1990) defined flow as 'the mental state of operation in which the person is fully immersed in what he or she is doing, characterized by a feeling of energized focus and full involvement'. Flow is more commonly referred to in the sporting world for example as being 'In The Zone'. Games also provide feedback and interaction via audio, visual and sometimes tactile means and therefore they can appeal to different learning styles.

Different Types of Games

Not all games are the same; they vary immensely as do books, films and teaching styles. Games have genres, narrative, delivery styles, and game play mechanics unique to the context of the game. Games can be very effective learning tools, although it is not safe to make the assumption that all games teach. Most commercial games are designed for purely entertainment reasons and there are many types of game genre from strategy, turn based and real time to action and adventure games. The game mechanics and game play are often different in each of these genres and each tends to have a distinctive style. Due to the variety of games available it is important to understand the differences, at least at a high level. There is a certain level of cross over between genres and these categories should not be regarded as black and white, however I have aimed to distinguish, at a high level, how they differ.

Wolf (2001, pp. 116-117) lists 42 distinct genres of games in his adapted taxonomy of genre. Apperley, (2006, pp. 3) lists simulation, strategy, action, and role-playing as amongst the more popular video game genres. For simplicity, these

are the ones we will look into further. Strategy games are games where some level of strategy is required to complete the game. Civilization, Command and Conquer and Theme Park are all examples of strategy games. It should be noted that strategy, to a certain extent is required in almost all games but this genre focuses on the art of strategy, without a strategic approach you will not 'win' the game.

There are also Simulations which are realistic representations of activities such as flying an aircraft or driving a car. Action and Adventure games generally consist of 'twitch speed' controls, relying on reflexes, such as shoot-em and beat-em ups, but Role Play and Interactive Movies are also included in this genre. It has been found that surgeons who play games that incorporate twitch speed reactions are 37% more accurate than surgeons who don't play (Rosser, 2004). Finally there are abstract games, which consist of puzzles and problem solving such as Tetris.

McFarlane and Kirriemuir (2003) claimed that the games that are most suitable for use in the classroom generally fit into the role play, strategy, simulation and puzzle genres. These genres lend themselves to experiential learning and problem solving in a particular context and are relatively gender agnostic. Whist Commercial off the Shelf games (COTS) produced by the games industry for entertainment purposes are also popular tools within schools, structure, skill and effort is needed to ground the game in an educational context otherwise the effectiveness may be reduced.

Why have Games not been Widely Adopted?

There are two main reasons for the lack of uptake of computer games in learning, the limitations of the applications and the limitations of the environment; namely cost and infrastructure. It is important to consider these aspects to maximize the effectiveness of any application.

Limitations of Current Applications

The caveat mentioned in the introduction to this section, may seem flippant but is vitally important. There are many games-based learning applications produced every year but they vary in quality. Many lack the understanding of how the game will actually be used and who will be using it.

The reality is that many educational games are not fun. When considering games for your classroom think carefully about how much fun the students will think the game is. If it isn't fun, it won't engage them and may be a waste of your very tight budget. It may be worth asking for a trial of the software from a developer, especially if it is a new product. If it is well established, there should be a wealth of evidence available for you to check out. Take a similar approach as you would to buying a car for example; look at what other consumers have said about it and what they think.

The balance of content and engagement in games is often lacking; the physical and emotional release we get when we achieve something, especially when we are under the simulated pressure of saving a person's life, for example, is extremely rewarding. However some applications have relied too heavily on subject matter, in other words they felt too much like work. There is a general misconception that for learning to be effective it needs to be serious, formal and rigid. However for games-based learning to work it should follow the principles of free exploration, experimentation, and is to a certain extent informal. Not everything that games are applied to are fun subjects, such as surgery, emergency response and disaster control but 'fun' can come in the form of engagement or satisfaction as a result of achieving a goal. Quinn (2005) refers to this as 'Hard Fun' (p. 11).

Related to the lack of fun, is the lack of 'out of the box thinking' by some designers. Too many applications rely on text surrounded by colorful graphics and little animation, what is sometimes called 'the dancing bananas' effect. Incorporating

text into a virtual world with avatars does not make for an engaging experience for the user. Many applications also rely on 'Click to Turn' the page methodology, as this is an easy way of adding content but in reality is no different from e-learning, merely displaying content in a digital format. The best games-based applications intertwine the subject matter with the game play, so you learn through interacting with the game.

Finally, this brings me on to the importance of emotion which is so often forgotten in this field. It is an integral aspect to an effective learning environment. Emotion can be achieved in games as it can be in film, and many games stimulate some level of emotion in the player, whether it be frustration, fear, excitement or relief, each of which we might find 'enjoyable' to varying degrees. When a subject is emotionally linked to an experience, it acts just like a marker or flag and establishes a privileged place in memory (LaBar and Cabeza, 2006), thereby making it easier to access in future situations. This emotion can then be linked to other memories and learning experiences and therefore builds a network of knowledge and improves the accessibility of the memory. Finally and most surprisingly, is that the learning framework is commonly forgotten and people believe the game is all that is required. There is the illusion that if you 'use this game, learning will be fun and kids will learn more!' But this is just not the case; just like any other tool it requires effort to fit games into the learning environment.

Limitations of the Environment

The classroom is not considered a natural gaming environment and many people still have a negative view of games. On the other hand a report by Entertainment Software Association (2007) found that the majority of pupils spend a lot of their free time playing games, suggesting young people enjoy using and interacting with games. Misconceptions about games, confusion over to

how to use them as teaching tools and limited access to PCs may, in part, be responsible for the lack of games in the classroom.

This misconception was perfectly highlighted, for me, by one teacher who suspected that a game was encouraging bullying. The accusation had been sparked after a little girl ran from the classroom in tears. The teacher immediately blamed the game, thinking it was providing a conduit for bullying and closed it down. What the bullies didn't know was that everything was recorded; there was a log of the evidence. The log revealed that, this case of bullying had been continuing for some time, but the game acted as a mechanism to bring it to light. The logs were shown to the students, the Principal, and the parents and therefore this case was tackled. The invisible had become visible.

Within the 50 minute time-frame of a class, teachers need to get students' attention and impart a certain level of knowledge and confirm their comprehension, and therefore are incredibly pressured for time. Some applications take a phenomenal amount of time before you learn anything; in a class of 40-50 minutes, for example, you have to set up and load the game, students need to get to know the controls and do their first mission. This may leave no time for reflection and for understanding the achievements and gaps.

There can also be problems with the peripherals required for the games themselves. These sometimes require specialized equipment which may be priced out of a teacher's budget. Also some games require very high spec machines, something that some schools just don't have.

It is clear that the environment in which we hope games-based learning will be used can be far from ideal. There is a problem with time, attitude, as well as an enormous amount of pressure and a lack of materials for teachers to use. However all is not lost and the following section begins to break down what is required for integrating games into the classroom effectively.

Integrating Games into the Classroom

Teaching with games is not about sitting students down in front of a pc and then forgetting about them until the bell rings. I have seen this happen on numerous occasions where teachers have left the kids and chatted at the front of the class thinking the game is a magic bullet for their subject.

Games are highly interactive. They involve the individual player, the team, the guild, the NPC's (Non Player Characters) etc. Games used for educational purposes include the learner, the teacher and sometimes even the parent.

Games rely heavily on free exploration which is a move away from traditional methodologies. Through the changing landscape of education, the teacher's role in the classroom has altered and it is common for teachers to misunderstand the use of games as a replacement for their role. I have often heard teachers say 'this game teaches my subject and therefore you don't need me'. In fact the opposite is true. Teachers are integral to the learning process. Gone are the days when the teacher stands at the front of the class and dictates. Utilizing constructivist techniques such as experimentation, games allow students to discuss and demonstrate actions and reactions; this is part of inductive discovery, learning through practice and learning through experience.

Games can allow the teacher a level of interaction, some only dream of. Second Life, for example, a Multi-User Virtual Environment, developed by Linden Labs is being used by many universities and institutions for virtual campuses where teachers and students interact online (Cohen, 2006).

From. my. personal. experience,. when. one. teacher. used. a. multiplayer. game. with. disengaged. young. people. with. learning. and. behavioral. difficulties, the results amazed both the teacher and. the. students.. The. students. asked. him. to. participate. in. the. game. as. one. of. the. team;. he. agreed. reluctantly,. not. wanting. to. make. a. fool.

of.himself.in.front.of.his.students,.but.ended.up.enjoying.himself..This.showed.the.students.a.side.to.the.teacher.they.hadn't.seen.before..They.saw.him.as.a.human.being.not.just.the.teacher..The.students.ended.up.leading.the.teacher.through.the.game.and.this.shared.experience.improved.the.rapport.between.the.teacher.and.students.fostering.more.open.communication,.trust.and.a.better.working.relationship,something.which.had.been.very.difficult.before,much.to.the.surprise.of.all.participants.

When the game is complete, a further window of interaction occurs; students will want to talk about their achievements, their battles, their missions, what they did right and where they went wrong, and crucially what they will change next time, in order to become more successful. In the context of games-based learning, they are learning about the strategies they need to complete the game and consequently the subject matter. This is reflection and is explored in more detail below.

Be One with the Game

A game is a tool like any other. Some look at games, and immediately panic, thinking 'how am I supposed to use this in my classroom?' However all tools require familiarity and games are no different. They are tools to be used alongside other methods.

To use games in the classroom the teacher must be familiar with the game at the very least. At the very most they should be an expert on all the rules, levels, characters etc, in order to guide students through the experience. Some believe it is too much to ask to be an expert in game as well as their subject area, but it's similar to knowing the location of information in a textbook for example and it comes with practice.

With a cleverly designed application becoming familiar with the game should not be too much of a burden as you should hopefully play the game yourself to plan lessons, and the interface and game play should be clear and understandable. Some

applications come combined with lesson plans to aid the smooth transition into the classroom. Any developer of games-based learning should provide guidance on how to use their games and as a teacher you should expect this to be packaged with the software.

Teacher training is vital as you must feel confident that you know what to do and say if asked a question. Often I hear feedback from teachers relating to the fact that they don't know everything about the game, the kids know more than they do...the tables have turned in a way. So a good training course can help to allay this fear. Don't look at the game and think, I don't understand this, so they won't. As you know kids play games and you may not, but they will understand the game, and most likely dive right in. As referenced earlier from the ESA (2007) report young people spend up to 7 hours a week playing games and therefore are willing to experiment and are reasonably familiar with the gaming environment from playing at home.

Using games in the classroom will change the way you work. Games are not a replacement for teachers but they should enhance the teaching experience. Students require the skills of the teacher to guide and draw out the learning as you would if your students went on a field trip for example.

Don't be afraid to pick up the game and play it yourself. You won't break it and no one will be there to see if you make mistakes, in fact it's a great way to pick up and understand the principles behind the game.

The game is a tool, and may come supplied with a learning framework. However games can be used for many things, and are only limited by your imagination. By playing the game you will be able to tailor the experience to your students by understanding the subtle nuances as well as seeing the learning outcomes in practice. You will be able to devise strategies and plans that you can use to assess your students, and by pulling this information together it will help to

create lesson plans. Also think about what other teaching techniques, such as class discussion or creative writing, can be applied and which ones will complement the game play.

Preparation, Practice, and Realization

Briefing

It is important to set the right expectations about the experience, the format it will take, and the process you are planning to implement. The students need to be in the right frame of mind, that is, they need to understand this is a learning activity and they need to use the game for more than fun. You don't need to 'suck the fun out' but students should be informed of what is expected of them and the types of activities that will follow. Students should be aware the game is for learning and that they should be prepared to do some work!

After one gaming session, focused around communication skills, a class who, after playing through a game, and thoroughly enjoying themselves, were told to take out a pen to complete a worksheet, something with which they should be familiar, however, surprisingly, they all groaned as they weren't expecting to do any work! They had interpreted the introduction of a game as a frivolous activity something akin to activities that occur towards the end of the semester.

Activity

Now, the fun part; it's time to let the students play the game.

Students will take to the game like ducks to water; they will jump right in and click everything; they have no fear, and understand the need to experiment. Often I have seen students do this, play and then fail; however what is so often the case is that they ask to play again.

This was highlighted during a competition. I ran with local High Schools. One boy had taken control of his team and wasn't listening to their suggestions. After the first round his team was last. This was a total shock to the boy as he had genuinely believed his ideas were the best! After a quick time out, he sat back during the next round and more discussion took place. It turned out that he didn't understand the game but wanted to take control, but once he listened to his team-mates, they managed to claw their way back up the league table to finish in a comfortable 3rd place.

Time and time again students playing games are motivated to improve their score, to work better as a team, to communicate more, and to plan. We do not see this very often in traditional pedagogical methodologies in schools today.

During a session with a group from an average high school, using a multiplayer game focused on problem solving, I was surprised to witness 86% of students, who, after about 10 minutes in game, when asked what they could do to improve on their score, were able to come up with an effective strategy. They had recognized their weaknesses and wanted to put them right. The interesting thing was that they were keen to discuss their weaknesses, review their peer's performance and write down a new strategy and try it out.

This was Stealth Learning in practice; they were learning about the game and learning outcomes through experimentation and peer interaction. A well designed game will inspire students to keep playing; beat their score, or beat their friend.

Debriefing

Reflective learning is just as important a step in using games as teaching tools. Although games are important for the experience, learning will also happen away from the PC and it is essential to encourage students to think about the activity after the game has finished. You can encourage reflective learning using techniques such as class discussion or written evaluation.

Add in time for reflection throughout the lesson. You should be able to pause or save the game so you can discuss what is happening. As seen above, peer debriefing is also a great tool. Young people love to talk and share their experiences, their points, or whatever the game rewards them with.

The reflection and debrief often lead to what I like to call the ‘Aha’ moment, where the student links their activity in the game back to the real world and transference is achieved. The student can then go back into the game and apply their newly constructed knowledge, and the learning cycle begins again.

Assessment Using Games

Beyond the benefits of reflection is the need for more formal assessment. Some games have the benefit of recording certain pieces of information and these are referred to as Game Logs. These can prove invaluable as ready to use pieces of evidence of learning. However games can’t do all the assessment, there is still the need for some level of manual work. Observation of in-game behavior as well as creating assignments for students to do out with the game can be engaging and interesting. As logs differ from game to game, the focus of the following section is around creating a structure for using games in the classroom.

Lesson Structure

Think of the game as a context for learning. The learning outcomes set by the teacher do not have to meet the goal, challenge, or mission set by the game and you can adapt the lesson, focusing on any aspect of the game you choose for example, Civilization has been used to teach History (Squire, 2003). Nintendogs, currently being piloted in Scotland can be used to teach social responsibility. However, you will need to be aware of the games’ rules and variables for each mission, challenge

or task. An example of this using COTS games would be to use The Sims to examine interpersonal relationships or to use Championship Manager, a soccer management game, for accounting. A game designed as a learning tool should come with these learning outcomes outlined, if it does not you can gather this information by playing the scenarios. Pick a scenario that is relevant to what you want to teach, taking into account the difficulty level of the problem or challenge. It is best to test the experience yourself to get an idea of the time it will take coupled with other activities as part of the lesson. Think about the end state. What can students achieve in the allotted time and will they complete the scenario? This is important as, if students do not complete the scenario, will they gain all the knowledge from the experience? You should note when crucial learning moments occur within the game to aid in planning the session.

Framework

Use the structure below to help create well thought-out plans for using games-based learning:

- Name, learning outcomes and aims of the scenario – this will help to maintain the focus of the session and understand the goal for the game and the lesson
- Rules, Variables and Interactions are also useful to note
- What are the strategies that players can adopt to complete the scenario? Are there multiple strategies and where can they be implemented?
- What actions will the students have to perform in order to accomplish the goal and how does this link to the learning outcomes?
- What are the links to other activities and areas of the curriculum? What other tools can be used to complement the game play?
- What constitutes success in the game? What are the assessment criteria?

I have mentioned incorporating other tools alongside the game and an example could be to create somewhere for the class to log their game data which could become a shared record, perhaps a spreadsheet with sharing enabled, to which they all have access and can track their scores.

A recent pilot I was involved with introduced pod casting and blogging as part of an overall games-based learning centered course. The course aimed to introduce games-based learning into everyday workings of the school and closely tie the results to the curriculum. The kids recorded their experiences with the games, their successes, and failures and what they hoped to improve on next time to get a better score. This enabled the students to express themselves in yet another dimension. The information captured enabled the students to create a more formal report, which focused on what they had learned, which was presented back to the teacher. The students I must add were disengaged; they were in a group known as ‘Support for Learning’ made up of those with learning difficulties and behavioral problems. Not usually known for enjoying their work or their time in school, so what’s more encouraging is that they relished the chance to use new technologies in school. The course allowed them to experience a level of ownership over the records and ultimately the final piece of work.

If blogging and pod casting send shivers down your spine, how about PowerPoint or Word, tools that you are probably familiar with, can be used in some of the ways as described above to produce evidence of learning. As mentioned, some games actually produce logs of the play activity, and this information can be very useful as a report on their progress.

Other examples could include creative writing, or getting students to design a game to highlight an important era in history, for example about life in ancient Rome, where they will have to research the topic to uncover the facts and weave them into an engaging and educational experience. Students will probably find this more interesting and creative than writing an essay for example.

Assessments can also benefit from writing structures, such as, “during the first level I did...” and “a more effective strategy would be...” to help solidify the activities in the students’ minds.

Peer review is another valuable tool and something which young people are likely to be familiar with. Games have large communities around them; young people are used to discussing progress, tactics and strategies, and therefore should enjoy the opportunity to discuss this in the classroom.

How to Choose a Good Games-Based Learning Application

Now that you have gleaned all this knowledge about games-based learning and how great it can be, it’s time to understand what makes a good application so you can make a more informed choice.

A good application will allow the player a level of self-exploration, as that is what it’s all about. If you can’t immediately see the educational content, don’t worry, it may be delivered more subtly than in traditional educational methodologies.

Many applications also forget that teachers are under pressure to deliver knowledge in very limited periods. A good design will allow for the game to fit easily into class time. Vital supporting material is often missing from products. Many designers make the mistake of thinking the game is all the teacher needs. Lesson plans, instructions, even a walk through are often needed to ensure a teacher can get to grips with the game quickly. Teachers will also need some sort of assessment framework, either built into the game or provided as part of the surround supporting materials.

Look for something that comes with training or that is easy to use, but not to the detriment of the audience. Games-based learning applications sometimes miss out the most important element of all in their design, namely the teacher and the

teacher's ability to use the game and facilitate their classes. After all if you, the teacher cannot use the software, or need to spend hours trying to understand it, you are less likely to adopt it into your teaching regime.

Facilitation of the game is extremely important. This ensures that exploration and experimentation is not endless and actually leads somewhere. This could take the form of an extra character in the game, access to the saved files of the students, recorded scores, or in the form of a surround accompanying the game such as lesson plans.

Pick something that will appeal to your pupils. They will probably have a different taste to you, something you think looks fun, might not appeal to them. Don't always go for the most educational looking, as this may in fact be quite uninspiring. Think about what your audience will find appealing in the game and you could even have session thinking about what they like and why.

Use these simple guidelines to help choose an application and your job should be a lot easier.

Implications and Future Research

This chapter began life as a practical guide for the implementation of games in the classroom. There are, therefore several levels of implications to which I would like to draw attention. Firstly we will start with the learners. Incorporating games-based learning into students' educational career can lead to higher levels of engagement with school as well as with subject matter. This has been reported in many papers such as the Federation of American Scientists (2005) report and I personally have seen this engagement first hand. This is a real result of using games as teaching tools seen time and time again from my experience. This increased engagement in turn, will likely lead to many positive outcomes such as higher attainment levels in school and more interest in lifelong learning. This implication is resonant

for teachers also, as they will begin to see more engaged students. However we must remember that facilitation is the key to using games-based learning effectively and that the role of the teacher is moving more towards a guide or coach and therefore a shift in teacher training methodologies would be beneficial moving forward.

The benefits that games can bring will only be realized with well thought out design and support material and therefore designers must continually familiarize themselves with educational theory and work more closely with teachers, students and educationalists, thereby making the integration of games into schools smoother. One critical barrier to games being used effectively is the lack of out of the box thinking on behalf of designers. In a world where young people go home and play their Xbox or PlayStation we must ensure the games being designed for the classroom move beyond multiple choice tests with game play tagged on, or reams of text in a virtual world. Games must be engaging so that young people actually want to play them. However these aspirations must be realized in the limitations of the classroom environment and the technology available.

Continued research is required with different user groups and subject areas to investigate the sustained impact these tools have both on the learner, teacher and society as a whole. Further research can also benefit the design of future applications where the need to engage, is pitted against the limitations of the classroom environment.

CONCLUSION

Video games can have a very positive impact upon young people, and if we could harness these benefits and apply them effectively to education, imagine what could be achieved: curious learners, critically analysing actions and reactions, expanding their existing cognitive structures, formalizing their own conclusions, comfortable in a familiar environment. Pupils who want to

spend time learning new skills and applying them just to see what happens.

Integrating games into the classroom won't happen overnight, as there are significant changes to the infrastructure which must take place to produce a more flexible learning environment for our young people. However as we have discussed there are certain things that can be done today and the lessons learned about Games Based Learning within this chapter should help progress the use of games in the classroom.

Games are meant to be enjoyable, that's why people play them, and that's why they are so successful. Don't view the fact that your students are having fun while at school as a bad thing; you will have more motivated students and it is likely that their knowledge will be more heavily grounded as a result of the enjoyment they receive for their achievements.

Actual implementation of games in the classroom should follow the recommended cycle outlined in this chapter and only when each of the steps is used effectively will the true power of games-based learning be accomplished. Remember to set the scene for the students, as providing them with a context of the activity is absolutely essential. The debrief and reflection is arguably the most important aspect of the cycle, this is where the learning is drawn out and grounded. Also encourage students to continually debrief about the experience as this is the key to improvement.

An important lesson to remember is that it's not all about the game; it does not and should not replace the teacher. A structured learning environment is still required where the teacher guides the student through the experience. Integrating other tools alongside the game is also recommended. Also be creative in how you apply them. Therefore, in order to realize the use of games as teaching tools it is important to do the preparation, including familiarizing yourself with the game, rules and characters, as well as becoming familiar with this new form of learning.

Games can and are being integrated into classrooms. It is happening little by little throughout many schools in many countries. To facilitate this process we will need to continually share the lessons learned, as has been done in this chapter, and encourage the use of people's imaginations on how to use these engaging and motivating tools for the benefit of each new generation.

Mission Impossible Accomplished!

REFERENCES

Apperley, T. H. (n. d.). *Genre.and.game.studies: Toward.a.critical.approach.to.video.game.genres* (PDF). University of Melbourne.

Cohen, K. (2006). Right Click to Learn. *The Phoenix*. Retrieved July 6th, 2007, from http://the-phoenix.com/article_ektid20561.aspx

Cragg, R., Dawson, Cragg, A., Taylor, C., Et al. (2007). *Video. Games*. Prepared for the British Board of Film Classification. Retrieved October 6th, 2007, <http://www.bbfc.co.uk/downloads/pub/Policy%20and%20Research/BBFC%20Video%20Games%20Report.pdf>

Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper and Row

Entertainment Software Association (2007). *Facts.and.Figures*. http://www.theesa.com/facts/gamer_data.php

Federation of American Scientists (2005). *Harnessing.the.Power.of.Video.Games.for.Learning*. Retrieved June 25th, 2007, from <http://www.fas.org/gamesummit/>

Gee, P. (2003). *What. Video. Games. Have. to. Teach.Us.About.Learning.and.Literacy*. Palgrave Macmillan.

Greenfield, P. M. (1994). Cognitive effects of video games: guest editor's introduction: video

- games as cultural artifacts. *Journal of Applied Developmental Psychology*, 15(1), 3-12.
- King, A. (1993). From Sage on the Stage to Guide on the Side. *College Teaching*, 41(30). Retrieved June 24th, 2008, from <http://www.questia.com/googleScholar.qst;jsessionid=LhmfD5DS05RYcptnByT3TnFG9phhkyMG9n7cLKfz7MyStt6GrXdk!-766956787?docId=94305197>
- LaBar, K., & Cabeza, R. (2006) Cognitive neuroscience of emotional memory. *Nature*, 7, 54-63.
- McFarlane, A., & Kirriemuir, J. (2003, November). Use of Computer and Video Games in the Classroom. *Presented at the DiGRA conference*, Holland.
- Malone, T. W., & Lepper, M. R. (1987). Making learning fun: a taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning, and Instruction*, 3, 223-253. Cognitive and Affective Process Analyses. Hillsdale, NJ: Erlbaum.
- Prensky, M. (2001). *Digital Game-Based Learning*. New York: McGraw-Hill.
- Rosser, J. et al (2004). *Surgeons may err less by playing video games*. http://www.psychology.ia-state.edu/faculty/dgentile/MMVRC_jan20_MediaVersion.pdf
- Squire, K. (2003). Video games in education. *International Journal of Intelligent Simulations and Gaming*, (2), 1.
- Quinn, C. (2005). *Engaging Learning*. San Francisco: Pfeiffer
- Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: M.I.T. Press.
- Wolf, M. J. P., & Baer, R. H. (2002). Genre and the Video Game. *The Medium of the Video Game*. University of Texas Press.

Section IV

Gender and Disabilities

Chapter XVII

Games for Learning: Does Gender Make a Difference?

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ABSTRACT

Developing educational computer games that will appeal to both males and females adds an additional level of complexity to an already complicated process. Schools and universities need to be inclusive and new learning methods and materials should aim to be gender neutral. Traditional computer games are more popular with males than females, although the use of some simple guidelines in developing games for learning should reduce this preference. However, females have a more careful and committed approach to learning and may be more willing to try out new methods of learning including computer games. These opposing influences make it difficult to predict how gender will impact on the acceptance of games for learning. There is some evidence that both males and females enjoy the kinds of games that have most potential for learning. The impact of new computer games for learning needs to be evaluated to ensure that they facilitate learning without disadvantaging one gender over the other.

INTRODUCTION

The idea that computer games might be useful for learning has been gaining acceptance due to the recognition that computer games are both highly engaging (Garris, Ahlers & Driskell, 2002) and have the potential to support many of the skills

that are required by modern approaches to learning (Connolly, Boyle, Stansfield & Hainey, 2007). However, a key issue that needs to be addressed in considering the use of computer games in learning concerns whether there are differences between learners in their acceptance of games for learning. In introducing any new method of learning, it is

desirable that it should not favour one group of students over another. In particular the evidence that males are much more enthusiastic players of computer games for leisure than females (Gorriz & Medina, 2002), are more confident users of computers generally (Lee, 2003) and have better computer skills and more positive attitudes to computers (Bonnano & Kommers, 2008) suggests that males might benefit more than females from computer games for learning.

Understanding the relationship between gender and computer games is extremely important for creating computer games that will function as effective educational tools. In this chapter we look at explanations of gender differences in playing computer games, consider the impact of these gender differences for the development of games in learning and consider features of the educational context in which games for learning are being introduced that might impact on the acceptability of games for learning for males and females.

PREVIOUS RESEARCH

Table 1 summarizes some of the findings of the literature on gender differences in playing computer games for leisure in terms of patterns of play, characteristics of games and reasons for playing.

Gender Differences in Amount and Patterns of Play

Over the last thirty years computer games have become one of the most popular leisure pastimes for children, adolescents and even adults. However there is consistent evidence that playing computer games is a much more popular activity with males than it is with females. Research has shown that, across ages and cultures, more males play computer games than females. For example in a recent survey of Scottish students, Connolly

et al (2007) found that 91.8% male students but only 80.7% of female students played games. In addition males played for significantly longer than females, 9.3 hours per week on average compared with 5.9 hours per week for females and 36% of male students but only 9% of females played for more than 6-10 hours per week. Hartmann and Klimmt (2006) found similar gender differences with German children with only 33% of 6-13 year old girls playing compared with 54% of same-age boys and only 12% of female adolescents compared with 52% of male adolescents. Bonanno and Kommers (2005) found that Maltese boys (6.71 hours) also play for significantly longer per week than girls (2.49 hours).

Gender Differences in Games Preference

There are also differences between males and females in the kinds of games that they play. Males show a consistent preference for most game genre including strategy, adventure, sports and simulations (Bonanno and Kommers, 2005; Connolly et al, 2007) but this preference is particularly strong for violent games. Connolly et al found that 84.3% of their sample of Scottish male students but only 36.1% of females played shoot-em-ups. Others have found a female preference for puzzle type games (Bonnano & Kommers, 2005), board games, quizzes, puzzles and card/dice games (Lucas and Sherry, 2004) and educational games (Gorriz & Medina, 2000).

Taylor (2003) also found that more women than men play games such as hearts and dominoes online. It seems likely that these games are popular with women because they are single user games and take less time to play.

The most popular explanations of the male preference for traditional computer games centre on the view that computer games are designed by men for men (Gorriz & Medina, 2000) and consequently include features that are more appealing to men. In particular computer games

Table 1..Summary of gender differences in playing computer games for leisure: patterns of play, characteristics of games and reasons for playing

Amount of play and patterns of play	
Males are much more enthusiastic players of computer games for leisure than females	Gorriz & Medina (2002) Connolly et al (2007)
More males than females play games for leisure	Connolly et al (2007)
Males play for significantly longer periods of time per week than females	Connolly et al (2007) Hartmann and Klimmt (2006)
More males than females play for extended period of time	Connolly et al (2007)
Males have higher IT skill levels and are more confident users of computers generally	Lee (2003)
Males have better computer skills and more positive attitudes to computers	Bonnano & Kommers (2008)
Males are more interested in IT and computer science than females	Pinker (2008)
Characteristics of games	
Males prefer games with violent content, such as shoot-em-ups	Connolly et al (2007)
Females prefer puzzle type games	Bonnano & Kommers (2005)
Females prefer board games, quizzes, puzzles and card/dice games	Lucas and Sherry (2004)
Females prefer educational games	Gorriz & Medina (2000)
Female characters are under-represented in games	Dietz (1998)
Representation of female sexuality in game characters is highly exaggerated	Beasley & Standley (2002)
Males are better than females at the spatial awareness and visualisation skills that underlie many games	Halpern (1992); Subrahmanyam & Greenfield (1994)
Reasons for playing games	
Males give higher ratings to challenge as a reason for playing games than females	Lucas and Sherry (2004) Connolly et al (2007)
Males more likely than females to use games to increase physiological and emotional arousal and excitement	Anderson and Bushman (2001) Jansz (2005)
Games with a competitive structure appeal more to males than to females	Hartmann and Klimmt (2006) Connolly et al (2007)
Males are more likely to use computer games to socialise with their friends	Lucas and Sherry (2004)
Females rate social interaction between characters in games as important	Hartmann and Klimmt (2006)

frequently include violent content (Provenzo, 1991), are strongly gender stereotyped (Bryce & Rutter, 2002; Beasley & Standley, 2002) and require visualisation skills at which men perform better than women (Halpern, 1992).

Violent Content

The level of violence found in many computer games is one of the key features that males seem to enjoy but which puts many females off. The majority of popular computer games targeted at

teenagers and adults present violence in varying degrees of realism (Dietz, 1998; Schneider et al, 2004) and male adolescents and young adults are the most devoted players of these violent games (Gentile et al, 2004; Lucas & Sherry, 2004). Media genre preference research suggests that males are more interested in violent entertainment generally than females (Slater, 2003) and that females typically do not like violence, twitch games where speed and action are key, time pressure, competition or repetitive action. All of these are found in popular video games (Beato, 1997;

Murray & Kliman, 1999) such as *Grand Theft Auto*, *Mortal Combat*, *Halo* and *Counterstrike*. For example, in 'Grand Theft Auto: Vice City' players are rewarded for having sex with and kicking a prostitute to death and male characters can beat women with their fists. Although such depictions may attract male players, the violence and gender-stereotyped representations may put women off because they fail to identify with female characters in the game. Females have a low tolerance for observing or participating in conflicts and violence (Bussey & Bandura, 1999) and show a preference for non-violent entertainment (Oliver, Weaver & Sargent, 2000). They dislike such portrayals of female characters (McCroskey & McCain, 1974) and as a result their enjoyment of the game and motivation to play the game could be reduced.

Jansz (2005) argues that violent computer games provide an opportunity for male adolescents to experience intense emotional arousal. Computer games offer a laboratory-type of environment where young males can experience a variety of both positive and negative emotions and test out their reactions to these emotions in a safe and controlled environment which is removed from reality and which allows them to explore their identity. While in school, boys have to put on a show of bravado, but in computer games they can openly express fear, sadness and envy that they are not able to show in the real world. Olson et al (2007) also found that boys were much more likely than girls to use computer games to manage their emotions.

Some research suggests that girls and women do not mind violence itself as much as the repetition of the same violent acts ad nauseum. In effect women are more easily bored by computer games than men are (Graner Ray, 2004).

Representation of Gender in Games

In addition to violent content, many games also include gender-stereotyped representations of

women that repel females. Douglas et al (2002) found that few female characters are included in popular games and those who are depicted have few opportunities for action. The sexuality of the female characters who are included, depicted via physical attributes and clothing, is highly exaggerated (Downs & Smith, 2005; Ivory, 2006). Dietz (1998) surveyed 33 of the most popular computer games and found that 41% had no female characters and only 15% depicted women as action or heroic characters. Females tended to be portrayed in stereotypical ways, for example wearing pink or revealing clothing; 21% of the games that had female characters portrayed these characters as 'damsels in distress'; 21% of the games had violence directed at female characters and nearly 80% of the games included aggression or violence as part of the strategy or object. Similarly, the research organization Children Now studied best-selling computer games and found that only 16% of game characters were female and about half of the female characters were bystanders rather than active participants in the action (Douglas et al., 2002).

Computer games manufacturers have invested a lot of effort in developing computer games that appeal to females, although their motivation for doing so is possibly more to do with capturing the potentially huge market for female-oriented games rather than bowing to pressure from feminist groups. One of the early successes, Mattel's *Barbie Fashion Designer* allowed girls to design and print clothes for Barbie dolls (Gorritz & Medina, 2000). This game sold 200,000 copies within the first month of its release and was the sixth best-selling CD-ROM game in 1996 and 1997. This showed that games targeted at girls could be popular, although it is rather paradoxical that it featured Barbie, hardly a feminist icon with her highly exaggerated representation of feminine characteristics!

Skills Required in Games

Another feature of games that has been identified as important in shaping the male preference for games concerns the perceptual and cognitive abilities required in playing many computer games. Many games require good spatial awareness and visualisation skills and there is evidence that males are better than females at tasks involving these skills (Halpern, 1992; Subrahmanyam & Greenfield, 1994). Tetris for example requires the manipulation and rotation of objects in 3D worlds, Mario Kart involves the navigation of vehicles around a track, while first person shooters require accuracy in aiming at a target. Kimura's (1999) extensive summary of gender differences in cognitive abilities broadly confirmed that males have an advantage in spatial awareness and visualisation skills, while women have an advantage on verbal and social perception tasks, although these differences all tend to be small.

Uses and Gratifications Theory

A theoretical perspective that has been influential in providing a more coherent account of why people play games is uses and gratifications theory. Uses and gratifications theory explains the preferences of different groups of individuals for different media in terms of how these media satisfy differing entertainment needs. Uses and gratifications theory was initially developed as a theory of media use to explain why individuals watch TV (Rosenberg, 1974), but it has been broadened out to explain why individuals use a range of new media and technologies. Lucas and Sherry (2004) applied uses and gratifications theory to playing computer games and identified competition, challenge, social interaction, diversion, fantasy and arousal as the main reasons for playing games. Lucas and Sherry also found that males rated all six of these reasons for playing games as more important than females.

Challenge

Challenge was rated by both males and females as the most important reason for playing games both in Lucas and Sherry's study of American students and in a study of Scottish students by Connolly et al (2007). In Connolly's study, challenge was also rated as significantly more important than the next highest rated reason for playing games, pleasure. Challenge involves performance on a demanding task where effort and persistence are required and success is not necessarily ensured. The human need for challenge is the same as the need for achievement first described by McLelland (1961) as the strong motive to acquire high levels of competence in particular domains. Individuals differ in how they satisfy their needs for achievement, but males seem to find that computer games satisfy this need to a greater extent than females do.

Arousal

Arousal refers to the strong need that human beings have for excitement and stimulation and computer games seem to address this need. Lucas and Sherry found that arousal, assessed by questionnaire items such as "I find that playing games raises my level of adrenalin.", was rated the second most important reason for playing games for females and the third for males, although males still gave higher ratings to arousal than females did. This is consistent with evidence from other domains, such as gambling and extreme sports, that males have a stronger need for sensation seeking than females do (Arnett, 1996; Malkin & Rabinowitz, 1998). Sensation seeking refers to the pursuit of new and varied, physically stimulating and sometimes dangerous or risky activities and it is regarded as a partially hard-wired personality characteristic.

The term "arousal" is a well-known and well-accepted construct in the psychological literature. The Yerkes-Dodson law expresses the relationship

between arousal and performance by an inverted U curve showing that performance on a task increases up to a maximum as arousal increases but decreases again as arousal increases further. Human beings prefer to maintain an optimal level of arousal where performance is at its best.

Vorderer (2000) and Hanoch and Vitouch (2004) have recently argued that the concept of arousal requires further clarification. Arousal is usually regarded as a simple concept referring to physiological arousal but these authors have argued that it is more appropriate to characterise it as a multidimensional concept, including physiological, sensory, cognitive and emotional arousal. They propose that we need to specify more clearly which aspects of arousal are being referred to.

Hanoch and Vitouch also argued that the link between emotional arousal and performance is more complex than we have previously thought. They propose that there are situations where performance may increase linearly with arousal rather than showing the typical inverted U-curve. High levels of emotional arousal in particular may well be beneficial to, rather than detrimental to, performance on many tasks. Many computer games seem to elicit high levels of arousal, especially emotional arousal, and the impression we get from people playing computer games is that they are intent upon achieving and maintaining heightened (rather than optimal) levels of arousal. However it seems unlikely that these higher levels of arousal would lead to poorer performance. Players would quickly realize that it is counter-productive to experience high levels of emotional arousal if this leads to poor performance.

Social Interaction

In Lucas and Sherry's study, males rated social interaction as the second most important of the six reasons for playing games, while females rated it the least important reason. In addition the biggest difference between males and females in their

ratings of the importance of reasons for playing games was for social interaction. At first glance this is surprising since we tend to think that it is females who prefer social interaction. However these results show that males use computer games as an occasion for socialising with their friends. Females are much less likely to use computer games in this way. Moller, Hymel and Rubin (1992) argue that boys and girls are socialised into taking part in activities that are accepted as congruent with their own gender. Computer games are widely perceived as "boys' toys" and consequently playing games is socially more acceptable for boys than it is for girls. For boys, playing computer games with their friends will increase their acceptance by peers, but for girls would be considered as gender inappropriate play. Girls' joint activities with friends tend to be focused on more feminine pursuits.

Interestingly Hartmann and Klimmt (2006) found that social interaction of a different kind was perceived by females as important. In their study females rated social interaction between game characters in the development of a story line as important. Just as females prefer television programmes with a lot of meaningful dialogue and interactions between the characters, this preference also transfers to computer games (Inkpen et al, 1994; Murray & Kliman, 1999). In fact Hartmann and Klimmt found that female German students aged 18-26, rated opportunities for social interaction between characters in games as even more important in their evaluations of computer games than gender role portrayal and violence. This was rather surprising given the focus of much previous research on gender and violence. 'The Sims', a game that centres around social interaction between players and characters, is one of the few "gender neutral" computer games that has attracted many female players (Steen, Greenfield, Davies, & Tyne, 2006).

Massive multiplayer online games (MMOG) are an increasingly popular kind of online game in which hundreds of thousands of players can

simultaneously interact in graphically-rendered immersive worlds. These games combine the opportunities for social interaction between characters and character development that women seem to like, with the opportunities for socialising with friends (albeit online) that men seem to like. Consequently we might predict that MMOGs might be popular with both males and females but, from the point of view of social interaction, for different reasons. Although both males and females play, male players of MMOGs still outnumber females. Connolly et al (2007) found that more males (49%) than females (32%) played games online and those who played online also played for longer than those who did not. Seay, Jerome, Lee and Kraut (2004) found an even stronger male preference for MMOGs: 90% of their players were males who played MMOGs for 15-21 hours per week.

Competition

Lucas and Sherry (2004) found higher ratings for competition by males than females as a reason for playing games, suggesting that males regard the competitive element of games as more important than females. Connolly et al (2007) found a small but significant negative correlation between students' rating of competition as a reason for playing games and time spent playing games for female students only, suggesting that more competitive games actively put females off. Hartmann and Klimmt (2006) argued that generally games with a competitive structure appeal more to men than to women. They categorised games as competitive or non-competitive and found that males played competitive but not non-competitive games much more than females. Hartmann and Klimmt distinguished three different aspects of competitiveness – the desire to challenge or surpass others, the desire to win and the belief that one could win and found that males scored higher than females on all of these competitive traits.

Vorderer, Hartmann and Klimmt (2003) claim

that competition is the most important variable with respect to enjoyment of games because success on a task leads to an increase in enjoyment and the desire to continue playing. However in Lucas and Sherry's study young men rated competition as the least important of six reasons for playing games and in Connolly et al's study, competition was the 9th rated reason for playing games. These contradictory results may indicate that while competition is an important feature of game play, it is not perceived as a reason for playing *per se*.

The male preference for competition is evident in many domains, including sport, education and business, not just in computer games. From an early age boys tend to engage in competitive activities more than girls. Men are clearly much more involved in competitive sports such as football than women and relish its competitive nature even as supporters. In an intriguing laboratory experiment involving a relatively easy cognitive task where there was no gender difference in performance, Niederle and Vesterlund (2007) found that 73% of men but only 35% of women subsequently selected a competitive version of the task. They argued that this shows that the majority of men embrace competition while women tend to shy away from it.

Competition and violence frequently go together (Eastin, 2007) and it seems likely that the male preference for violence is related to their preference for competition. Very often violent games have competitive goals where the success of one player in achieving a goal inevitably leads to the failure of another to achieve that goal. Aggression can arise when competitors block a player's attempts to reach a goal.

It may seem paradoxical, but due to their competitive nature, men are happy to cooperate with others in groups, especially when their group is competing against another group. The male warrior hypothesis proposes that cooperation to defeat a common enemy is more common in males as it emerges from mankind's history

of group conflict and warfare where men have played a more prominent role than women (Van Vugt, De Cremer & Janssen, 2007).

The male liking for competition and cooperation in groups also helps to explain the popularity of MMOGs that incorporate both of these features. In MMOGs players work collaboratively in groups to compete against other groups. While the games can be played individually, many games of this genre can often only be mastered or even completed by working collaboratively with other players, which contributes to a substantial sense of community where players can work together in “guilds” (Connolly et al, 2007).

Although competition and challenge are similar constructs in many ways, they are viewed as separate needs (Lucas and Sherry, 2004). Both involve the need or desire to participate in a difficult task requiring effort and persistence. The difference is in how competence is evaluated. With challenge, performance is evaluated with respect to oneself, while with competition performance is evaluated with respect to others. This distinction between challenge and competition reflects the mastery/performance distinction in the achievement goal theory of motivation (Elliot, 1999). Mastery motivation, which underlies challenge, refers to the need to acquire knowledge, skills and competence and the criterion of success is the extent to which an individual acquires competence. In contrast performance motivation, which underlies competition, focuses on demonstrating competence relative to other students and the criterion of success is how well one does compared to other students.

Diversion

Using games as a diversion or distraction from other activities is another reason for playing games and this was also rated by males as more important (Lucas & Sherry, 2004). It is interesting in this respect that Anderson and Dill (2000) found a weak, negative relationship between time

spent playing computer games for leisure and academic performance, showing that those who play computer games more actually perform worse at school. This is presumably because time spent playing computer games reduces the amount of time that students spend studying. Further support for this view comes from the Pew project (Jones et al, 2003) which found that while 66% of college students claimed that gaming had no effect on their academic performance, 48% of students agreed that gaming keeps them from studying “some” or “a lot” and 9% admitted that their main reason for playing games was to avoid studying.

Recognition of Individual Variation

Of course in discussing gender differences we need to be careful that we do not make simplistic generalisations about men and women, but recognise the individual variation found in males and females. Many computer games seem to reflect a simple dichotomous perspective on gender with extremes of masculinity and femininity portrayed and little middle ground. However this is an unrealistic representation of gender. In real life people are more accurately represented by dualistic theories of gender that view both masculine and feminine characteristics as present to some extent in all people with a balance of the two being psychologically healthy (Spence & Helmreich, 1978). For example, while it is true that males generally tend to prefer violent games, many females enjoy and are successful at playing ‘hard-core’ games, as can be seen from their comments on various sites devoted to female gamers (e. g. GameGal.com; GrrlGamer.com; gamegirladvance.com; Game-Girlz.com; WomenGamers.com). Hayes (2005) contends that women’s past experience, identities, and motivations will determine their attitudes to violent games. Cunningham (2000) argues that social norms dictate that women should display feminine behaviours and repress their violent and aggressive side. However playing violent games gives female players the chance to express their aggression in a safe context.

Impact of Male Preference for Games

A number of authors have suggested that girls' early childhood exposure to traditional computer games with their male biases contributes to the female dislike of computers. This has a serious knock-on effect on subject choices at school and university, putting girls off computer-based subjects, constraining their skill-set and consequently cutting them off from a range of interesting and lucrative careers in IT and technology (Kiesler, Sproull and Eccles, 2002). Woudhuysen (2006) quotes Pickot-White (2005) who claims that sexist computer games are partially to blame for the gender gap in US computer science. This phenomenon, known as the pipeline shrinkage problem for women, has been well documented in the area of IT and computing, where the ratio of women to men involved in computing jobs shrinks dramatically from early years to working years (NSF, 2000; Güler & Camp, 2002).

Although sexist computer games may be partially to blame for the pipeline shrinkage problem it seems likely that the problem is more complex. The real issue is whether computer games shape or reflect our interests. It could be argued that the very fact that boys gravitate towards violent games while girls like games based on Barbie provides evidence of deep-seated differences between the sexes. There has been much debate over the origins of these strong and enduring gender differences in interests and preferences. Some have argued that differences in interests are biologically determined and consequently impossible to change (Pinker, 1999), while others have argued that they are attributable more to socialisation processes. Woudhuysen (2006) proposes that these preferences are very difficult to change as they probably reflect biologically influenced inclinations that are crystallised by socialisation.

Whether determined by nature or nurture male and female interests and preferences are very deep rooted, emerge at a very early age

and are resistant to change. Despite attempts to encourage boys and girls to take part in "gender neutral" play, they still tend to gravitate at a very young age to specific kinds of toys and games. Jacklin, Maccoby and Dick (1973) found such preferences at one year of age with girls preferring dolls or stuffed animals and boys preferring bricks and lorries. These gender differences in play and games preferences in young children carry on into their subject choices at school and university. Croxford (in Riddell, 2003) found gender-stereotyped patterns of subject choice in science subjects and argued that this was due to deep-seated attitudes that some subject areas are more suitable for boys, while others are more appropriate for girls. A head count of students in different departments at any British university would confirm that males still show a strong preference for maths, engineering, science and computing, while many more females are attracted to social science and social care subjects such as psychology and nursing (Lightbody et al, 1996).

Woudhuysen (2006) claims that much of the research argues that girls are somehow actively excluded from science and technology, but he disputes this, proposing instead that far from being excluded, girls actively choose to take subjects that they prefer. The fact that girls have caught up with and even overtaken boys in entry to subjects such as law, medicine and accountancy suggests that girls do have the academic opportunities and can follow them up if they are interested. By comparison, the relative lack of girls in engineering and IT suggests that girls are simply less interested in these areas.

Woudhuysen bravely suggests that the female dislike of computer games is ultimately linked to the life roles that women adopt in adult life: in modern society most adult females choose to bring up children as well as following a career. Susan Pinker (2008) makes a similar claim arguing that women's life goals are broader than men's. Where men put status at the top of their list of attributes in choosing a career, women are more interested

in flexibility, autonomy and social connections than status and choose careers that have a social purpose and humanitarian goals. Male and female interests are dictated by these differing goals at a startlingly early age.

Gender Differences in Games for Learning

In responding to criticisms that computer games are male-oriented the leisure industry developed games targeted at females. This has been an expedient approach, reflecting the differing needs and interests of males and females that are also evident in other leisure activities. However when it comes to designing computer games for learning the situation is more problematic. In order to ensure equal opportunities for all students, learning materials, teaching methods and practices should, as far as possible, be gender neutral (Riddell, 2001) and this also applies to computer games for learning. Although the games for leisure research indicates that this may be a difficult task, a few commonsense guidelines do emerge from this evidence, such as reduce the violent content, gender stereotyping and the competitive structure of games.

Fortunately there is some evidence that the kinds of games that might be useful as games for learning tend to appeal to both males and females. Connolly et al (2007) found that popular computer games such as strategy, adventure and role-playing games not only support the kinds of skills that could be useful in learning, but are also popular with both males and females. Role playing games provide opportunities to take part in activities and situations that players could not normally take part in, and to acquire communication, team building, negotiation and decision-making skills in an environment that has many features of the original, but without the attached risks (Aldrich, 2004). Females tend to like these games as they often include a strong story line.

Games for learning are increasingly diverse and require a range of skills that are less focused on the visualisation skills that favour males and include verbal skills and soft skills that favour females. While many traditional computer games require repetitive actions that are of limited use outside the game, the real power of games for learning is thought to be in their ability to provide open ended activities that have the potential to teach complex skills that can be transferred to other domains (Garris, Ahlers & Driskell, 2002). These skills include higher order thinking skills of the type increasingly recognised as valuable in higher education such as critical thinking, problem solving, decision making, argumentation and hypothesis testing skills, but also reflection and self-regulation skills that help students to evaluate their performance, and communication, negotiation and team working skills, which allow people to work better in groups. These are recognised as the kinds of skills crucial for the global, knowledge based economy (Dondlinger, 2007). Many new learning games involve combinations of activities that require players to integrate a variety of skills and abilities. Such complex games are less likely to favour one gender from a cognitive perspective, as they are less like “pure” tests of specific abilities where gender differences are more evident (Lawton and Morrin, 1999).

Where traditional computer-based learning applications tended to focus on the male dominated areas of maths and science, computer games for learning are now being developed in subject areas with a more social focus that attract more women, such as law and business (de Freitas, 2006) and politics, advertising and education (Bogost, 2007). De Freitas describes a simulation game based on Ardcalloch, a fictional town, which allows student lawyers to develop their skills in making the transition from being a student to being a professional. Bogost (2007) describes games that are intended to change people’s attitudes. He argues that such games provide a procedural rhetoric, a powerful new, visually based means

of presenting arguments in a procedural or active way that offers unique opportunities to persuade other people and change their opinions. Bogost offers many examples of these persuasive games. The McDonald's Videogame aims to help change attitudes to fast food and environmental issues by alerting players to inconsistencies in the aims of making profits while also considering environmental and health constraints. In the area of advertising, J₂O's toilet training game provides a compelling but bizarre (and very male-oriented) demonstration of the effects of inebriation on targeting behaviour, in this case urination, thus promoting the advisability of sticking to soft drinks! While the latter game is obviously an exception, there seems no reason to believe that women would not benefit from these games as much as men.

With such diverse games being created, realistically some will appeal more to males, others to females and others will appeal to both. Very few games for learning have been evaluated in terms of how effective they are in helping students learn (Akilli, 2007) and even fewer have addressed gender differences in their value and effectiveness. However comprehensive evaluation should address this.

The Educational Context of Games for Learning

In introducing games for learning into the classroom we need to consider the educational context in which these games will be used. There is a lot of evidence from the UK and other European countries as well as the US that currently girls of all ages are outperforming boys in school. In recent years females have outperformed males at primary school, secondary school (Riddell, 2001) and university level (McNabb, Pal & Sloan, 2002). McLean (2003) argues that boys perform badly because schools have been feminised providing de-motivating environments for large numbers of boys. Modern educational methods and practices,

such as the emphasis on mastery motivation and the de-emphasis of competition in the classroom, the primarily verbal, passive delivery of the curriculum and the increased emphasis on assessment by coursework rather than exam seem to suit the more methodical, committed and conformist approach of girls better than boys. Girls are better at the self-regulation required for successful performance and seem to be more willing to put in the effort than boys.

There is increasing concern that many boys and young men are being turned off education at an early age, so that they fail to fulfil their potential. Many boys find that the prevailing ethos in schools does not support their need for achievement in ways that they find conducive to learning. Many young men, not just the academically disengaged, subscribe to the "Not cool to study" view (McLean, 2003) and this has led to a culture of underachievement and "laddishness" amongst boys (Jackson, 2003). Laddishness denotes anti-school and anti-learning attitudes as well as "academic self-handicapping" behaviours (Urdan & Midgely, 2001), where males prefer to withdraw effort or avoid engaging in academic pursuits so that they don't lose face when they perform poorly. Using computer games as a diversion may well be an example of self-handicapping. Males have poorer academic self-perceptions than females (Jones & Myhill, 2004). In a study of Scottish 13 year olds Young (2007) confirmed that boys regard academic ability as much less important than girls, had more doubts about their academic ability and engaged in more avoidance behaviours than girls do.

However in sharp contrast to their lack of engagement within the classroom, boys seem to relish the challenge, stimulation and competition that computer games offer. It seems likely that, if boys are not satisfying their basic need for achievement (McLelland, 1961) in the area of academic pursuits, they will meet it in other ways, through football, music, computer games or other activities. Computer games provide

an arena where boys can satisfy their need for achievement and be successful in a safe domain without fear of failing or of ridicule. To be good at school is perceived as “sissy” but computer games are perceived as a macho activity where boys can demonstrate their competence. Bonanno and Kommers (2008) found that boys are much more confident than girls in performing the actions required in games and feel more confident in solving game related problems, whereas girls felt that they need a lot of support and guidance in using games. While recognising that ideally new educational methods should be “gender neutral”, in an educational climate that is currently more favourable to girls and where many boys do not thrive, it is tempting to argue that we should welcome any new teaching method that might help to re-capture boys’ interest and re-engage them in learning.

Females tend to be more committed and conscientious learners. They value activities that they perceive as having educational benefit and are more willing than males to put effort into such activities. Indeed the favourite computer games of females are puzzle and educational games. This suggests that girls would be willing to invest time in computer games if they were presented as a method for learning. It seems likely that it will be more important for girls than for boys that games for learning should help them to learn, whereas it would be more important for boys than for girls that games for learning should be fun. These factors and others make it difficult to predict precisely how gender will impact on the use of games in learning.

CONCLUSION

Developing educational computer games is not a trivial task and developing games that will appeal to and be accepted by both males and females provides an additional layer of complexity to the process. Research on computer games for leisure

confirms a strong and enduring male preference for computer games in terms of frequency of play, time spent playing and games played. Features of games such as the violent and gender stereotyped content and competitive structure of many games, the male superiority in the visualisation skills required in many games and the perception that games are “boys’ toys” seem to contribute to this persistent male preference for games.

Games manufacturers have responded to criticisms that games are male-oriented by developing games targeted specifically at females. This has been a successful strategy within the games for leisure arena, although it supports the view that there are fundamental differences between males and females in their freely chosen leisure interests and entertainment needs. However the situation is more complicated with respect to education. Schools and universities need to be inclusive and ideally new learning methods and materials should aim to be gender neutral. The research on games for leisure suggests a number of simple guidelines in developing games for learning, such as avoid gratuitous violence and gender-stereotyped representations of women and reduce the competitive structure of games. However we need to be careful that we do not strip out feature of games that make them enjoyable for males!

In reality a wide variety of games for learning is currently being developed to support a range of skills and content areas. It seems likely that some of these games will appeal more to boys and some to girls. In addition the kinds of games that might be useful in learning, such as strategy, adventure and role-playing games, are exactly the kinds of games that appeal to both males and females. As with any other educational intervention, we need to continuously evaluate the impact of introducing any computer game for learning to ensure that the game does assist learning and that it does so in a way that supports an inclusive curriculum without disadvantaging one gender compared with the other. Finally we must be careful not to stereotype boys and girls,

assuming for example that all boys like violent and competitive games and all girls do not. The reality is more complex.

REFERENCES

- Akilli, G. K. (2007). Games and Simulations: a new approach in education? In D. Gibson, C. Alrich, & M. Prensky (Eds.), *Games and Simulations in Online Learning: Research and Development Frameworks*. Idea Group Inc.
- Aldrich, C. (2004). *Simulations and the future of learning*. San Francisco, CA: John Wiley and Sons.
- Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: a meta-analytic review of the scientific literature. *Psychological Science*, 12, 353-359.
- Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings and behaviour in the laboratory and in life. *Journal of Personality and Social Psychology*, 78, 772-790.
- Arnett, J. J. (1996). Sensation seeking, aggressiveness, and adolescent reckless behavior. *Personality and Individual Differences*, 20(6), 693-702.
- Beasley, B., & Standley, T. C. (2002). Shirts vs. skins: Clothing as an indicator of gender role stereotyping in video games. *Mass Communication and Society*, 5(3), 279-293.
- Beato, G. (1997). *Girl games: Computer games for girls is no longer an oxymoron*. *Wired Magazine*. (April). Retrieved 6 September 2006, from http://www.wired.com/wired/archive/5.04/es_girlgames.html.
- Bogost, I. (2007). *Persuasive Games: the expressive power of Videogames*. Cambridge, MA: The MIT Press.
- Bonanno, P., & Kommers, P. A. M. (2005). Gender differences and styles in the use of digital games. *Educational Psychology*, 25(1), 13-41.
- Bonanno, P., & Kommers, P. A. M. (2008). Exploring the influence of gender and gaming competence on attitudes towards instructional games. *British Journal of Educational Technology*, 39(1), 97-109.
- Bryce, J., & Rutter, J. (2002). Killing like a girl: Gendered gaming and girl gamers' visibility. In F. M. Ed., *Computer Games and Digital Cultures—Conference Proceedings* (pp. 243-255). Tampere, Finland: University of Tampere Press.
- Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review*, 106(4), 676-713.
- Connolly, T. M., Boyle, E. A., Stansfield, M. H., & Hainey, T. (2007). The potential of online games as a collaborative learning environment. *International Journal for Advanced Technology for Learning*, 4(4), 208-0923.
- Cunningham, H. (2000). Mortal kombat and computer game girls. In J. T. Caldwell (Ed.), *Electronic media and technoculture*. New Brunswick: Rutgers.
- de Freitas, S. (2006). *Learning in Immersive Worlds: A review of games based learning*. Bristol. JISC. www.jisc.ac.uk/eli_outcomes.html.
- Dietz, T. L. (1998). An examination of violence and gender role portrayals in video games: Implications for gender socialization and aggressive behavior. *Sex Roles*, 38(5-6), 425-442.
- Dondlinger, M. J. (2007). Educational video games design: A review of the literature. *Journal of Applied Educational Technology*, 4(1), 21-31.
- Douglas, C. A., Dragiewicz, M., Manzano, A., & McMullin, V. (2002). United States: In video games, black women are victims, Latinas don't exist. *Off Our Backs*, 43(3/4), 6.

- Downs, E., & Smith, S. (2005). Keeping abreast of hypersexuality: A video game character content analysis. *International Communication Association Conference*, New York, NY.
- Eastin, M. S. (2007). The effect of competitive and co-operative group game play on state hostility. *Human Communication Research*, 33, 450-466.
- Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist*, 34(3), 169-189.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation and Gaming*, 33(4), 441-467.
- Gentile, D. A., Lynch, P. J., Ruh Linder, J., & Walsh, D. A. (2004). The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *Journal of Adolescence*, 27, 5-22.
- Gorriz, C. M., & Medina, M. (2002). Engaging girls with computers through software games. *Communications of the ACM*, 43, 42-49.
- Graner, Ray, S. (2004). *Gender inclusive game design: Expanding the market*. Hingham, Massachusetts: Charles River Media.
- Gürer, D., & Camp T. (2002). An ACM-W literature review on women in computing, *ACM SIGCSE Bulletin*, 34, 2.
- Halpern, D. F. (1992). *Sex differences in cognitive abilities*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Hanoch, Y., & Vitouch, O. (2004). When less is more information, emotional arousal and the ecological reframing of the Yerkes-Dodson Law. *Theory & Psychology*, 14(4), 427-452.
- Hartmann, T., & Klimmt, C. (2006). Gender and computer games: Exploring females' dislikes. *Journal of Computer-Mediated Communication*, 11(4), 910-941.
- Hayes, E. (2005). Women and video gaming: gendered identities at play. In *Games, Learning & Society Conference*, Madison, WI, June 2005.
- Inkpen, K., Upitis, R., Klawe, M., Lawry, J., Anderson, A., Ndunda, M., Sedighian, K., Leroux, S., & Hsu, D. (1994). We have never forgetful flowers in our garden: Girls' responses to electronic games. *Journal of Computers in Math and Science Teaching*, 13(4), 383-403.
- Ivory, J. D. (2006). Still a man's game: Gender representation in online reviews of video games. *Mass Communication & Society*, 9(1), 103-114.
- Jacklin, C. N., Maccoby, E. E., & Dick, A. E. (1973). Barrier behaviour and toy preference: sex differences and their absence in the one year-old child. *Child Development*, 44, 557-569.
- Jackson, C. (2003). Motives for "Laddishness" at school; fear of failure and fear of the feminine. *British Educational Research Journal*, 29(4), 583-598.
- Jansz, J. (2005). The emotional appeal of violent video games for adolescent males. *Communication Theory*, 15(3), 219-241.
- Jones, S., & Myhill, D. (2004). Troublesome boys and compliant girls: gender identity and perceptions of achievement and underachievement. *British Journal of Sociology of Education*, 25, 547-561.
- Jones, T. (2003). Let the games begin: Gaming technology and entertainment among college students. *Pew Internet and American Life Project*. Retrieved 10 October 2006, from http://www.pewinternet.org/pdfs/PIP_College_Gaming_Report.pdf.
- Kiesler, S., Sproull, L., & Eccles, J. E. (2002). Pool halls, chips and war games: women in the culture of computing. *SIGCE Bulletin*, 34(2), 159-164.
- Kimura, D. (1999). *Sex and Cognition*. The Massachusetts University Press.

- Lawton, C. A., & Morrin, K. A. (1999). Gender differences in pointing accuracy in computer simulated 3D mazes, *Sex.Roles*, 40(1/2), 73–92.
- Lee, A. C. K. (2003). Undergraduate students' gender differences in IT skills and attitudes. *Journal of Computer Assisted Learning*, 19, 488-500.
- Lightbody, P., & Durndell, A. (1996). Gendered career choice: is sex-stereotyping the cause or the consequence? *Educational Studies*, 22(2) 133-146.
- Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication Research*, 31(5), 499-523.
- Malkin, M. J., & Rabinowitz, E. (1998). Sensation seeking and high-risk recreation. *Parks and Recreation*, 33(7), 34-39.
- McCroskey, J.C., & McCain, T.A. (1974). The measurement of interpersonal attraction. *Speech Monographs*, 41(3), 261-266.
- McLean, A. (2003). *The Motivated School*. Paul Chapman Publishing.
- McLelland, D. C. (1961). Methods of measuring human motivation. In J. W. Atkinson (Ed.), *The Achieving Society* (pp. 41-43)... Princeton, N.J.: D. Van Nostrand.
- McNabb, R., Pal, S., & Sloan, P. (2002). Gender difference in educational attainment: the case of university students in England and Wales. *Economica*, 69, 481-503.
- Moller, L.C., Hymel, S., & Rubin, K. H. (1992). Sex typing in play and popularity in middle childhood. *Sex Roles*, 26, 331-353.
- Murray, M., & Kliman, M. (1999). Beyond point and click: The search for gender equity in computer games. *ENC focus*, 6(3), 23–27.
- Niederle, M., & Vesterlund, L. (2007). Do women shy away from competition? Do men compete too much? *The Quarterly Journal of Economics*, 122(3), 1067-1101..
- NSF. (2000). *Women, Minorities, and Persons with Disabilities. in Science and Engineering*. 2000, National Science Foundation report. Retrieved 10 October 2006, from <http://www.nsf.gov/cgi-bin/getpub?nsf00327>.
- Oliver, M. B., Weaver, J. B., & Sargent, S. (2000). An examination of factors related to sex differences in enjoyment of sad films. *Journal of Broadcasting and Electronic Media*, 44(2), 282-300.
- Olson, C. K., Lawrence, S. D., Kutner, A., Warner, D. E., Almerigi, J. B., Baer, L., Nicholi, A. M., & Beresin, E. V. (2007). Factors Correlated with Violent Video Game Use by Adolescent Boys and Girls. *Journal of Adolescent Health*, 41, 77–83.
- Pinker, S. (1999). *How the Mind Works*. Hammondsworth: Penguin Books.
- Pinker, S. (2008). *The Sexual Paradox.. Men, Women, and the Real Gender Gap*. London: Atlantic Books.
- Provenzo, E. F. (1991). *Video kids: Making sense of Nintendo*. Cambridge, MA: Harvard.
- Rosenberg, K. E. (1974). Uses and gratifications a paradigm outlined. In J. G. Blumler and E. Katz (eds.) *The uses of Mass Communication: Current Perspectives of Gratifications Research*. (pp. 269-286). Beverley Hills, CA: Sage.
- Riddell, S. (2003). Gender and Scottish Education. In T. G. K. Bryce & W. M. Humes (Eds.), *Scottish Education, second edition. Post-devolution*. Edinburgh: Edinburgh University Press.
- Schneider, E. F., Lang, A., Shin, M., & Bradley, S. D. (2004). Death with a story: How story impacts emotional, motivational, and physiological responses to first-person shooter video games. *Human Communication Research*, 30(3), 361-375.

- Seay, A. F., Jerome, W. J., Lee, K. S., & Kraut, R. E. (2004). Project massive: A study of online gaming communities. In *Extended abstracts of the Conference on Human Factors in Computing Systems*, Vienna, Austria, (pp. 1421-1424).
- Slater, M. D. (2003). Alienation, aggression, and sensation seeking as predictors of adolescent use of violent film, computer, and website content. *Journal of Communication*, 53(1), 105-121.
- Spence, J. T., & Helmreich, R. L. (1978). *Masculinity and femininity: their psychological dimensions, correlates, and antecedents*. Austin, TX: University of Texas Press.
- Steen, F. F., Greenfield, P. M., Davies, M., & Tynes, B. (2006). What went wrong with The Sims Online: Cultural learning and barriers to identification in a massively multiplayer online role-playing game. In P. Vorderer & J. Bryant (Eds.), *Playing Video Games: Motives, Responses, and Consequences* (pp. 307-324). Mahwah, NJ: Lawrence Erlbaum Associates.
- Subrahmanyam, K., & Greenfield, P. M. (1994). Effect of video game practice on spatial skills in girls and boys. *Journal of Applied Developmental Psychology*, 15, 13-32.
- Taylor, T. L. (2003). Multiple pleasures: Women and online gaming. *Convergence*, 9(1), 21-46.
- Urdan, T., & Midgley, C. (2001). Academic self-handicapping: what we know what more there is to learn. *Educational Psychology Review*, 13, 115-138.
- Van Vugt, M., De Cremer, D., & Janssen, D. P. (2007). Gender differences in cooperation and competition: The Male Warrior Hypothesis. *Psychological Science*, 18(1), 19-23.
- Vorderer, P. (2000). Interactive entertainment and beyond. In D. Zillmann & P.
- Vorderer (Eds.), *Media entertainment: The psychology of its appeal* (pp. 21-36). Mahwah, NJ: Lawrence Erlbaum Associates.
- Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing videogames: the role of competition. *ACM International Conference. Proceeding. Series; Proceedings of the second international conference on Entertainment computing*, Pittsburgh, Pennsylvania, (pp. 1-9).
- Woudhuysen, J. (2006). *Computer Games and Sex Difference*. Retrieved 23rd June 2008 from <http://www.woudhuysen.com/documents/ComputerGamesSexDifference.pdf>
- Young, A. (2007). *An investigation of possible gender differences in students' academic self-perceptions within a classroom environment*. Unpublished Dissertation, University of Paisley.

Chapter XVIII

Digital Games–Based Learning for Students with Intellectual Disability

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ABSTRACT

Students with Intellectual Disability (ID) are often described as “slow learners” and cannot easily integrate to the normal curriculum. Still, the needs of a person with ID for accomplishment, enjoyment and perception of high quality multimedia content are augmented. In general education settings digital games for learning seem to work successfully with students, regardless of their developmental state or academic achievements. However, can such an approach work in a suitable and effective way for students with ID? If the answer to this question is positive, under which conditions and limitations can digital games be integrated into the ID instructional process? The purpose of this chapter is to investigate the common grounds between methodologies for Special Education Needs/Intellectual Disability (SEN/ID) pedagogy on the one hand and Digital Games-Based Learning (DGBL) on the other, as well as to explore the potential of using digital games for SEN/ID students. To this end, the usage of digital games in the learning experience of students with Intellectual Disability is discussed, the ways in which commercial and educational games support various SEN methodologies and theories regarding Intellectual Disability pedagogy are examined and findings from the education literature as well as experimental observations and case studies are presented in order to investigate how and to what extent learning-purposed, as well as entertainment-purposed games are able to constitute a powerful educational medium for SEN education and its inclusive objectives.

Objectives of this Chapter and Questions Addressed

Intellectual Disability (ID) is a term employed to refer to certain limitations of children and adults in mental development, communication and social skills. These limitations will cause a child to learn and develop more slowly than typical. In addition children with intellectual disability may take longer to learn to speak, walk and take care of their personal needs such as dressing or eating.

It should be noted that a number of wordings and definitions has been employed for the limitations and difficulties that Intellectual Disability refers to. Terms such as “Developmental Delay(s)”, “Mental Retardation”, “Learning Disability” and “Special Learning Difficulties” have been used over the past years. The term “Mental Retardation” has prevailed for some time but has received a number of criticisms lately. Following a 2002 survey by the American Association on Intellectual and Developmental Disabilities (AAIDD, formerly the AAMR¹) which has shown the general consensus among parents, educators and other professionals to be that this term has a negative connotation, the term “Intellectual Disability” is currently used in British Commonwealth countries and by the International Association for the Scientific Study of Intellectual Disabilities (IASSID).

Intellectual Disability represents a widespread and heterogeneous condition, characterized principally by cognitive deficits in relation to the normal population (Zeaman & House, 1963; Ellis, 1963). According to the authoritative definition of the AAIDD² which undertakes a functional perspective, as well as the statements of researchers such as (Schalock et al, 2007) who states that “*Intellectual Disability is characterized by significant limitations both in intellectual functioning and in adaptive behavior as expressed in conceptual, social, and practical adaptive skills*”, one of the basic characteristics of ID is the lack of adaptivity in everyday situations. Persons with Intellectual Disability might be delayed or lacking some of the

so called Adaptive Behavior Skills such as reading, writing, expressive and receptive language, money concepts, self directions, responsibility, self-esteem, gullibility, understanding and following rules, daily living activities and occupational skills (AAIDD, 2008).

Within a formal educational context students with Intellectual Disability are often described as “slow learners” and cannot easily integrate to the normal curriculum, as a result of the aforementioned lack of adaptive skills and other low IQ-related difficulties, often coupled with additional handicaps and special needs. It is exactly these conditions, however, that result in an augmented need for persons with ID to draw a sense of enjoyment and personal accomplishment from the educational process. The aim of this chapter is to investigate to what extent pre-adult learners (children and adolescents) with Intellectual Disability are able to use digital games in order to test their abilities in a trial-and-error fashion within a formal – but nonetheless friendlier – learning process while at the same time having fun.

This objective calls for highlighting the common grounds between Intellectual Disability pedagogy on the one hand and Digital Games-Based Learning (DGBL) on the other, with a view to shedding light on the capabilities and limitations of applying digital games as instructional tools in the ID classroom. To this end a review of the relevant literature is provided, coupled with observations from a number of case studies using digital games as an instructional tool for students with ID. It must be noted that the term “digital games” is used in this chapter to refer to a broad spectrum of games running on stand-alone computers or on-line and implemented at various degrees of sophistication, ranging from browser-based applications to fully developed commercial-off-the-shelf (COTS) products, and also including a number of edutainment software applications.

The following questions are addressed in this chapter:

1. Can DGBL meet the instructional requirements of ID pedagogy?
2. Are there specific types of digital games that seem to meet these requirements in a particularly effective way?
3. What are the critical success factors for applying DGBL to the ID classroom?
4. What are the limitations of such an effort?

The rest of the chapter is organized as follows:

- Section 2 sets out a correspondence between requirements for the instructional process and curriculum for students with intellectual disability, on the one hand, and the capabilities of digital gaming and digital games-based learning, on the other.
- Section 3 reports on a number of case studies on DGBL applications in the special and ID classroom, taken from a review of the associated literature as well as from the authors' own research.
- Section 4 discusses findings, recommendations, limitations and critical success factors associated to the application of DGBL as an instructional tool for students with ID.
- Finally, Section 5 concludes the chapter.

ID Instructional Requirements and Digital Game Play

ID Instructional Requirements

The aim of Special Education is to design and implement an alternative learning framework, in order to overcome the learning difficulties of special students and at the same time enable their social integration at the highest possible level of autonomy and self-determination. To this end, special education is offered through different structures and services, ranging from special

schools, inclusion practices, pull-out classrooms and support classes to SEN bases or units, outreach services as well as residential care centers.

Adoption of a number of instructional principles is instrumental to the achievement of the objectives of Special Education in a systematic and effective way. The relevant literature discusses a number of such principles, whose applicability may depend or not on specific types of special needs such as ID and others. Table 1 below, lists requirements applicable to the planning of instructional processes and curricula for learners with Intellectual Disability, as adapted from (Kalantzis, 1985) and (Christakis, 2002).

Digital Gaming Capabilities and Digital Game Types

It is interesting to see how the requirements for planning instructional processes and curricula for learners with Intellectual Disability listed in Table 1 correspond to some established capabilities of digital gaming, especially when specific game types are selected which are more appropriate for a particular ID instructional requirement. Table 2 presents such a correspondence between ID requirements and digital gaming capabilities while Table 3 presents a correspondence between ID requirements and specific digital game types. It should be noted that the term “digital gaming” refers here to engaging in general-purpose gameplay, and in many cases the digital gaming capabilities and game types mentioned are not specific to educational games. The resulting correspondence, therefore, indicates that even *pure* (i.e. entertainment-only) digital gameplay can still be of value to the ID instructional process.

The strict conclusion that can be drawn from the correspondence shown below is that, *in principle*, digital gaming is *not excluded* from serving as an instructional tool for ID. This somewhat weak argument of non-exclusion, however, will be complemented in the following by concrete examples of digital games for learning that

Table.1..Requirements.affecting.how.an.ID.instructional.curriculum.and.process.needs.to.be.planned

Monitoring and immediacy (Christakis, 2002)	Individuals with moderate or severe intellectual disability have difficulties in the understanding of meanings, ideas and objects that are not situated in their “here and now” experience. Monitoring and immediacy are essential components of the instructional process.
Entrenchment and practice (Christakis, 2002)	Repetition and constant practice are indispensable for the development of knowledge, experience and skills that will have application in everyday situations.
Therapeutic intervention and assistance (Kalantzis, 1985)	Background demands need to be in harmony with learner needs and able to lead to positive interaction.
Child-centered/individual adaptation (Christakis, 2002), Adaptive curriculum (Kalantzis, 1985)	A prerequisite to the success of an instructional plan is adaptation to the abilities and educational needs of the learner, as these are combined with the instructional goals and individual objectives of the instructor involved.
Curriculum localization in the direct natural and cultural environment (Kalantzis, 1985)	The ultimate goal of Special Education is to prepare every student for adult life at the highest possible level of autonomy. To this end, the special curriculum needs to be localised on what is needed to cope with the learner’s natural and cultural environment.
Proximity to real-life situations (Christakis, 2002)	Every teaching unit should satisfy the real current and future needs of the learner, in order to make efficient use of instructional time.

Table.2..Correspondence.between.ID.instructional.requirements.and.digital.gaming.capabilities

ID instructional requirements	digital gaming capabilities
Monitoring and immediacy (Christakis, 2002)	Digital games can include software agents that not only monitor and log player behavior during gameplay, but are also able to offer help in case of a difficult situation, hint at the solution and highlight the next step. Therefore the player can be constantly monitored and supported, with the game itself operating as a patient and omnipresent tutor.
Entrenchment and practice (Christakis, 2002)	Most games (ranging from simple applications like Dora the Explorer to much more complex games as The Sims) are based on mechanisms of trial-and-error and repetition of steps in order for player to learn the essential skills and continue the game. New tasks integrate with the repetitive process of acquired skills and form a complete instructional goal. In a popular educational title, for example, the user has to pick letters throughout his/her journey in various cities and form words and sentences. Acquired letters are used again and again and the process itself has to be repeated in order for the player to travel to the next city. As (Brooks, 1997) notes, an important value of digital games for learning is that they motivate players to focus, test their skills, use trial-and-error and learn while having fun.

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Table.2..continued

Therapeutic intervention and assistance (Kalantzis, 1985)	This principle ensures that the co-existence of student's skills along with background demands will be harmonized and lead to positive interaction. Educational games such as "Dominic Interactive" are able to have a therapeutic result in cases of anxiety, racism, violence, and raise awareness. Additionally, digital games with popular animated heroes can have a therapeutic value in issues of self-esteem or loneliness.
Child-centered/individual adaptation (Christakis, 2002), Adaptive curriculum (Kalantzis, 1985)	A digital game could cover one or more educational needs, specialized on the mental and physical age of the player and reflecting his/her interests and necessities. By adjusting the level of difficulty and the pattern of navigation, both content and design can be adapted accordingly. Digital games allow the possibility of repetition and practice, allowing the player to practice and learn within his/her own cognitive capabilities and timeframe (Rooms, 2000). What is more, adaptivity and personalization are characteristics that many digital games share and therefore can be modified and used accordingly by the educator, meeting instructional goals adapted to each student's particular skills.
Curriculum localization in the direct natural and cultural environment (Kalantzis, 1985)	Digital games, through their immersive logic and cinema-style narrative, can be used as an effective medium for teaching attitudes and social behavior according to the cultural environment of the student. Brigadoon, for example, is a small virtual island within the Second Life massively multiplayer online game, created for individuals with autism and Asperger's syndrome in order to give them the possibility to explore the social interactions that are so hard for them in the real world (Lester, 2006).
Proximity to real-life situations (Christakis, 2002)	A large category of digital games simulates real-life situations and allows players to easily assimilate patterns and solutions (e.g. <i>The Sims</i> , <i>Roller Coaster Tycoon</i> , simulation games regarding money/shopping, dressing up etc). The second category of digital games which can be characterized as fictional, can still have adequate proximity to real-life situations since, by means of dramatization and engagement, the player not only identifies to the game hero, but is able to make connections between the fantasy and real worlds. While using a fictional character (such as a cartoon hero or a fictional creature, e.g. a dragon), children are able to equal fantasy to real life emotions and situations and find practical usefulness in a fictional scenario.

Table.3..Correspondence.between.ID.instructional.requirements.and.types.of.digital.games

ID instructional requirements	types of digital games
Monitoring and immediacy (Christakis, 2002)	Every type of games can embed the principle of player monitoring. Especially adventure, simulation and role-playing games are particularly suited to this requirement as they define game progress according to player decisions and gameplay efficiency.
Entrenchment and practice (Christakis, 2002)	All game genres give the possibility to repeat an action till it is successful and to learn through practice. Especially drill and practice games as well as arcade/platform games are based on these characteristics, at times to an undesirable extent known as tread-milling.
Therapeutic intervention and assistance (Kalantzis, 1985)	Interactive digital storytelling for audience with intellectual disability needs to be used with caution. Depending on the scenario, graphics and sound effects, a complex adventure, simulation or role-playing game can cause stress to a player with ID. Simple platform or drill and practice games with soothing music and graphics, on the other hand, might prove relaxing.
Child-centered/individual adaptation (Christakis, 2002), Adaptive curriculum (Kalantzis, 1985)	Role-playing games are based on adaptivity and user-centered gameplay, whereas many simulation games offer various possibilities of personalization. Additionally, many drill and practice games offer player-adjustable difficulty and speed, font size and color density, as well as guided or free-style gameplay. Drill and practice games are often preferred for classroom usage due to their simple scenario and obvious learning outcomes. However simulation games with rich scenario options may equally well be adapted to fit instructional goals, whereas arcade/platform games with simple scenarios can also be created by the instructors themselves using simple game development tools.
Curriculum localization in the direct natural and cultural environment (Kalantzis, 1985)	Simulation and high-quality role-playing games are the game genres that are able to respond better in the principle of localization. The educator is able to choose the most suitable game according to the direct needs of the student in order to prepare the student for the social and practical necessities of adult life. According to researchers such as Elaine Raybourn and Annika Waern, games have long provided a structured environment for quickly learning complex behaviors, especially role playing games can help gamers explore skills, methods and concepts rapidly within an engaging non threatening environment (Raybourn and Waern, 2004).
Proximity to real-life situations (Christakis, 2002)	Simulation and role-playing games are the most efficient game types when it comes to this principle. Successful games of these genres are able to embed real-life situations in their scenarios and allow the player to take decisions. Previous work (Standen, Cromby & Brown, 1997) suggests that virtual environments are effective in facilitating the acquisition of everyday living skills, as for example shopping.

provide thematic coverage of the ID educational curriculum, as well as by additional findings from actual cases of successfully applying DGBL with SEN and ID learners.

Digital Games-Based Learning for Students with SEN

The proposed correspondence between instructional requirements for learners with ID and digital game capabilities and types presented in the tables above should not really come as a surprise. As early as 1981, Malone was one of the first to recognize that digital games engage students' interest through mechanisms of balanced challenge, curiosity and imagination, while at the same time lending themselves to personalization and adaptivity according to the learners' capabilities and needs (Malone, 1981). Nowadays, computer games-based learning has taken its place in homes and national curricula in the form of educational and edutainment software, while game researchers such as Becker and Verenikina have connected existing game design with scholarly and widely accepted pedagogy (Becker, 2005a; Verenikina, Harris and Lysaght, 2003).

Becker, in particular, has demonstrated how games, even purely commercial ones, already embody the fundamental elements of learning and instructional theories. Learning theories such as Gagné's Five Categories of Learning and Nine Events of Instruction (Gagné, Briggs and Wager, 1992) or Gardner's Theory of Multiple Intelligences closely correspond to game design principles (Becker, 2005b). Design of an entertainment or education-oriented game can incorporate support for various learning styles (Becker, 2005a), including the different types or levels of learning mentioned in the analysis of Gagné:

- “verbal information” is provided by digital games both verbally and textually;
- “intellectual skills”, such as the use of concepts and rules to solve problems, form the basis of most strategy games;

- “cognitive strategies” are essential in order to accomplish game tasks;
- “attitudes” are of cardinal importance to role-playing games; and
- most games require the use of some sort of controller or keypad, thereby helping to develop “fine motor skills” (Becker, 2005a).

All these five categories of learning come to life in Gagné's Nine Events of Instruction, a theory that provides the essential conditions for effective learning. Becker has shown that there are types of games (according to the author's terminology, “good games”) that meet practically all of the above criteria (Becker, 2005b).

All over the world today researchers, educators and game designers are increasingly becoming interested in the potential use of computer and video games to support the learning experience of young people. There are still questions and open issues, however, as to whether proprietary games developed for educational purposes can deliver a more effective DGBL experience, in comparison to COTS games designed for entertainment rather than instruction (de Freitas, 2006). COTS might fail in supporting defined learning objectives, but their game design and levels of immersiveness, are superior to their educationally driven rivals. The research into how games can support learning both in and out of school by engaging students has led to a recent interest in developing state of the art personalized educational games. Therefore, efforts are made to develop educational games that will exhibit the same levels of quality, playability and immersiveness of the bestselling mainstream games (Sandford and Williamson, 2005, p. 23).

Regarding special learners, researchers as Langer, Pronger and Lester have stressed the importance of technology in the facilitation of social interaction for people with cognitive and physical disabilities and the fact that advances in computer and communication technology present a great opportunity for people with disabilities to gain

equal access to a number of social opportunities (Langer, 1985; Pronger, 1995; Lester, 2006).

Apart from conventional non-digital gameplay students with cognitive disabilities can use educational software and digital games in order to experience everyday situations and curriculum learning subjects such as mathematics, reading and vocabulary, promote problem solving skills and prepare themselves virtually for social integration, vocational training and safety (Fitros, 2005). According to the literature, besides the enjoyment that students experience thanks to digital gaming, concentration is also being supported and students are able to prove their skills and knowledge (Detheridge, 1996).

An additional argument in this line of thought in favor of the introduction of DGBL as an instructional tool for Special Education in general, and Intellectual Disability in particular, comes from the observation that there is currently available a number of educational games which can clearly cover subject matter of the ID instructional curriculum, as detailed in the following section.

ID Curriculum and Digital Games

Although every single digital game can operate as a tool for skill acquisition, not all games can have the same instructional effectiveness within the general or SEN/ID classroom. Generalizing the connection between digital gameplay and learning outcomes without paying attention to the different qualities of each game leads to misunderstandings and fruitless debates on the barriers of DGBL, rather than on its potential.

Therefore, it is essential to discuss different games and their corresponding educational potential with respect to the instructional curriculum at hand, and in particular to the SEN/ID curriculum of interest here. Table 4 shows some examples of digital games which are now freely or commercially available and address major topics of the SEN/ID curriculum such as literacy and numeracy skills, social and communicational

skills, personal safety and hygiene, physical and psychological health as well as specific cases of vocational training.

As can be seen from Table 4, when referring to students with ID educators are not necessarily more constrained in their options; on the contrary, in some cases they can have more flexibility on the usage of different game types and genres.

Using DGBL for Learners with ID/SEN: Case Studies

Review of Cases Reported in the Literature

Studies and cases have gradually started to appear in favor of the introduction of digital games in Special Education. At Becta's Computer Games in Education project, SimCity 3000 and The Sims were used with key stage 3 and 4 students with special needs. According to the Becta report *"the primary learning aims were for the pupils to build simple models (a city or house) within a microworld, to understand the rules governing the model, and to vary the parameters for different effects.. SimCity was used to enable pupils to develop some technical ICT skills such as using menus and viewpoints, and to be able to read and understand data in various forms (databases, graph, etc).. The Sims was used to encourage understanding of the importance of budgeting, and gave support to discussions and exploration of emotional and relationship issues.. Other unintended benefits included use of the Internet for focused reasons (information, new items)"* (Becta, 2001).

Research on autism and multimedia games has revealed increased interest and sense of personal accomplishment on behalf of the players, on top of very positive results in educational objectives such as reading and concept learning (Williams et al, 2001).

Table.4..Indicative.digital.games.available.for.subjects.of.the.ID.curriculum

ID curriculum subject matter	digital games available
literacy and numeracy skills (writing and verbal skills, arithmetic skills, logic, counting, significance of time and date etc)	In games such as <i>Sebran</i> ³ and <i>All. About. Numbers</i> ⁴ students visualize grammatical, vocabulary and mathematical concepts with colorful pictures and animations. <i>Alphabet.Track</i> ⁵ allows players to move through eight fun activities at their own pace. By learning to recognize and locate letters of the alphabet quickly and consistently, students at all levels acquire more spelling independence and remain on track for developing vocabulary and other vital literacy skills.
social and communicational skills	<i>Toward.Independence</i> ⁶ is a well-rounded collection of five life-skill programs that covers functional vocabulary and community outings, money skills, shopping and social behavior, presented in a step-by-step fashion.
personal safety and hygiene	<i>Body.Explorer</i> ⁷ and <i>Bodywise</i> ⁸ are able to enliven health and life science curriculums via animations and graphics and allow students to investigate body systems, health education topics, and frequently asked questions about the human body. <i>Out.and. About</i> ⁹ , on the other hand, includes activities such as cooking, shopping, use-by dates and others.
physical and psychological health	<i>Dominic.Interactive</i> ¹⁰ is a computer game that helps children to reveal their anxiety, including depression tendencies and strengths. <i>Smart.Alex</i> ¹¹ is a cartoon character that can undertake over a hundred faces, expressing different emotions. At a higher level, users can hold a simple conversation with Alex and talk about their likes and dislikes.
vocational training (selected topics)	<i>Happenings</i> ¹² . and <i>Restaurant. Game</i> ¹³ help students increase awareness of the descriptions and responsibilities of everyday professions, while through <i>The.Sims.-.Open.for.Business</i> ¹⁴ they can better apprehend the notions of responsibility, punctuality and duty.

Lynne Padgett and Dorothy Strickland (2006), have used a specifically designed computer game, in order to teach fire safety skills to children diagnosed with Fetal Alcohol Syndrome¹⁵. Children participated in this study by using a multiple baseline, multiple probe design. Before the game, no child could correctly describe the proper actions that should be taken during a home fire. A computerized game allowed them to learn the recommended safety steps in a virtual world. Skill learning and real-world generalization were

tested immediately after the intervention and at an 1-week post-test. As a result of this study, all children reached 100% accuracy on the computer intervention, defined as successfully completing each of the safety steps. At the 1-week follow-up, all the children were able to perform the steps correctly in a real world simulation (Padgett and Strickland, 2006).

Another case study conducted by Demarest brings to light persuasive results. As mentioned in Griffiths' work regarding the educational benefits

of videogames: *“Demarest’s report of her own autistic 7-year-old son reported that although he had serious deficiencies in language and understanding, and social and emotional difficulties, videogame playing was one activity he was able to excel. This was ego-boosting for him and also had a self-calming effect. Videogames provided the visual patterns, speed and storyline that help children’s basic skills development. Some of the therapeutic benefits Demarest outlined were language skills, mathematics and reading skills, and social skills.”* (Griffiths, 2002)

Moreover, according to a research which used a fully interactive virtual school, with playful activities, specifically designed for students with Down Syndrome “combining learning with a positive and comfortable experience, provided by playful environments should be critical in edutainment”, with desktop devices being indispensable for obtaining this.” The application was designed and applied in order to make it possible for the students, to learn about the physical and social world (Vera, Herrera and Vived, 2005).

Contributed Case Study A: Athens-Based ID/SEN Rehabilitation Center

Description of the Case

In order to better identify the potential and limitations of applying digital games-based learning solutions at the service of learners with intellectual disability a series of pilot observations has been organized by the authors, in collaboration with an Athens-based rehabilitation and education center for children with intellectual and other developmental disabilities. These observations have taken place in two periods for a total duration of 9 months during school years 2006-2007 (April 2007 – June 2007) and 2007-2008 (November 2007 – April 2008).

During these observations, 12 individuals with intellectual disability (ages 10-17 years old) collaborated as players of educational interactive applications and digital games. These students were exposed to open source digital games, COTS titles and educational software, with both academic as well as social skills content in sessions of 40 minutes per student pair.

Each gaming session of this pilot observation was designed beforehand in terms of educational goals, abilities of each student involved and results from previous sessions. During the session information was recorded on the cognitive and emotional condition of each player, duration of playtime, games played and reactions, achievement of objectives with or without help, preferences, communication amongst peers, difficulty and success playing the games as well as any general observations that seemed to be significant. In the end of the session, participant players filled in a simple questionnaire regarding their likes, dislikes and difficulties.

The sessions of the first period (April 2007 – June 2007) involved small tutorials regarding IT skills and participant observation, while in the second period of the pilot (November 2007 – April 2008) participants were followed-up through informal interviews, direct observation, collective discussions and the aforementioned questionnaires. All-in-all, this 9-month pilot observation revealed important facts and findings regarding the use of DGBL within a classroom of SEN and ID learners. With the use of commercial entertainment as well as proprietary educational games such as *The Sims*¹⁶, *Body Explorer*, *World Explorer*¹⁷ and educational open source and online solutions such as *Travel Trainer*, *Sebran*, *Mini Sebran*¹⁸, *Poisson Rouge*¹⁹ and others, participating students were able to practice:

- language skills
- basic math skills
- basic reading skills
- social skills.

Findings from the Pilot Observation

1. From the usage of various online and commercial-off-the-shelf games as well as educational games and simulations in the context of this DGBL pilot with students of different emotional and cognitive maturity and ability it has been observed that all five central fields of knowledge are supported by various game types.
2. More specifically, it was observed that children have proven high IT literacy and were able to use the personal computer efficiently. By using gaming and multimedia software such as drill-and-practice educational software (e.g. Sebran ABC) and on-line edutainment games (e.g. Poisson Rouge), students were able to acquire the practical knowledge needed in order to use a personal computer.
3. In various cases, moreover, it has been observed that following a number of gaming sessions students were able to recognize the letters on the keyboard and their typing speed improved. In some cases it was observed that even though a student held a negative attitude towards classroom-based reading and writing activities, this was not the case during the gaming sessions, where the student's accuracy on recognizing and typing letters was improved. It is worth mentioning at this point that, during gaming sessions, those students who were not able to read tended to encourage their fellow students to read out loud in order to help them understand, participate and enjoy the game.
4. Through the usage of traditional games such as hangman in digital animated form, as well as drill-and-practice applications such as picture-meaning and counting identifications, high participation and cooperation was observed even by children with various communication limitations. Reaction speed and accuracy was increased, while the interest seemed elevated no matter the repetition of the drill.
5. Additionally, exploiting the need for collaboration between fellow players, the educators became able to use digital games as a communication medium as well and promote a common communication code among students, thus acquiring an important ally in order to counterbalance diversities in the educational process
6. The educators observed that games, especially simulations and adventures, not only lent themselves to repetition and practice, but could also be employed as innovative introductions to various curriculum topics and social activities. Students became able to identify terms and meanings such as the human body, organs, daily routine, fatigue, traveling, distance, direction and map reading through the usage of adventure games and simulations. Terms that might seem complicated to be included in a single class hour were introduced in a fascinating matter through commercial and edutainment games.
7. Due to the shared use of personal computers, children were willing to express themselves during gameplay, give instructions, offer possible solutions and cooperate with their peers. Students proved themselves able to cooperate responsibly, helping one another, in order to have fun.
8. It was very important that the selected videogames were able to facilitate, discussing and sharing, following and giving directions, answering questions, and therefore they provided a discussion topic to share with others. Especially regarding following and giving directions we should mention that students with problems in verbal communication were more than happy to participate and demonstrate to their fellow students their ability to control the game hero successfully.

It was observed that they didn't hesitate to follow directions by their co-students, taking initiatives and organizing spontaneously a new game amongst their peers.

9. During the second period of observation the team was able to self-manage gameplay, taking turns smoothly. As a result the need for instructors' intervention regarding the time of each players' gameplay was limited. Special teachers taking part in the study found that use of the games could not only provide motivation among students with intellectual disability, but at the same time help them develop skills and encourage collaboration. The motivating power of games and their ability to encourage co-operation were felt to support the work of schools in developing independent, yet socialized individuals.
10. There have been cases of students who, without any further mention or dramatization from the educator, were able to make the correlation between in-game situations and real-life practices on their own. In one of those cases, a 14 year old student would proudly mention that *"last. Saturday. we. went. with. our. family. to. the. restaurant. and. I. washed. my. hands. and. used. the. forks. as. it. was. shown. by. the. Restaurant. Game"*; in another case, and without any prior motivation, a 12 year old claimed: *"I. think. I. am. older. now. and. I. should. not. be. afraid. of. the. dark. just. like. Victor;. (the. game. hero). I. will. try. not. to. keep. the. light. on. when. I. go. to. bed"*. For every educator and specialist working with children, especially those having difficulties in emotional communication, such statements are clearly encouraging.

All-in-all, this 9 months' pilot has shown that the games-based learning process in the ID/SEN classroom indeed seems to become more engaging and enjoyable; students have actually enjoyed playing digital games and, although most of their

teachers were not familiar with new technologies and especially digital gameplay, children have shown the need to carry on with the gaming sessions.

Contributed Case Study B : ID/SEN Class of Provincial Public Special School

Description of the Case

A second pilot observation was organized during academic year 2007-2008 in the SEN Class of a Greek provincial public special school. The pilot was implemented under supervision of the authors by two public education teachers as part of their postgraduate assignments within the MSc Program "ICT in Education", jointly organized by the Faculty of Communication and Media Studies and the Faculty of Early Childhood Education of the University of Athens.

The special school where the pilot was conducted is located in the same premises with the local public primary school. It accommodates 12 children with serious mental disabilities aged between 4.5 and 14 years old and is run by 4 teachers. Most of the students were familiar with using computers since their school curriculum includes a computer-based activity, whereas two of them had their own personal computers at home. In the context of this pilot, DGBL material was presented to 11 out of the school's 12 children.

The objective of this pilot was to investigate whether digital games can provide a pleasant and effective means of learning for children with special needs such as severe learning difficulties, mental health problems, as well as some physical and/or developmental disabilities. Besides using on-line freeware games and commercial edutainment software selected in accordance to the formal SEN curriculum, the intervening educators also created their own flash games with academic curriculum and social/emotional skills content using Macromedia Flash and Microsoft PowerPoint.

The two intervening educators planned the DGBL pilot in accordance with the educational objectives of the official SEN curriculum. The whole process, however, was intentionally left informal, in order to allow students to feel free to participate and have fun playing without any pressure or the fear of evaluation from their teachers.

The educators' role was planned as that of an animator and instructor who would help students during gameplay. Considering possible negative reactions of the students towards persons that they were not familiar with, and in order not to disturb the daily school program, the educators opted to implement the DGBL pilot in hours separate from the daily timetable. Therefore, this pilot took place as an activity parallel to the daily school program with a total duration of 10 hours in 5 school days.

During the application, the intervening educators recorded for every student, information such as age, cognitive and emotional condition, duration of playtime, games played and reactions, achievement of objective with or without help, preferences, difficulty or facility playing the games and general observations that seemed to be significance. 9 out of 12 students of the school were finally able to participate in the trial application; 6 of them played all the games, while the 3 remaining students played only games for learning colours.

As far as the cognitive objectives of the trial are concerned, games were chosen that would help students learn to:

- add and subtract
- recognize primary colours
- measure and calculate money
- put pictures in order /time sequence
- group and distinguish objects in categories.

The socialization objectives of the trial mainly had to do with enabling students to express them-

selves as well as communicate and collaborate with each other during gameplay.

Findings from the Pilot Observation

Overall, this pilot has highlighted a number of interesting practical issues for DGBL attempts such as game usability, student cooperation and the critical role of the educator. Digital games have again proven to offer a pleasant and effective way of learning for children with intellectual disability. Learning scenarios of both academic and social content were specifically designed by the educators and students felt free to participate, cooperate with one another and have fun without any pressure or the fear of judgement from their peers and teachers.

Detailed findings of the pilot are as follows:

1. The most impressive observation during the entire trial was the eagerness of the children; they waited their turn to play without causing any trouble in order not to lose the opportunity to play. The teachers stated that they had not seen the students so calm before.
2. Generally the students showed a big interest and a strong will to participate no matter the errors they made. Students did not react negatively to failure during gameplay and despite problems they might face during this experience, they still wanted to be "exposed" in playing. Most students needed help but they were able to finish the gaming sessions successfully, getting better and better after each session.
3. As for the school teachers, the application confirmed in certain cases their estimates of the knowledge and the capabilities of their students. However it seemed that in some cases, even though they were friendly to the whole idea of these gameplay sessions, they did not have an interest in the actual experience of their students. Sadly it seemed

that the trial application constituted a rather good excuse for their absence from the classroom.

4. In this particular case, the use of digital games in the education of students with SEN has seemed to confirm some initial expectations, concerning both the benefits and the problems of this attempt:
 - the training process became enjoyable
 - digital games functioned as a challenge, activated the children but simultaneously highlighted capacities and issues that the local teachers had not perceived
 - some school teachers showed ignorance and lack of interest in using ICT tools as an instrumental part of the educational process.
5. Even though the special school provided a warm reception for the project and the students showed great appreciation, the intervening educators faced certain problems concerning:
 - technical equipment (malfunction of one of the four computers in the school laboratory, special keyboards with Latin characters that could not be recognized by the children, lack of utility of special levers installed)
 - cooperation with school educators (teacher refusal to allow 3 students to participate saying they were not capable, teachers' minimal knowledge of computers' use, existence of only one teacher eager and available to help the intervening educators, frequent absences of children due to illness and other problems).

Towards Using DGBL in the ID Classroom

Game Types Suited to the ID Instructional Process

Many researchers and educators seem to believe that special games are needed for people with special needs, especially when the intention is to use them as educational tools. This line of thought tends not to consider that the sheer act of gameplay itself has its own potential and exhibits the essential characteristics of a successful educational framework adaptable to the capabilities of individual students. As various studies for students with disabilities have highlighted, children and young adults with disabilities prefer COTS computer games which provide the player "*with an environment not only to learn within, but also a world when experiences can affect emotional and social development*" (Kearney, 2005).

Nonetheless, the digital game as an interactive medium still has to transform its educational potential into real instructional assets. Various research efforts have identified characteristics of successful educational games or, to be more exact, characteristics of *games that can be successfully used as educational tools*. *The Sims*, *Civilization*, *Rollercoaster Tycoon*, *Second Life*, *SimCity* and others are some good examples.

Throughout the discussion so far, based on the correspondence between ID instructional requirements, curriculum and digital gameplay, as well as the literature review and our own reports for DGBL cases for ID learners, adventure and drill-and-practice educational games seem to be quite effective instructional games for students with ID. However it is of cardinal importance that every single game type can be of high educational and entertainment value, when designed and introduced in the classroom as appropriate.

Regarding the question between preferring COTS games over educational software or vice versa, it has been observed that COTS solutions can be used not only as an appealing kick-start for the entire DGBL process, but also as effective instructional tools themselves. In that case, however, the educators' needs to facilitate the process properly so as to ensure quality of gameplay and accomplishment of the educational objectives

sought. Educational games, on the other hand, should be selected in order to be just as amusing as they are instructional. In the bottom line, the educator will be the one to set the goals and choose the products appropriate for his/her classroom.

The following table sums up some literature- and research-based observations as to the degree that usual types of digital games seem appropriate tools for the ID instructional process.

Table.5..Appropriateness.of.digital.game.types.for.the.ID.instructional.process

digital game types	appropriateness for the ID instructional process
drill-and-practice games	Traditionally games intended for educational purposes have been designed according to the drill-and-practice paradigm. These types of games involve problems or multiple-choice questions about the subject area of interest; in general they have simple goals, providing the player with practice in a certain subject area and thus helping to improve some basic skills. While such an approach can be beneficial, drill-and-practice games are often not as engaging for the learner as many commercial games (Prensky, 2005). Games that are not designed with education in mind, on the other hand, are almost never developed in a drill-and-practice format.
adventure games	Some of the most successful commercial games represent a mixture of gameplay types, the one most commonly used being adventure games and simulations. Both of these types can be easily adapted to educational goals and are often used in an instructional context. Adventure games generally ask the player to assume the role of a character and solve problems within a world by collecting objects and information and applying it to the situation at hand. Our own research shows that adventure games can practically incorporate any kind of educational content while remaining highly enjoyable. Moreover, adventure games encourage cooperation between students and engagement in brainstorming. In some cases, however, adventure games offer more information than students can handle and provide textual instructions that make the game difficult to play without an educator's assistance.
simulation games	Simulation games enable the player to manipulate a number of variables determining the outcome of the situation at hand. In this type of games the player is generally given control of some sort of entity, ranging from a country, to an amusement park, to a shopping mall. In our own research we have used <i>Sims.2</i> , some on-line cooking and serving simulations as well as <i>DK Body Explorer</i> ²⁰ asking students to make decisions with respect to everyday activities and well-being. A key aspect of these games is the provision of immediate feedback to the players about their decisions as well as the collaborative style of learning that they call for, especially among peer students with varying abilities of verbal communication.

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Table.5..continued

role-playing games	Technically speaking, role-playing games (RPGs) can be characterized as offering to the players an opportunity to immerse themselves in the player characters' situation. RPGs continue the rich history of storytelling by embracing innovative approaches to digital narration. Characters tend to be rich in features, gameplay has a long duration whereas character management is quite technical in nature in RPGs such as <i>Baldur's Gate</i> ²¹ , <i>Fable</i> ²² , <i>Might and Magic</i> ²³ , <i>Neverwinter Nights</i> ²⁴ , <i>Ultima</i> ²⁵ and <i>World of Warcraft</i> ²⁶ . Multiplayer RPGs seem to promote collaboration and decrease tensions between fellow students, while at the same time augmenting their interest and self-involvement in the learning process. At the same time, however, even a single-player game can have the same benefits under appropriate instructor guidance. As already mentioned, in vast gaming environments students may have the tendency to experiment and walk about the game's virtual world, rather than follow a specific goal; this should be carefully considered before deciding to use a role-playing game in the classroom.
arcade/platform games	Students seem to enjoy even the simplest of arcade games. Moreover, this type of games can be easily coupled with educational content. A game of Space Invaders, for instance, can be easily transformed into a simple maths or grammar game. It has been observed, however, that when arcade games without educational content are used in the classroom students do not find it easy to stop playing, while at the same time they may have difficulty in concentrating because of the simplicity and repeatability of these games.

DGBL Activities in the SEN Classroom: The Role of the Educator

According to the mentioned case studies, effective usage of DGBL in a classroom of students with intellectual disability is based not only in the choice of suitable games but on proper preparation and intervention of the educator as well, he/she being the one who will choose the games, introduce them to the class and guide students through a successful gaming and learning experience.

Educators planning DGBL processes should be aware of the instructional capabilities and limitations of selected games in order to facilitate exploration or resolve possible issues during gameplay. A basic issue raised by educators is the fact that each student might react differently to the game introduced. Therefore, the intervening educator needs to set the limits and rules of in-class gaming including time of gameplay, sharing of computers with fellow players and other provisions.

Educators should remain in the background, as guides or fellow players for the students, facilitating their gaming experience and infusing trust to the DGBL activity. According to educators who participated in the case studies reported above, gameplay time gave them the chance to observe abilities and potentials regarding academic, communicational, problem solving and art skills that had gone unnoticed during normal class hours.

As these case studies have shown, the more controlling an educator appears the less fun the DGBL experience turns out for the students, which is only to be expected since gaming is all about exploring, making mistakes and having fun while learning. An interesting analogy can be drawn here with case studies on the introduction of students with ID to virtual environments where it was observed that teachers contributed significantly less as sessions progressed, selectively dropping the more didactic and controlling behaviors from their repertoire (Standen & Low, 1996). During

the DGBL pilot interventions reported above it has been made clear that the point where the educator stops controlling the DGBL process in a didactic way and allows the game to take over is exactly the point where students start to feel comfortable and express themselves while playing. The DGBL educator should always be aware of the process but in a manner of non-explicit control.

An extremely important part of effective GBL activities in the special classroom seems to rely on the connections that can be established with real-life situations. Yes, digital gaming is definitely able to provide photorealistic graphics and direct references to the “real” experience, especially considering simulations and MMOGs. For children with ID, however, photorealism cannot make much of a difference for the connection to real-life situations if gameplay is not accompanied by the educator’s assistance for that purpose. As we have observed during our pilot research, digital games seem to offer a privileged occasion for educators to introduce topics of communication and socialization, on the condition that they are present and prepared to do so.

One more point that should be noted is that digital games, much like any other artifact, can be of high quality or not. Educators are inevitably responsible not only for the right usage of the game, but also for the selection of a game of suitable quality from the options that the gaming industry offers. As acknowledged in the relevant literature, *“In addition, the games development industry needs to understand the constraints on schools, teachers, parents and above all children of time, resources, and the requirements of curriculum and examination if games with more direct educational value are to emerge”* (Kirriemuir and McFarlane, 2004).

The studies of Kirriemuir and McFarlane for applying commercial games in the classroom, as well as the work reported by Sandford and Williamson (2005), both show that using COTS games in the classroom is not only a matter of technological literacy and adequate game de-

sign. It has to do with the educator’s views as well. Our own findings from the application of DGBL pilots in the ID classroom do not differ. How will a special teacher be able to assimilate a “foreign body” into his/her lesson plan, and so much so in a way that fits well to the students’ capabilities and instructional needs? According to our experience, gaming literacy and proper preparation seems to be the answer. In the case of students with intellectual disability the educator has to be certain that the game will be suitable for every one of his/her students and that she/he will be able to integrate the game well with the rest of the classroom activities. As mentioned by one of the educators: *“especially regarding children with intellectual disability, the connection between gaming experience and real-life settings is mandatory”*. Since in most cases the educators will not be able to design and create the games themselves, they need to be prepared to highlight the qualities of each game and identify content which may not be appropriate according to their own educational agenda and their students’ profiles.

Limitations and Critical Success Factors for DGBL Activities in the ID Classroom

The instructional potential of DGBL activities in the ID classroom may be limited due to a number of reasons.

First of all, digital games are not necessarily accessible on an equal basis to all players. Players with disabilities may encounter a number of accessibility problems, the most important of which are summarized in a relevant IGDA report (Bierre et al, 2005).

Secondly, one of the most common problems is the difficulty in following a storyline in cases where no subtext is available, storytelling advances by cut scenes and/or the story is very complex to follow. Lack of a tutorial mode, poor documentation and lack of guidance are common

shortcomings often mentioned by both students and educators.

Thirdly, students may be unable to complete a game task because they simply cannot understand the game goal, or because they find it hard to determine the game mechanics since clues are given in textual format, not catering for players with reading problems.

Other common issues among special players have to do with the inability to use adaptive hardware and/or to adapt game speed according to the players' cognitive and memory capabilities. Related problems are also found in games that require precise timing or accurate cursor positioning.

Apart from these issues, our findings regarding students with intellectual disability and severe educational problems show that there are also some general problems with game design that may possibly be circumvented through the help of an educator.

One such risk is that students who succeed in accomplishing the game goal may bypass and in the end ignore the educational scope of the game. This is something extremely vivid with gamers, especially when the amusement that gameplay offers is much stronger than its educational intention. As a result, a gamer may be able to play without any learning implications, or in any case without implications relevant to the learning objectives that he/she was originally supposed to meet. In the end of the day, understanding the game logic rather than acquiring bits of knowledge through gameplay seems to be an equally tempting gaming experience.

This situation may also appear in more complex games such as adventures and simulations played by ID students. In most cases of children with mild ID, when a game is particularly fun students may eventually tend to comprehend the pattern they need to use in order to avoid the educational strains of the game, getting only pure fun. In this case the assistive role of the educator is of cardinal importance in order for the players

to be able not only to enjoy gameplay, but at the same time achieve their instructional goals.

On the opposite side, there is a great number of edutainment titles where the educational agenda is so obvious that students, especially students with digital native and avid gamer profiles, will show signs of boredom. A student experienced in gaming may soon reveal the educational intentions of such a game and, at the best case, start trying to play "correctly", thus converting the educational game into poor educational software and losing all the qualities of games-based learning. At this point, however, it is worth mentioning a difference observed during our own research in ID classrooms. Even though students made quite soon the connection between the in-game situation and the instructional goals, mentioning clearly most of the times the true goal of the game, they still did not abandon the game and in some cases they even tried hard to achieve the educational part of it while having fun. As it was observed, even for applications with poor animations and recurrent sounds, provision of an interactive interface with a gaming essence and combination with teachers' assistance were able to raise interest and create fun for the students. In some cases of avid gamers with a preference for popular COTS games and mild ID, it was surprising to observe that even an absent storyline, poor animation and strong educational content were not enough to make them lose their interest in gameplay and the challenge to succeed. What is more, for games lacking sufficient instructions or somewhat dis-orientating for the students, more advanced players would still try to help their less experienced peers, in some cases operating more like mentors rather than as fellow players.

Last but not least, considerations for introducing DGBL to players with disabilities must also incorporate some important issues raised by the educators. Lack of appropriate technology training in teacher education programs is the most commonly cited barrier to the use of games in the classroom, in general and special education

alike. Moreover, individual schools are often hesitant to provide the necessary technology because they need to fund these purchases on their own budget, rather than being able to rely on the school district's resources (Hasselbring and Glaser, 2000).

CONCLUDING REMARKS

As it has been discussed in this chapter, digital games have a rich potential to incorporate the instructional content and methodologies required for students with intellectual disability. A number of considerations for the applicability of digital games and DGBL to the ID classroom are still valid, but the overall idea seems nevertheless to be grounded in theory and justified by the pilot research findings available thus far.

At the bottom line, it seems that the integration of digital games in the classroom, general and special classroom alike, is more of a matter of attitude rather than a question of appropriate game design. What happened some decades ago with the integration of play in the classroom is necessary to happen today as well. Educators need to rebuild their faith in gaming, become familiar with digital gaming and assimilate a medium that promises to reveal the hidden potential of their students.

In addition, game researchers and the game industry need to understand the possibilities of DGBL and create games that are able to unleash learning. The limits of time, resources as well as the requirements of curriculum and individual instructional needs should clearly be taken into consideration, especially with respect to students with intellectual or other disabilities.

The educational sector, the game industry and the public need to better understand the potential and diversity of digital games before this new medium can take up a meaningful role in formal or informal education. Different game genres need to be studied more thoroughly in order to provide

educators with clear guidelines which they will be able to apply with confidence.

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REFERENCES

- AAIDD (2008). *Frequently Asked Questions on Intellectual Disability and the AAIDD Definition*, [online], Available URL: http://www.aaidd.org/Policies/faq_intellectual_disability.shtml (last accessed Jul 7, 2008).
- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders.. American Psychiatric Publications*, Inc. ISBN 0890420254.
- Becker, K. (2005a). Games and Learning Styles. *ICET.2005.Education.and.Technology..7/4/2005..7/6/2005*, Calgary, Alberta, Canada.
- Becker, K. (2005b). How Are Games Educational? Learning Theories Embodied in Games *DiGRA. 2005.2nd.International.Conference.. "Changing Views:. Worlds. in. Play"* Vancouver, B.C. June 16-20, 2005.
- Becta (2001). *Computer Games in Education project*. [online], Available: URL <http://partners.becta.org.uk/index.php?section=rh&rid=13595> (last accessed Jul 7, 2008).

- Bierre, K., Chetwynd, J., Bierre, E., Hinn, M., Ludi, S., & Westin, T. (2005). Game Not Over: Accessibility Issues in Video Games. In *Proc. of the 3rd. International. Conference. on. Universal. Access. in. Human-Computer. Interaction*, March 2005.
- Brooks, R. (1997). *Special. Educational. Needs. and. Information. Technology: Effective. Strategies for Mainstream Schools*. Berkshire: National Foundation for Educational Research.
- Christakis, K. (2002). *Educational. approach. of. children. and. young. people. with. mild. and. sever learning difficulties*. Atrapos, Athens. (in Greek)
- De Freitas, S. (2006). Using games and simulations for supporting learning. IN C. Martin & L. Murray (Eds.), *Learning, Media and Technology. Special Issue on Gaming*.
- Detheridge, T. (1996). Information Technology. In B. Carpenter, R. Ashdown, & K. Bovair (Eds.), *Enabling Access: Effective teaching and Learning for Pupils with Learning Difficulties*. London: David Fulton.
- Ellis, N. R. (1963). The stimulus trace and behavioral inadequacy. In N. R. Ellis (Ed.), *Handbook of Mental Deficiency*, (pp.134-58). New York, NY: McGraw-Hill.
- Fitros, K. (2005). *The importance of Informatics in Special Education*. [online], Available: URL http://www.specialeducation.gr/files/fytros_cor1.pdf (last accessed Jul 7, 2008).
- Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles of instructional design, 4th ed.* Fort Worth, Texas: Harcourt Brace Jovanovich College Publishers.
- Griffiths, M. (2002). The educational benefits of videogames. *Journal of Education and Health*, 20(3), 47.
- Grossman, H. J. (Ed.). (1983). *Classification in mental retardation* (Rev. ed.). Washington, DC: American Association on Mental Deficiency.
- Hasselbring, T. S., & Glaser, C. W. (2000). Use of Computer Technology to Help Students with Special Needs. *Children and Computer Technology*, 10(2) – fall/winter 2000.
- Kalantzis, K. (1985). *Didactics of Special Educational Schools for mentally retarded children*. Karavias. Athens. (in Greek)
- Kearney, P. R. (2005). Playing in the Sandbox: Developing games for children with disabilities. *Proceedings of DiGRA 2005 conference: Changing Views. – Worlds in Play*, June 16th - 20th, 2005
- Kirriemuir, J., & McFarlane, A. (2004). Literature Review in Games and Learning Report 8 – A report for NESTA Futurelab. [online], Futurlab Series, 2004., Available URL: http://www.futurelab.org.uk/resources/documents/lit_reviews/Games_Review.pdf (last accessed Jul 7, 2008).
- Langer, A. (1985). Personal computers and people with disabilities. *Australian Disability Review*, 15(4), 28-33.
- Lester, J (2006). Brigadoon, An innovative online community for people dealing with Asperger's Syndrome and Autism. *Project Brigadoon, Braintalk Communities, Inc.* Available: URL http://braintalk.blogs.com/brigadoon/2005/01/about_brigadoon.html (last accessed Jul 7, 2008).
- Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 4(4), 333-369.
- Padgett, L. S., & Strickland, D. (2006). Case Study: Using a Virtual Reality Computer Game to Teach Fire Safety Skills to Children Diagnosed with Fetal Alcohol Syndrome. *Journal of Pediatric Psychology*, 31(1), 65–70.

- Prabhala, A. (2007). Mental Retardation Is No More—New Name Is Intellectual and Developmental Disabilities. *American Association on Intellectual and Developmental Disabilities*. Available URL: http://www.aamr.org/About_AAIDD/MR_name_change.htm (last accessed Jul 7, 2008).
- Prensky, M. (2005). Computer games and learning: Digital game based learning. In Raessens & Goldstein (Eds.), *Handbook of Computer Game Studies*. MIT Press.
- Pronger, N. (1995). Micro-technology. In J. Hogg & J. Cavet (Ed.). *Making leisure provision for people with profound learning and multiple disabilities*. (pp. 197-209). USA: Chapman & Hall Publishers.
- Raybourn, E. M., & Waern, A. (2004). Social Learning through Gaming. *Conference on Human Factors in Computing Systems*. CHI. '04. extended abstracts on Human factors in computing systems (pp. 1733-1734), Vienna, Austria: Workshops, Pages.
- Rooms, M. (2000). Information and Communication Technology and Dyslexia. In J. Townend, & M. Turner, (Eds.), *Dyslexia in Practice: A Guide for Teachers*. New York: Kluwer Academic/Plenum Publishers.
- Sandford, R., & Williamson, B. (2005). Games and learning. *NESTA Futurelab*. [online], Available URL: http://www.nestafuturelab.org/download/pdfs/research/handbooks/games_and_learning.pdf (last accessed Jul 7, 2008).
- Schalock R. L., Luckasson, E. A., & Shogren K. A. (2007). The Renaming of Mental Retardation: Understanding the Change to the Term Intellectual Disability. *Intellectual and Developmental Disabilities*, 45(2), 116–124.
- Standen, & Low, H. L. (1996). Do virtual environments promote self-directed activity? A study of students with severe learning difficulties learning Makaton sign language. In P. M. Sharkey (Ed.), *Proceedings of the First European Conference on Disability, Virtual Reality and Associated Technologies* (pp. 123-127). Maidenhead, UK.
- Standen, P. J., Cromby J. J., & Brown, D. J. (1997). Evaluation of the use of virtual environments with students with severe learning difficulties. *Proceedings of the British Psychological Society*, 10(8), 139.
- Vera, L., Herrera, G., & Vived, E. (2005, June). Virtual reality school for children with learning difficulties. *ACM SIGCHI ACE05*.
- Verenikina, I., Harris, P., & Lysaght, P. (2003). Child's play: computer games, theories of play and children's development. *Proceedings of the international federation for information processing working group 3.5 open conference on Young children and learning technologies*. (pp. 99-106), Sydney, Australia, Pages.
- Williams, C., Wright, B, Callaghan, G., & Coughlan, B. (2001). Do Children with Autism Learn to Read more Readily by Computer Assisted Instruction or Traditional Book Methods? *Autism*, 6, 71-91. The National Autistic Society, SAGE Publications.
- Zeaman, D., & House, B. (1963). The role of attention in retarded discrimination learning. In N. R. Ellis (Ed.), *Handbook of Mental Deficiency*, (pp. 159-223). New York, NY: McGraw-Hill.

ENDNOTES

- ¹ It should be mentioned that the American Association on Mental Retardation (AAMR) continued to use this term until 2006. In June 2006, under the leadership of editor Steven J. Taylor, AAMR members voted to change the name of this association to “American Association on Intellectual and Developmental Disabilities” (AAIDD). As

Taylor himself explains, however, “anyone who believes that we have finally arrived at the perfect terminology will be proven wrong by history. I am sure that at some future point we will find the phrase *intellectual. and. developmental. disabilities* to be inadequate and demeaning” (Prabhala, 2007)

- 2 “Intellectual disability is defined as significantly sub-average general intellectual functioning existing concurrently with deficits in adaptive behavior and manifested during the developmental period (Grossman, 1983 p.11) that adversely affects a child’s educational performance. Based on the former American Association on Mental Retardation (Grossman, 1983) and the Diagnostic and Statistical Manual of Mental Disorders (American Psychiatric Association, 1994) and using intelligence (IQ) test scores, intellectual disability occurs on the four levels of mild (score 50 through 55 to approximately 70), moderate (score 35 through 40 to 50 through 55), severe (score 20 through 25 to 35 through 40), and profound (20 through 25)”.
- 3 <http://www.wartoft.nu/software/sebran/>
- 4 http://www.virtualimage.co.uk/html/all_about_numbers.html
- 5 <http://www.onestopeducation.co.uk/icat/1844410595main&bklist=icat>
- 6 <http://www.attainmentcompany.com/xcart/product.php?productid=16279&cat=0&page=1>
- 7 <http://www.amazon.co.uk/Become-A-Human-Body-Explorer/dp/B00004UCNT>
- 8 <http://shop.sherston.com/products/details.aspx?p=1&prodId=93>

- 9 http://www.inclusive.co.uk/catalogue/acatalog/out_and_about1.html
- 10 <http://www.dominicinteractive.com/>
- 11 <http://www.autismcoach.com/Smart%20Alex.htm>
- 12 <http://www.inclusive.co.uk/catalogue/acatalog/happenings.html>
- 13 <http://web.media.mit.edu/~jorkin/restaurant/>
- 14 http://thesims2.ea.com/about/ep3_index.php
- 15 According to traits among clinically referred preschool children symptoms include (a) problems in learning and preacademic skills, (b) arousal dysregulation (impulsivity and hyperactivity), (c) poor adaptive skills, (d) unresponsiveness to verbal danger cautions, (e) difficulty in generalization from one learning setting to another, and (f) behavior and discipline problems (Padgett and Strickland, 2006).
- 16 <http://thesims.ea.com/>
- 17 <http://www.amazon.co.uk/DK-Become-A-World-Explorer/dp/B00004UCNQ>
- 18 <http://www.wartoft.nu/software/minisebran/>
- 19 <http://www.poissonrouge.com/>
- 20 http://www.avanquest.com/UK/kids/learning/key-stage-2/Become_a_Human_Body_Explorer.html
- 21 <http://www.planetbaldursgate.com/>
- 22 <http://fable.lionhead.com/>
- 23 <http://www.mightandmagic.com/>
- 24 <http://www.neverwinternights.com/>
- 25 <http://www.uoherald.com/>
- 26 <http://www.worldofwarcraft.com/>

Compilation of References

- AAIDD (2008). *Frequently Asked Questions on Intellectual Disability and the AAIDD Definition*, [online], Available URL: http://www.aaidd.org/Policies/faq_intellectual_disability.shtml (last accessed Jul 7, 2008).
- Adolph, S. (1999). *Whatever happened to reuse?* Software Development Magazine.
- Advanced Distributed Learning (ADL) (Ed.). (2004). *Sharable content object reference model (SCORM) 2004*, 2nd edition, overview. ADL Co-Laboratory.
- Aguilera, M. d., & Mendiz, A. (2003). Video games and education: (education in the face of a “parallel school”). *Computers in Entertainment (CIE)*, 1, 10-10.
- Ainsworth, S. (2003). Evaluation Methods for Learning Environments. Amsterdam. *A tutorial for the 11th International Conference on Artificial Intelligence Education*. Retrieved March 28, 2008, from <http://www.psychology.nottingham.ac.uk/staff/Shaaron.Ainsworth/Evaluation-tutorial.ppt>
- Akilli, G. K. (2007). Games and Simulations: a new approach in education? In D. Gibson, C. Alrich, & M. Prensky (Eds.), *Games and Simulations in Online Learning: Research and Development Frameworks*. Idea Group Inc.
- Akilli, G. K., & Cagiltay, K. (2006). An Instructional Design/Development Model for the Creation of Game-Like Learning Environments: The FIDGE Model. In M. Pivec (Ed.), *Affective and Emotional Aspects of Human-Computer Interaction. – Game-Based and Innovative Learning Approaches* (pp. 93-112). Amsterdam: IOS Press.
- Aldrich, C. (2003). *Simulations and the Future of Learning: An Innovative (and Perhaps Revolutionary) Approach to e-Learning*. Pfeiffer.
- Aldrich, C. (2004). *Simulations and the future of learning*. San Francisco, CA: John Wiley and Sons.
- Aldrich, C. (2005). *Learning by Doing: The Complete Guide to Computer-Based Simulations*. San Francisco: Pfeiffer Wiley.
- Alessi, S. M., & Trollip, S. R. (2001). *Multimedia for Learning*. Boston: Allyn and Bacon.
- Alessi, S., & Trollip, S. (2001). *Multimedia for learning: methods and development*. (3rd Edition). Pearson Education. USA.
- Alkin, M., & Christie, C. (2002). The use of role-play in teaching evaluation. *American Journal of Evaluation*, 23(2), 209-218.

Compilation of References

- American Psychiatric Association. (1994). *Diagnostic and Statistical Manual of Mental Disorders..American. Psychiatric.Publications*, Inc. ISBN 0890420254.
- Amory, A. (2006). Game object model version II: A theoretical framework for educational game development. *Educational. Technology. Research. and. Development..* 55(1), 51–77.
- Amory, A., Naicker, K., Vincent, J., & Adams, C. (1999). The use of computer games as an educational tool: 1. Identification of appropriate game types and game elements. *British.Journal.of.Educational.Technology*, 30, 311-322.
- Anderson, C. A., & Bushman, B. J. (2001). Effects of violent video games on aggressive behavior, aggressive cognition, aggressive affect, physiological arousal, and prosocial behavior: a meta-analytic review of the scientific literature. *Psychological.Science*, 12, 353-359.
- Anderson, C. A., & Dill, K. E. (2000). Video games and aggressive thoughts, feelings and behaviour in the laboratory and in life. *Journal.of.Personality.and.Social. Psychology*, 78, 772-790.
- Anderson, C. A., Carnagey, N. L., Flanagan, M., Arlin J. Benjamin, J., Eubanks, J., & Valentine, J. C. (2004). Violent video games: Specific effects of violent content on aggressive thoughts and behavior. *Advances.in.Experimental.Social.Psychology*, 36, 199-249.
- Appelman, R. (2007). Serious Game Design: Balancing Cognitive and Affective Engagement. *Digital. Voodoo. Review*. Retrieved 28th April 2008. URL: <http://digital-voodoooreview.com/index.php?option=com_content&task=view&id=24&Itemid=9>
- Appelman, R., & Goldsworthy, R., (1999). *The.Juncture.of.Game.&Instructional.Design:Can.Fun.be.Learning?* Paper presented at the Association for Educational Communications and Technology, Houston, TX.
- Apperley, T. (2006). Genre and game studies: Toward a critical approach to video game genres. *Simulation.& Gaming* ,37(1), 6-23.
- Apperley, T. H. (n. d.). *Genre.and.game.studies:Toward.a.critical.approach.to.video.game.genres* (PDF). University of Melbourne.
- Arnett, J. J. (1996). Sensation seeking, aggressiveness, and adolescent reckless behavior. *Personality.and.Individual.Differences*, 20(6), 693-702.
- Aronson, E., & Carlsmith, J. M. (1968). Experimentation in social psychology. In G. Lindzey, & E. Aronson (Eds.), *Handbook.of.Social.Psychology*, 2, 1-79 (2nd ed.) Reading, MA: Addison-Wesley.
- Arts, E. (2005). *SimCity.2004*. Retrieved August 20th, 2006, from <http://simcity.ea.com>
- Arts, E. (2005). *The.Sims.2*. Retrieved August 20th, 2006, from www.eagames.com
- Astleitner, H. (2000). Designing emotionally sound instruction: the FEASP-approach. *Instructional.Science*, 28, 169-198.
- Aufderheide, P. (1997). Media literacy: From a report of the National Leadership Conference on Media Literacy. In R. Kubey (Ed.), *Media.literacy.in.the.Information.Age:Current.perspectives*. (pp. 79-86). New Brunswick, NJ: Transaction Publishers.
- Auralog. (2005). *Talktome*. Retrieved August 20th, 2006, from http://www.auralog.com/es/particulares_talktome.htm
- Austin, J. L. (2006). *How.to.do.things.with.words*. In A. Jaworski & N. Coupland (Eds.), *The.Discourse.Reader*. London: Routledge.
- Ausubel, D. P. (1968). *Educational.Psychology:A.Cognitive.View*..New York: Hold, Rinehart & Winston.
- Backlund, P., Engström, H., Johannesson, M., & Lebram, M. (2007). Games and traffic safety – an experimental study in a game-based simulation environment. *Proceedings.of.the.International.Conference.Information.Visualization*, 11, 908–916.
- Baer, L. L. (2005). The Generation Gap: Bridging Learners and Educators. *The.International.Digital.Media.&Arts.Association.Journal*, 2(1).

- Baker, A., Navarro, E. O., & Hoek, A. v. d. (2005). An experimental card game for teaching software engineering processes. *Journal of Systems and Software*, 75(1-2), 3-16.
- Baker, E. L. & Mayer, T. E. (1999). Computer-based assessment of problem solving. *Computers in Human Behavior*, 15, 269-282.
- Baker, M. J., & Lund, K. (1996). Flexibly structuring the interaction in a CSCL environment. In P. Brna, A. Paiva & J. Self (Eds.), *Proceedings of the European conference on Artificial intelligence in Education*. Lisbon, Portugal Sept-20-Oct 2.
- Baker, S. J., d. Hadgood, J., Ainsworth, S. E., & Corbett, A. T. (2007). Modeling the Acquisition of Fluent Skill in Educational Action Games. *Proceedings of User Modeling*, 17-26.
- Bakhtin, M. (1986). *Speech genres and other late essays*. Austin: University of Texas.
- Banos, R. M., Botella, C., Liano, V., Rey, B., Guerrero, B., & Alcaniz, M. (2003). Virtual reality as mood induction procedure. *Presented at PRESENCE 2003, 6th Annual International Workshop on Presence*. Available at: <http://www.presence-research.org/papers/Banos.html>
- Barab, S. A., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, 53(1).
- Barab, S., Thomas, M., Dodge, T., Carteaux, R., & Tuzun, H. (2005). Making learning fun: Quest Atlantis, a game without guns. *Educational Technology Research and Development*, 53(1), 86-107.
- Barab, S., Warren S., & Ingram-Goble, A. (2006, April). *Academic play space: Designing games for education*. Paper presented at the meeting of the American Educational Research Association, San Francisco, CA.
- Barker, M. (2001). The Newson Report: a case study in 'common sense'. In *Ill Effects: The Media/Violence Debate* (2 ed., pp. 27-46). London, New York: Routledge.
- Baruch, Y. (2006). Role-play teaching: Acting in the classroom. *Management Learning*, 37(1), 43-61.
- Bateman, C. (2007). *Game Writing, Narrative Skills for Videogames*. Boston, MA: Charles River Media.
- Beale, I. L., Kato, P. M., Marin-Bowling, V. M., Guthrie, N., & Cole, S. W. (2007). Improvement in cancer-related knowledge following use of a psychoeducational video game for adolescents and young adults with cancer. *Journal of Adolescent Health*, 41, 263-270.
- Beasley, B., & Standley, T. C. (2002). Shirts vs. skins: Clothing as an indicator of gender role stereotyping in video games. *Mass Communication and Society*, 5(3), 279-293.
- Beato, G. (1997). *Girl games: Computer games for girls is no longer an oxymoron*. *Wired Magazine*. (April). Retrieved 6 September 2006, from http://www.wired.com/wired/archive/5.04/es_girlgames.html.
- Beck, J. C., & Wade, M. (2004). *Got Game: how the gamer generation is reshaping business forever*. Boston, MA: Harvard Business School Press.
- Becker, B., & Mark, G. (2002). Social Conventions in Computer-mediated Communication: A Comparison of Three Online Shared Virtual Environments. In R. Schroeder (Ed.), *The Social Life of Avatars* (pp. 19-39): Springer-Verlag.
- Becker, K. (2005, 16-20 June 2005). *How Are Games Educational? Learning Theories Embodied in Games*. Paper presented at the DiGRA 2005 - the Digital Games Research Association's 2nd International Conference, Simon Fraser University, Burnaby, BC, Canada.
- Becker, K. (2005). Games and Learning Styles. *ICET 2005. Education and Technology*, 7/4/2005 - 7/6/2005, Calgary, Alberta, Canada.
- Becker, K. (2005). How Are Games Educational? Learning Theories Embodied in Games *DiGRA 2005. 2nd International Conference*, "Changing Views: Worlds in Play" Vancouver, B.C. June 16-20, 2005.
- Becta (2001). *Computer Games in Education project*. [online], Available: URL <http://partners.becta.org>.

Compilation of References

- uk/index.php?section=rh&rid=13595 (last accessed Jul 7, 2008).
- Becta (2001). *What.aspects.of.games.might.contribute.to.learning*. Available at: <http://partners.becta.org.uk/index.php?section=rh&rid=13588>
- Becta. (2001). *Computer.Games.in.Education.Project.Findings.Report*. Retrieved July 3, 2008 from <http://partners.becta.org.uk/index.php?section=rh&rid=13595>
- BECTa. (2001). Computer Games in Education: Aspects. Retrieved 19 February, 2008, from <http://partners.becta.org.uk/index.php?section=rh&rid=13588>
- BECTa. (2006). Computer Games in Education: Findings Report. Retrieved 19 February, 2008, from <http://partners.becta.org.uk/index.php?section=rh&rid=13595>
- Bednar, A., & Levie, W. H. (1993). Attitude-change principles. In M. Fleming & W. H. Levie (Eds), *Instructional.message.design.Principles.from.the.behavioral.and.cognitive.sciences* (pp. 283-304). Englewood Cliffs, NJ: Educational Technology Publications.
- Belanich, J., Sibley, D. E., & Orvis, K. L. (2004). *Instructional.characteristics.and.motivational.features.of.a.PC-basedgame* (Research Report No. 1822). Alexandria, VA: U.S. Army Research Institute for the Behavioral and Social Sciences.
- Bell, L., Lindbloom, M.-C., Peters, T., & Pope, K. (2008). Virtual Libraries and Education in Virtual Worlds: Twenty-First Century Library Services. *Policy.Futures.in.Education*, 6(1), 49-58.
- Benyon, D., Turner, P., & Turner, S. (2005). *Designing.Interactive.Systems*. Harlow: Addison-Wesley.
- Ben-Zvi, D., & Sfard, A. (2007). Ariadne's Thread, Deadalus' Wings, and the Learner's Autonomy. *Education.and.Didactics*, 1(3).
- Bereiter, C., & Scardamalia, M. (1993). *Surpassing.ourselves.and.inquiry.into.the.nature.and.implications.of.expertise*. Chicago and LaSalle, IL: Open Court.
- Berlyne, D. E. (1954). A theory of human curiosity. *British.Journal.of.Psychology*, 45(3), 180-191.
- Berlyne, D. E. (1960). *Conflict, Arousal, and Curiosity*. New York, NY: McGraw Hill.
- Bierre, K., Chetwynd, J., Bierre, E., Hinn, M., Ludi, S., & Westin, T. (2005). Game Not Over: Accessibility Issues in Video Games. In *Proc.of.the.3rd.International.Conference.on.Universal.Access.in.Human-Computer.Interaction*, March 2005.
- Biggs, J. (1999). *Teaching.for.Quality.Learning.at.University*. Buckingham: Society for research in Higher Education. Open University Press. See also <http://www.dmu.ac.uk/~jamesa/learning/solo.htm>. Last accessed 23rd March 2004.
- Billett, S. (1996). Situated learning: bridging sociocultural and cognitive theorising. *Learning.and.Instruction*, 6(3), 263-280.
- Bisson, C., & Luckner, J. (1996). Fun in learning: The pedagogical role of fun in education. *Journal.of.Experimental.Education*, 19(2), 109-110.
- Björk, S., & Holopainen, J. (2004). *Patterns.In.Game.Design*. Charles River Media.
- Björk, S., Lundgren, S., & Holopainen, J. (2003). Game Design Patterns. In M. Copier and J. Raessens (Eds.), *Proceedings.of.the.Level.Up:Digital.Games.Research.Conference*. Utrecht, The Netherlands.
- Blecic, I., Cecchini, A., & Colorni, A. (2007). StraDe: a Web-based Role-play Game for Strategic Planning. In M. Taisch, & J. Cassina (Eds.), *Learning.with.Games* (pp. 17-23). Sophia Antipolis, FR: Politecnico di Milano.
- Blecic, I., Cecchini, A., & Colorni, A. (2007). University Explorer: a Web-based Role-play Game for University Orientation. In M. Taisch, & J. Cassina (Eds.), *Learning.with.Games* (pp. 337-342). Sophia Antipolis, FR: Politecnico di Milano.
- Bloom, B. (1956). *Taxonomy.of.educational.objectives:The.cognitive.domain*. New York: Donald McKay.
- Bloom, B. S. (1956). *Taxonomy.of.Educational.Objectives,Handbook.I:The.Cognitive.Domain*. New York: David McKay Co Inc.

- Bluestone, G. (1957). *Novels into film*. Baltimore, MD: The Johns Hopkins Press.
- Bogost, I. (2007). Persuasive Games: How I Stopped Worrying About Gamers And Started Loving People Who Play Games. Retrieved 20 February, 2008, from http://www.gamasutra.com/view/feature/1543/persuasive_games_how_i_stopped_php
- Bogost, I. (2007). *Persuasive Games: the expressive power of Videogames*. Cambridge, MA: The MIT Press.
- Bonanno, P. (2005). Gender-based Neurocognitive Propensities influencing Gameplay: An Interactions-oriented approach. In M. Burmester, D. Gerhard, & F. Thissen (Eds.), *Proceedings of the 4th International Symposium for Information Design, 2nd June 2005 at Stuttgart Media University*, (pp. 59-82).
- Bonanno, P., & Kommers, P. A. M. (2005). Gender differences and styles in the use of digital games. *Educational Psychology*, 25(1), 13-41.
- Bonanno, P., & Kommers, P. A. M. (2008). Exploring the influence of gender and gaming competence on attitudes towards instructional games. *British Journal of Educational Technology*, 39(1), 97-109.
- Bonwell, C. C., & Eison, J. A. (1991). *Active Learning: Creating Excitement in the Classroom*. Washington, DC: ASHE-ERIC Higher Education Reports.
- Bouchard, S., Côte, S., St-Jacques, J., Robillard, G., & Renaud, P. (2006). Effectiveness of virtual reality exposure in the treatment of arachnophobia using 3D games. *Technology and Health Care*, 14, 19-27.
- Boyle, L., & Seeney, M. (2008). Using Computer Games to Promote Soft Skills in High School – The Winning Game Pilot Study. Unpublished
- Braden, R. A. (1992). Formative evaluation: A revised descriptive theory and a prescriptive model. Paper presented at the *Association for Educational Communications and Technology (AECT)*.
- Brand, J. (2007). *Interactive Australia: Facts About the Australian Computer and Video Game Industry*. Bond University. Retrieved 12 April, 2007 from <http://ieaa.com.au/doc/Interactive%20Australia%202007%20web.pdf>
- Brannick, M. T., Prince, C., & Salas, E. (2005). Can PC-based systems enhance teamwork in the cockpit? *The International Journal of Aviation Psychology*, 15, 173-187.
- Briggs-Myers, I. (1980). *Gifts Differing: Understanding Personality Type*. Davies-Black Publishing.
- Briggs-Myers, I., & McCaulley, M. (1985). *A guide to the development and use of the Myers-Briggs Type Indicator*. Consulting psychologists Pr.
- British Screen Advisory Council (2005). *The Games Industry: Changing times – reaching new audiences*. Retrieved 7 April 2007 from <http://www.bsac.uk.com/reports/gameschangingtimes.pdf>.
- Brooks, R. (1997). *Special Educational Needs and Information Technology: Effective Strategies for Mainstream Schools*. Berkshire: National Foundation for Educational Research.
- Brown, A. L., & Palincsar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. In L. Resnik (Ed.), *Knowing, learning and instructing: Essays in honour of Robert Glaser*. Hillsdale, NJ: Lawrence Erlbaum.
- Brown, E., Fisher, T., & Brailsford, T. (2006). Real users, real results: Examining the limitations of learning styles within AEH, *ACM.SIGWEB Newsletter*.
- Brown, J. S., Collins, A., & Duguid, P. (1989). Situated cognition and the culture of learning. *Educational Researcher*, 18(1), 32-42.
- Brox, E., Evertsen, G., & Heggelund, A. (2007). A Competence Jigsaw Puzzle – Making a Language Learning Game in a European Project With Diverse Competence and Diverging Standings. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 47-54). Paisley, UK: Academic Conference Limited.
- Bruckman, A. (1993). Community support for constructivist learning. In *Computer Supported Cooperative Work (CSCW)*, 7, 47-86. Springer

Compilation of References

- Bruner, J. S. (1966). *Toward a Theory of Instruction*. Oxford: Oxford University Press.
- Brusilovsky, P. (1999). Adaptive and Intelligent Technologies for Web-based Education, In C. Rollinger & C. Peylo (Eds.) *Kunstliche Intelligenz*. Special Issue on Intelligent Systems and Teaching.
- Bryce, J., & Rutter, J. (2002). Killing like a girl: Gendered gaming and girl gamers' visibility. In F. M. Ed., *Computer Games and Digital Cultures—Conference Proceedings* (pp. 243-255). Tampere, Finland: University of Tampere Press.
- Buckingham, D. (2003). *Media education. Literacy, learning and contemporary culture*. Cambridge, UK: Polity Press.
- Buckingham, D., & Burn, A. (2007). Game literacy in theory and practice. *Journal of Educational Multimedia and Hypermedia*, 16, 323-349.
- Buckley, K. E., & Anderson, C. A. (2006). A Theoretical Model of the Effects and Consequences of Playing Video Games. In P. Vorderer & J. Bryant (Eds.), *Playing Video Games—Motives, Responses, and Consequences* (pp. 363-378). Mahwah, NJ: LEA.
- Burgos, D. (2008, in press). Extension of the IMS Learning Design Specification based on Adaptation and Integration of Units of Learning (Extensión de la especificación IMS Learning Design desde la Adaptación y la Integración de Unidades de Aprendizaje). Doctoral thesis. University Carlos III, Leganés, Madrid, Spain
- Burgos, D., & Specht, M. (2006). Adaptive e-learning methods and IMS Learning Design. *An integrated approach. proceedings of ICALT2006*. Kerkraade, Holland.
- Burgos, D., & van Nimwegen, C. (2005). *Planning Educational Task*. August 15th, 2006, from <http://moodle.learningnetworks.org/course/view.php?id=45>
- Burgos, D., Tattersall, C., & Koper, R. (2007). How to represent adaptation in eLearning with IMS Learning Design. *Interactive Learning Environments*, 15(2), 161-170.
- Burn, A. (2005). Potter-literacy: From book to game and back again; Literature, film, game and cross-media literacy. *Papers: Explorations into Children's Literature*, 14(3).
- Burton, M. C., & Walther, J. B. (2001). A Survey of web log data and their application in use-based design. *In proceedings of the 34th Annual Hawaii International Conference on System Sciences* (pp. 1-10). Maui, Hawaii.
- Bussey, K., & Bandura, A. (1999). Social cognitive theory of gender development and differentiation. *Psychological Review*, 106(4), 676-713.
- Cabral, R. (1987). Role Playing As a Group Intervention. *Small Group Research*, 18(4), 470-482.
- Caillois, R. (1958). *Les jeux et les hommes: Le masque et le vertige*. Paris: Gallimard [English translation: (1962) *Man, play and games*. London: Thames and Hudson]
- Calvo, M. G., & Eysenck, M. W. (1996). Phonological working memory and reading in test anxiety. *Memory*, 4, 289-305.
- Campbell, D. T., & Stanley, J. C. (1963). *Experimental and Quasi-Experimental Designs for Research*. Chicago: Rand McNally.
- Candlin, C. N. (1997). General Editor's Preface. In B. L. Gunnarsson, P. Linell & B. Nordberg (Eds.), *The Construction of Professional Discourse*. London, Longman.
- Cappel, S., Green, S., Curless, B., Duchamp, T., & Popović, Z. (2002). *Interactive Skeleton-Driven Dynamic Deformations*. SIGGRAPH.
- Carbonell, J. R. (1970). AI in CAI: An Artificial-Intelligence approach to Computer-Assisted Instruction. *IEEE Transactions on Man-Machine Systems*, 11(4), 190-202.
- Carnagey, N. L., & Anderson, C. A. (2005). The Effects of Reward and Punishment in Violent Video Games on Aggressive Affect, Cognition, and Behavior. *Psychological Science Agenda: Science Briefs*, 16, 882-889.
- Carnagey, N. L., Anderson, C. A., & Bushman, B. J. (2007). The effect of video game violence on physi-

- ological desensitization to real-life violence. *Journal of Experimental.Social.Psychology*,.43, 489-496.
- Carrol, J. M. (1990). *The Nurnberg Funnel: Designing Minimalist Instruction for Practical Computer Skill*. Cambridge, MA: MIT Press.
- Carron T., Marty J. C., & Heraud J. M. (2008). Teaching with Game Based Learning Management Systems: Exploring and observing a pedagogical dungeon. *Simulation.&.Gaming*,.39(3), (pp 353-378), Special issue on eGames and adaptive eLearning: A practical approach. DOI: 10.1177/1046878108319580.
- Carron, T., Marty, J. C., Heraud, J. M., & France, L. (2006). Helping the teacher to reorganize tasks in a collaborative learning activity: An agent-based approach. In *International.Conference.on.Advanced.Learning.Technologies* (pp. 552-556), Kerkrade, The Netherlands.
- Carron, T., Marty, J. C., Heraud, J. M., & France, L. (2007). Games as Learning Scenarios: are you Serious? In *first European Conference on Games Based Learning* (pp. 55-64). Paisley, Scotland.
- Castel, A. D., Pratt, J., & Drummond, E. (2005). The effects of action video game experience on the time course of inhibition of return and the efficiency of visual search. *Acta.Psychologica*,.119, 217-230.
- Castronova, E. (July 2002). On Virtual Economies..*International.Journal.of.Computer.Game.Research*,.3(2). Retrieved June 29, 2008, from <http://www.gamestudies.org/0302/castronova/>
- Cates, W. M. (1992). *Fifteen.principles.for.designing.more.effective.instructional.hypermedia/multimedia.products*..*Educational.Technology*,.17(12), 5-11.
- Chaffar, S., & Frasson, C. (2005). The emotional conditions for learning. Available at: http://www.iro.umontreal.ca/labs/HERON/art/chaffar_frasson_2005.pdf
- Chamberlin, B. (2003). *Creating.entertaining.games.with.educational.content:.case.studies.of.user.experiences.with.the.children's.website,food.detectives.fight.bac!* A dissertation presented to the faculty at the Curry school of education, University of Virginia In partial fulfillment of the requirements for the degree doctor of philosophy May 2003.
- Champin P.A., Prié Y., & Mille A. (2004). Musette: a framework for knowledge capture from experience. In *12ème.atelier.de.raisonnement.à.partir.de.cas*, Villeteaneuse, France.
- Chen, H., Wigand, R., & Nilan, M. S. (1999). Optimal experience of web activities. *Computers.in.Human.Behavior*,.15, 585-608.
- Christakis, K. (2002). *Educational.approach.of.children.and.young.people.with.mild.and.sever.learning.difficulties*..*Atrapos*,.Athens. (in Greek)
- Christoph, L., Sandberg, J., & Wielinga, B. (2005). Added value of task models and use of metacognitive skills on learning. In *12th International Conference on Artificial Intelligence.in.Education.(AIED.2005)*, 774-776.
- Christoph, N. (2007). *The.role.of.metacognitive.skills.in.learning.to.solve.problems*. PhD Thesis submitted to the University of Amsterdam. Retrieved 28th November, 2007 from <http://dare.uva.nl/document/22568>
- Chua, A. Y. K. (2005). The design and implementation of a simulation game for teaching knowledge management. *Journal.of.American.Society.for.Information.Science.and.Technology*, 56(11), 120-1216.
- Chung, G. K. W. K., O'Neil, H. F., & Herl, H. E. (1999). The use of computer-based collaborative knowledge mapping to measure team processes and team outcomes. *Computers.in.Human.Behaviour*, 15.
- Clark, R., & Choi, S. (2005). Five design principles for experiments on the effects of animated pedagogical agents. *Journal.of.Educational.Computing.Research*, 32(3), 209-223.
- Coffield, F., Moseley, D., Hall, E., & Ecclestone, K. (2004). Learning styles and pedagogy in post-16 learning. *A.systematic.and.critical.review*. London: Learning and Skills Research Centre.
- Cohen, K. (2006). Right Click to Learn. *The.Phoenix*. Retrieved July 6th, 2007, from http://thephoenix.com/article_ektid20561.aspx

Compilation of References

- Colarusso, C. A. (1993). Play in adulthood. *Psychoanalytic.Study.of.the.Child*, 48, 225–245.
- Cole, J., & Foster, H. (2005). *Using Moodle: Teaching with the Popular. Open. Source. Course. Management. System*: O'Reilly.
- Coles, C. D., Strickland, D. C., Padgett, L., & Bellmoff, L. (2007). Games that “work”: Using computer games to teach alcohol-affected children about fire and street safety. *Research.in.Developmental.Disabilities: A.Mul-tidisciplinary.Journal*, 28(5), 518–530.
- Collins, A., (1991). Cognitive apprenticeship and instructional technology. In L. Idol & B. F. Jones (Eds.) *Educational.values.and.cognitive.instructions: Implica-tions.for.reform.*. Hillsdale, NJ: Erlbaum.
- Colt, H. G., Crawford, S. W., & III, O. G. (2001). Virtual Reality Bronchoscopy Simulation*: A Revolution in Procedural Training. *CHEST*, 120(4), 1333-1339.
- Computer, A. (1992). *Macintosh.Human.Interface.Guide-lines*: Apple Computer, Inc.
- Connolly, T. M., & Stansfield, M. (2007). From eLearning to Games-Based eLearning. *International.Journal.of.Information.Technology.and.Management*, 26(2/3/4), 188-208.
- Connolly, T. M., Boyle, E. A., Stansfield, M. H., & Hainey, T. (2007). The potential of online games as a collaborative learning environment. *International.Journal.for.Advanced.Technology.for.Learning*, 4(4), 208-0923.
- Connolly, T. M., Boyle, E., & Hainey, T. (2006). Can computer games motivate next generation learners? A survey of students' reasons for playing computer games. 10th. *International. Conference. of. Motivation*, 28-30 September 2006, University of Koblenz-Landau, Germany
- Connolly, T. M., Boyle, E., & Hainey, T. (2007). A survey of students' motivations for playing computer games. *First.European.Conference.on.Games.–Based.Learning*, 25 – 26 October 2007, Paisley, Scotland.
- Connolly, T. M., Stansfield, M. H., & Hainey, T. (2007). An application of games-based learning within software engineering. *British.Journal.of.Educational.Technology*, 38(3), 416-428.
- Connolly, T.M., Stansfield, M.H., & Hainey, T. (in press). Development of a general framework for evaluating games-based learning. *Second. European. Conference. on.Games.–Based.Learning*. The Hotel Silken Diagonal Barcelona, Barcelona, Spain 16-17 October 2008
- Cook, E. D., & Hazelwood, A. C. (2002). An active learning strategy for the classroom—“who wants to win ... some mini chips ahoy?” *Journal.of.Accounting.Education*, 20(4), 297-306.
- Cook, J. (1999). *Virtual.Learning.Environments: Making. the. Web. easy. to. use. for. teachers. and. learners*: LTSS, University of Bristol.
- Cooley R., Mobasher B., & Strivastava J. (1999). Data Preparation for Mining World Wide Web Browsing Patterns. *In.Knowledge.and.Information.Systems*, 1(1), (pp. 5-32).
- Cooper, P. A. (1993). Paradigm shifts in designed instruction: from behaviorism to cognitivism to constructivism. *Educational.Technology*, 33(5), 12–19.
- Cope, B., & Kalantzis, M. (Eds.). (2000). *Multiliteracies: Literacy.learning.and.the.design.of.social.futures*. London: Routledge.
- Costa, P. T., Jr., & McCrae, R. R (1992). *Revised.NEO. Personality.Inventory.(NEO.PI-R™).and.NEO.Five-Factor.Inventory.(NEO-FFI): Professional.manual*. Odessa, FL: Psychological Assessment Resources.
- Costa, P. T., Jr., & McCrae, R. R. (1985). *The.NEO.Per-sonality.Inventory.manual*. Odessa, FL: Psychological Assessment Resources.
- Costikyan, G. (2000). *Where.stories.end.and.games.be-gin*. Retrieved March 13, 2008, from <http://www.costik.com/gamnstry.html>
- Cowan, D. J. (2007). Assessment of a computer game for teaching architectural energy efficiency. *Journal.of.Advanced.Technology.for.Learning*, 4(4).
- Cragg, R., Dawson, Cragg, A., Taylor, C., Et al. (2007). *Video. Games*. Prepared for the British Board of Film

- Classification. Retrieved October 6th, 2007, <http://www.bbfc.co.uk/downloads/pub/Policy%20and%20Research/BBFC%20Video%20Games%20Report.pdf>
- Crawford, C. (1984). *The art of computer game design*. New York: McGraw-Hill.
- Crawford, C. (2003). *Chris Crawford on Game Design*. New Riders Publishing.
- Crichton, M., & Flin, R. (2001). Training for emergency management: tactical decision games. *Journal of Hazardous Materials*, 88(2-3), 255-266.
- Csikszentmihalyi, M. (1990). *Flow: The Psychology of Optimal Experience*. New York: Harper and Row
- Csikszentmihalyi, M. (1992). *Flow: the Psychology of Happiness*. London: Random House.
- Cugini J., & Scholtz J. (1999). Visvip: 3D visualization of paths through web sites. *In proceedings of the international workshop on web-based information visualization* (pp. 259-263). IEEE Computer Society, Italy.
- Cunningham, H. (2000). Mortal kombat and computer game girls. In J.T. Caldwell (Ed.), *Electronic media and technoculture*. New Brunswick: Rutgers.
- Daneman, M., & Carpenter, P. A. (1980). Individual differences in working memory and reading. *Journal of Verbal Learning and Verbal Behaviour*, 19, 450-66.
- Dantas, A. R., Barros M. O., & Werner, C. (2004) A simulation-based game for project management experiential learning. In F. Naurer & G. Ruhe (Eds.), *Sixteenth International Conference on Software Engineering and Knowledge Engineering (SEKE'04)*. Alberta, Canada, June 2003, 19–24.
- Dantas, A. R., Barros, M. O., & Werner, C. (2005). Simulation Models Applied to Game-Based Training for Software Project Managers. In *Process Simulation and Modeling Workshop (ProSim)*, St Louis, USA, May 2005, 110–116.
- Dawson, C. R., Cragg, A., Taylor, C., & Toombs, B. (2007). *Video Games Research to improve understanding of what players enjoy about video games, and to explain their preferences for particular games*: British Board of Film Classification (BBFC).
- Day, E. A., Arthur Jr., W., & Gettman, D. (2001). Knowledge structures and the acquisition of a complex skill. *Journal of Applied Psychology*, 86, 1022–1033.
- De Bono, E. (1987). *Six Thinking Hats*. London, UK: Penguin.
- de Freitas, S. (2006). *Learning in Immersive Worlds: A review of games based learning*. Bristol. JISC. www.jisc.ac.uk/eli_outcomes.html.
- de Freitas, S. (2006). Learning in Immersive Worlds. *Joint Information Systems Committee*.
- De Freitas, S. (2006). Using games and simulations for supporting learning. IN C. Martin & L. Murray (Eds.), *Learning, Media and Technology. Special Issue on Gaming*.
- de Freitas, S. (2007). *Learning in Immersive Worlds: a Review of Game-based Learning*. JISC.
- de Freitas, S. I. (2006). Using games and simulations for supporting learning. *Learning, Media and Technology*, 31(4), 343–358.
- de Freitas, S., & Jarvis, S. (2007). Serious Games – Engaging Training Solutions: A research and development project for supporting training needs. *British Journal of Educational Technology*, 38(3): 523-525.
- de Freitas, S., & Neumann, T. (2008). The use of ‘exploratory learning’ for supporting immersive learning in virtual environments. *Computers and Education*.
- de Freitas, S., & Oliver, M. (2006). How can exploratory learning with games and simulations within the curriculum be most effectively evaluated. *Computers & Education*, 46(3), 249–264.
- de Freitas, S., Harrison, I., Magoulas, G., Mee, A., Mohamad, F., Oliver, M., Papamarkos, G., & Poulouvassilis, A. (2006). The development of a system for supporting the lifelong learner. *British Journal of Educational Technology. Special Issue. Collaborative e-support for lifelong learning*, 37(6), 867-880.

Compilation of References

- de Freitas, S., Savill-Smith, C., & Attewell, J. (2006). *Computer games and simulations for adult learning: case studies from practice*. London: Learning and Skills Research Centre.
- Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in personality. In R. Dienstbier (Ed.), *Nebraska symposium on motivation*, 38. *Perspectives on motivation* (pp. 237-288). Lincoln, NE: University of Nebraska Press.
- Dede, C., Clarke, J., Ketelhut, D. J., Nelson, B., & Bowman, C. (2005, April). *Students' motivation and learning of science in a multi-user virtual environment*. Paper presented at the meeting of the American Educational Research Association, Montréal, Quebec.
- Dede, C., Nelson, B., Ketelhut, D. J., & Bowman, C. (2004). Design-based Research Strategies for Studying Situated Learning in a Multi-User Virtual Environment. Paper presented in *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.
- Dempsey, J. V., Haynes, L. L., Lucassen, B. A., & Casey, M. S. (2002). Forty simple computer games and what they could mean to educators. *Simulation & Gaming*, 33(2), 157-168.
- Depue, R. A., & Collins, P. F. (1999). Neurobiology of the structure of personality: Dopamine, facilitation of incentive motivation, and extraversion. *Behavioral and Brain Sciences*, 22, 491-517.
- Derryberry, A. (2007). *Serious games: online games for learning*. I'm Serious.net. Retrieved 28th April 2008. URL: <<http://imserious.typepad.com/imserious>>
- Detheridge, T. (1996). Information Technology. In B. Carpenter, R. Ashdown, & K. Bovair (Eds.), *Enabling Access: Effective teaching and Learning for Pupils with Learning Difficulties*. London: David Fulton.
- Dick, W., & Cary, L. (1990). *The Systematic Design of Instruction, Third Edition*. Harper Collins.
- Dickey, M. D. (2003). Teaching in 3D: Pedagogical Affordances and Constraints of 3D Virtual Worlds for Synchronous Distance Learning. *Distance Education*, 24(1), 105-121.
- Dickey, M. D. (2005). Engaging by design: How engagement strategies in popular computer and video games can inform instructional design. In *Educational Technology Research & Development*, 53(2), 67-83. New York: Springer.
- Dickey, M. D. (2005). Three-dimensional virtual worlds and distance learning: two case studies of Active Worlds as a medium for distance education. *British Journal of Educational Technology*, 36(3), 439-451.
- Dietz, T. L. (1998). An examination of violence and gender role portrayals in video games: Implications for gender socialization and aggressive behavior. *Sex Roles*, 38(5-6), 425-442.
- Dillenbourg P., Baker M., Blaye A., & O'Malley C. (1996). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), *Learning in Humans and Machine: Towards an interdisciplinary learning science*, (pp. 189-211), Oxford : Elsevier.
- Dillenbourg, P. (1999). What do you mean by 'collaborative learning'. In P. Dillenbourg (Ed.), *Collaborative Learning: Cognitive and Computational Approaches*. Oxford: Elsevier.
- Dillenbourg, P., Baker, M., Blaye, A., & O'Malley, C. (1995). The evolution of research on collaborative learning. In E. Spada & P. Reiman (Eds.), *Learning in Humans and Machine: Towards an interdisciplinary learning science*. Oxford: Elsevier.
- Dondi, C., & Moretti, M., (2007). A methodological proposal for learning games selection and quality assessment. *British Journal of Educational Technology*, 38(3) 502-512.
- Dondlinger, M. J. (2007). Educational video games design: A review of the literature. *Journal of Applied Educational Technology*, 4(1), 21-31.
- Dougiamas, M., & Taylor, P. C. (2003). Moodle: Using Learning Communities to Create an Open Source Course Management System. *EDMEDIA 2003. Conference*, Honolulu, Hawaii.

- Douglas, C. A., Dragiewicz, M., Manzano, A., & McMullin, V. (2002). United States: In video games, black women are victims, Latinas don't exist. *Off.Our.Back*s, 43(3/4), 6.
- Downing, K. J., Lam, T-F., Kwong, T., Downing, W-K., & Chan, S-W. (2007). Creating interaction in online learning: a case study. *ALT-J. Research. in. Learning. Technology*, 15(3), 201-216.
- Downs, E., & Smith, S. (2005). Keeping abreast of hypersexuality: A video game character content analysis. *International.Communication.Association.Conference*, New York, NY.
- Dreyfus, H. (2004). *A.Phenomenology.of.Skill.Acquisition.as.the.basis.for.a.Merleau-Pontian.Non-representation-alist.Cognitive.Science.*. Retrieved from <http://socrates.berkeley.edu/~hdreyfus/html/papers.html> (January 2008).
- Druin, A. (2002). The Role of Children in the Design of New Technology. *Behaviour.and.Information.Technology*, 21(1) 1-25.
- Ducheneaut, N., & Moore, R. J. (2005). More than just 'XP': learning social skills in massively multiplayer online games. *Interactive.Technology.&Smart.Education*, 2, 89-100.
- Duffy, T. M., & Cunningham, D. J. (1996). Constructivism: Implications for the desing and delivery of instruction. In D. J. Jonassen (Ed.), *Handbook.of.Research.for.Educational.Communications.and.Technology*. New York: Macmillan Library Reference USA.
- Dugdale, J., Pallamin, N., & Pavard, B. (2006). An assessment of a mixed reality environment: Toward an ethnomethodological approach. *Simulation.&Gaming*, 37(2), 226-244.
- Dunne R. (1996). *Activity.theory*. Invited paper presented at Utrecht University, Netherlands, Sep. 1996.
- Dziorny, M. (2007). *Digital. Game-based. Learning.and.dyslexia.in.higher.education*. Paper presented at the Society for Information Technology and Teacher Education International Conference 2007, San Antonio, Texas, USA.
- Eastin, M. S. (2007). The effect of competitive and co-operative group game play on state hostility. *Human.Communication.Research*, 33, 450-466.
- Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: An example from civil engineering. *Computers.&Education*, 49, 873-890.
- Ebner, M., & Holzinger, A. (2007). Successful implementation of user-centered game based learning in higher education: an example from civil engineering. *Computers.and.Education*, 49(3), 873-890.
- Elliman, N. A., Green, M. W., Togers, P. J., & Finsch, G. M. (1997). Processing efficiency theory and the working memory system: Impairment associated with sub-clinical anxiety. *Personality.and.Individual.Differences*, 23, 31-5.
- Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational.Psychologist*, 34(3), 169-189.
- Ellis, N. R. (1963). The stimulus trace and behavioral inadequacy. In N. R. Ellis (Ed.), *Handbook.of.Mental.Deficiency*, (pp.134-58). New York, NY: McGraw-Hill.
- Enochsson, L., Isaksson, B., Tour, R., Kjellin, A., Hedman, L., Wredmark, T., & Tsai-Fellander, L. (2004). Visuospatial skills and computer game experience influence the performance of virtual endoscopy. *Journal.of.Gastrointestinal.Surgery*, 8, 874-880.
- Entertainment Software Association (2007). *Facts.and.Figures*. http://www.theesa.com/facts/gamer_data.php
- Entertainment Software Association. (2007). *Facts.and.research:gameplayer.data*. Retrieved 3 July, 2008 from <http://www.theesa.com/facts/gamplayer.asp>
- Eskelinen, M. (2001). The Gaming Situation. In *Game.Studies*, 1(1).
- Evans, K., Kersh, N., & Kontianen, S. (2004). Recognition of tacit skills: sustaining learning outcomes in adult learning and work re-entry. *International.Journal.of.Training.and.Development*, 8(1), 54-72.

Compilation of References

- Everett, J. (2003). Building a business simulation for kids: the making of Disney's hot shot business *Computers.in. Entertainment.(CIE).*, 1, 18-18.
- Eysenck, H. J., & Eysenck, S. B. G. (1964). *Manual.of. the.Eysenck.Personality.Inventory*. London: University of London Press.
- Eysenck, M. W. (1992). Anxiety: the cognitive perspective. Hove: Lawrence Erlbaum Associates.
- FAS. (2006). Harnessing the power of video games for learning, Summit on Educational Games 2006. Retrieved 3 July, 2008, from <http://fas.org/gamesummit/Resources/Summit%20on%20Educational%20Games.pdf>
- FAS. (2006b). R&D Challenges for Games for Learning. Retrieved 3 July, 2008, from <http://www.fas.org/gamesummit/Resources/RD%20Games.pdf>
- Federation of American Scientists (2005). *Harnessing. the.Power.of.Video.Games.for.Learning*. Retrieved June 25th, 2007, from <http://www.fas.org/gamesummit/>
- Felicia, P., & Pitt, I. J. (2007). *The. PLEASE. model.: An. emotional. and. cognitive. approach. to. learning. in. video.games*. International Technology Education and Development Conference (INTED), Valencia, Spain, 8-10 March 2007.
- Feng, J., Spence, I., & Pratt, J. (2007). Playing an action video game reduces gender differences in spatial cognition. *Psychological.Science.*, 18, 850-855.
- Ferraris C., Martel C., & Vignollet L. (2007). LDL for collaborative activities. *Handbook.of.Visual.Languages. in.Instructional.Design:Theories.and.Practices*. Hershey, PA: Idea Group, (in press).
- Fine, G. (1983). *Shared.fantasy*. Chicago: The University of Chicago Press.
- Fischer, P., Kubitzki, J., Guter, S., & Frey, D. (2007) Virtual driving and risk taking: Do racing games increase risk-taking cognitions, affect, and behaviors? *Journal.of. Experimental.Psychology.:Applied.*, 13, 22-31.
- Fitros, K. (2005). *The. importance. of. Informatics. in. Special.Education*. [online], Available: URL http://www.specialeducation.gr/files/fytros_cor1.pdf (last accessed Jul 7, 2008).
- Fletcher, J.D., & Tobias, S. (2008). *What.research.has. to. say. (thus.far). about. designing. computer.games.for. learning*. Paper presented at the American Educational Research Association, New York, NY.
- Fontana, L., & Beckerman, A. (2004). Childhood Violence Prevention Education Using Video Games. *Information. Technology. in. Childhood. Education. Annual*, (pp. 49-62).
- Foster, A. L. (2007). Professor Avatar. *The.Chronicle.of. Higher.Education* (September 21).
- Fowlkes, J., Dwyer, D. J., Oser, R. L., & Salas, E. (1998). Event-based approach to training (EBAT). *The.International.Journal.of.Aviation.Psychology.*, 8(3), 209-222.
- France L., Heraud J. M., Marty J. C., & Carron T. (2005). Help through visualization to compare learners' activities to recommended learning scenarios. *In.5th.IEEE.International.Conference.on.Advanced.Learning.Technologies*, (pp. 476-480), Kaohsiung, Taiwan.
- France L., Heraud J. M., Marty J. C., & Carron T. (2006). Monitoring virtual classroom: Visualization techniques to observe student activities in an e-learning system. *In. International.Conference.on.Advanced.Learning.Technologies*. (pp. 716-720), Kerkrade, The Netherlands.
- Francis, R. (2006). *Towards.a.pedagogy.for.game-based. learning*. Paper presented at JISC Online conference: Innovating with e-Learning 2006. 30th March. Available in Innovating e-Learning Practice - The proceedings of the JISC Online Conference: Innovating e-Learning 2006. Cheltenham. Direct Learn Services Ltd. Last retrieved online at: www.jisc.ac.uk/elp_conference06.html.
- Francis, R. (2006). *Revolution.:Learning.about.history. through. situated. role. play. in. a. virtual. environment*. Paper presented at the American Educational Research Association Conference, San Francisco.
- Freeman, D. (2003). *Creating.emotions.in.games*. Peachpit (New Riders Games series).

- Freitas, S. d. (2007). *Learning.in.Immersive.Worlds:.A.review.of.game-based.learning*: JISC.
- Fullerton, T., Swain, C., & Hoffman, S. (2004). *Game.design.workshop:designing,prototyping,andplaytesting.games*. Gama Network Series.
- Furnham, A. (1992). *Personality.at.work. The.role.of.individual.differences.in.the.workPlace*. London and New York: Routledge.
- Furnham, A. (1996). The Big five versus the Big four: The relationship between the Myers-Briggs Type Indicator (MBTI) and NEO-PI Five-Factor model of personality. *Personality. and. Individual. Differences*, 21(2), 303-307.
- Futurelab, N. (2006). Close to 60% of UK Teachers Want Computer Games in the Classroom. Retrieved 30 June, 2008, from http://www.futurelab.org.uk/about_us/Press_Release184
- Gagne, R. (1977). *The. Conditions. of. Learning*. New York: Holt
- Gagné, R. M. (1977). *The.conditions.of.learning*. New York: Holt, Rinehart & Winston.
- Gagné, R. M., Briggs, L. J., & Wager, W. W. (1992). *Principles.of.instructional.design,.4th.ed*. Fort Worth, Texas: Harcourt Brace Jovanovich College Publishers.
- Galimberti, C., Ignazi, S., Vercesi, P., & Riva, G. (2001). Communication and cooperation in networked environments: An Experimental Analysis. *CyberPsychology.&. Behavior*, 4, 131–146.
- Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational.Researcher*, 18(8), 4-9.
- Garries, R., Ahlers, R., & Driskel, J. E. (2002). Game based learning cycle. *Simulation. &. Gaming*, 33(4), 441-467.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation.&.Gaming*, 33, 441–467.
- Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation.and.Gaming*, 33(4), 441-467.
- Gee, J. P. (2003). *What. Video. Games. Have. to. Teach. Us.About.Learning.and.Literacy*. New York: Palgrave MacMillan.
- Gee, J. P. (2005). Learning by Design: Good video games as learning machines..*E–Learning*, 2(1), 5-16.
- Gee, J. P. (2005). What would a state of the art instructional video game look like? *Innovate:Journal.of.online.education*, 1(6).
- Gee, J. P. (2006, August). Are Video Games Good for Learning? *Curriculum. Corportation. 13th. National. Conference*, Adelaide, Australia.
- Gee, J., P. (2004). *Game-Like.Learning:.An.Example.of.situation. Learning. and. Implications.for. Opportunity.to.Learn*. Retrieved 27th February 2008. URL: <<http://www.academiccolab.org/resources/documents/Game-Like%20Learning.rev.pdf>>
- Gee, P. (2003). *What. Video. Games. Have. to. Teach. Us. About.Learning.and.Literacy*. Palgrave Macmillan.
- Gentile, D. A., Lynch, P. J., Ruh Linder, J., & Walsh, D. A. (2004). The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *Journal.of.Adolescence*, 27, 5-22.
- Gentner, D., & Nielsen, J. (1996). The Anti-Mac Interface. *Communications.of.the.ACM*, 39(8), 70-82.
- Gerbaud, S., Mollet, N., Ganier, F., Arnaldi, B., & Tisseau, J. (2008). GVT: A platform to create virtual environments for procedural training. *In. Procs.. VR. 2008*, (pp. 225-232).
- Gerrards-Hesse, A., Spies, K., & Hesse, F. W. (1994). Experimental inductions of emotional states and their effectiveness: a review. *British.Journal.of.Psychology*, 85, 55-78.
- Gertner, A. S., & VanLehn, K. (2000). Andes: A coached problem solving environment for physics. *Proceedings.of.the.5th.International.Conference.on.Intelligent.Tutoring*.

Compilation of References

- Systems*, 1839 of Lecture Notes in Computer Science, (pp. 133-142).
- Gherardi, S. (2006). *Organizational knowledge, the texture of workplace learning*. Malden, MA: Blackwell.
- Gillen, K. (2005). *The first generation of the next generation: A Project Gotham Racing 3 postmortem*. Gamasutra: http://www.gamasutra.com/features/20050906/jenkins_01.shtml. Last viewed August 2008.
- Goldberg, L. R. (1999). A broad-bandwidth, public-domain, personality inventory measuring the lower-level facets of several five-factor models. In I. Mervielde, F. Deary, De Fruyt, & F. Ostendorf (Eds.), *Personality psychology in Europe*, 7, 7-28. Tilburg, The Netherlands: Tilburg University Press.
- Goldberg, L. R., Johnson, J. A., Eber, H. W., Hogan, R., Ashton, M. C., Cloninger, C. R., & Gough, H. C. (2006). The International Personality Item Pool and the future of public-domain personality measures. *Journal of Research in Personality*, 40, 84-96.
- Goldsmith, J. (1999) *A taxonomy of games*. Available at <http://www.gg.caltech.edu/~jeff/>. Last access in November 9th, 2005.
- Goleman, D. (1995). *Emotional Intelligence*. New York: Bantam Books.
- Good, J., & Robertson, J. (2006). Learning and motivational affordances in narrative-based game authoring. In the *Proceedings of the 4th International Conference for Narrative and Interactive Learning Environments* (NILE: pp. 37-51). Retrieved April 1, 2008, from http://www.cogs.susx.ac.uk/users/judithg/papers/NILE2006_GoodRobertson.doc
- Gorritz, C. M., & Medina, M. (2002). Engaging girls with computers through software games. *Communications of the ACM*, 43, 42-49.
- Grabinger, S., Dunlap, J., & Duffield, J. (1997). Rich environments for active learning. *ALT-J*, 5(2), 5-17.
- Graham, R., & Gray, C. (1969). *Business games handbook*. New York: American Management Association.
- Graner, Ray, S. (2004). *Gender inclusive game design: Expanding the market*. Hingham, Massachusetts: Charles River Media.
- Grantcharov, T. P., Bardram, L., Funch-Jensen, P., & Rosenberg, J. (2003). Impact of hand dominance, gender, and experience with computer games on performance in virtual reality laparoscopy. *Surgical Endoscopy*, 17, 1082-1085.
- Graves, D. (1983). *Writing: Teachers and children at work*. Exeter, NH: Heinmann.
- Greco, M. (2007). *Il Game Based Learning: le Nuove Frontiere dell'Apprendimento dalla Simulazione al Gioco di Ruolo*. Unpublished master's thesis, Tor Vergata University of Rome, Italy.
- Greco, M., & Murgia, G. (2007). Improving Negotiation Skills Through an Online Business Game. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 97-104). Paisley, UK: Academic Conferences Limited.
- Green, C. S., & Bavelier, D. (2003). Action video game modifies visual selective attention. *Nature*, 423, 534-537.
- Green, C. S., & Bavelier, D. (2006). Effect of action video games on the spatial distribution of visuospatial attention. *Journal of Experimental Psychology: Human Perception and Performance*, 32, 1465-1478.
- Green, H., Facer, K., & Rudd, T. (2006). *Personalisation and digital technologies*. Nesta Future Lab. Available at: http://www.futurelab.org.uk/resources/publications_reports_articles/opening_education_reports/Opening_Education_Report201/
- Green, K. C. (2002). Forecasting Decisions in Conflict Situations: A Comparison of Game Theory, Role-Playing, and Unaided Judgment. *International Journal of Forecasting*, 18, 321-344.
- Greenberg S., Gutwin C., & Cockburn A. (1996). Awareness through fisheye views in relaxed-WYSIWIS groupware. In *proceedings of Graphics Interface*, (pp. 28-38).

- Greenberg, J., & Eskew, D. (1993). The Role of Role Playing in Organizational Research. *Journal of Management*, 19(2), 221-241.
- Greenberg, J., & Folger, R. (1988). *Controversial issues in social research methods*. New York: Springer-Verlag.
- Greenfield, P. M. (1994). Cognitive effects of video games: guest editor's introduction: video games as cultural artifacts. *Journal of Applied Developmental Psychology*, 15(1), 3-12.
- Grice, H.P., (2006). Logic and Conversation, In A. Jaworski & N. Coupland (Eds.), *The Discourse Reader*. London: Routledge.
- Griebel, T. (2006). Self-portrayal in a simulated life: projecting personality and values in The Sims2, *International Journal of Computer Game Research*, 6(1), December 2006.
- Griffiths, M. (2002). The educational benefits of video-games. *Journal of Education and Health*, 20(3), 47.
- Größler, A., Maier, F. H., & Milling, P. M. (2000). Enhancing learning capabilities by providing transparency in business simulators. *Simulation & Gaming*, 31(2), 257-278.
- Grossman, H. J. (Ed.). (1983). *Classification in mental retardation* (Rev. ed.). Washington, DC: American Association on Mental Deficiency.
- Guha, M. L., Druin, A., Chipman, G., Fails, J., Simms, S., & Farber, A. (2004). Mixing Ideas: A new technique for working with young children as design partners. In *Proceedings of Interaction Design and Children (IDC'2004)*. College Park, MD: 35-42.
- Gunter, G., Kenny, R., & Vick, E. H., (2006). *A Case for a Formal Design Paradigm for Serious Games*. Retrieved 12th February 2008 URL: <<http://www.units.muohio.edu/codeconference/papers/papers/Gunter%20Kenny%20Vick%20paper.pdf>>
- Gürer, D., & Camp T. (2002). An ACM-W literature review on women in computing, *ACM SIGCSE Bulletin*, 34, 2.
- Guth, W., Schmittberger, R., & Schwarze, B. (1982). An experimental analysis of ultimatum bargaining. *Journal of Economic Behavior & Organization*, 3(4), 367-388.
- Hailey, C. E., & Hailey, D. E. (2003). How Genre Choices Effects Learning in Digital Environment. *Journal of Engineering Education*, 92(3), 287-294.
- Hainley V., & Henderson J. (2006). Instructional design principles for serious games. *MultiLingual*, 17(8), (pp. 49-52).
- Halpern, D. F. (1992). *Sex differences in cognitive abilities*. 2nd ed. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Halttunen, K., & Sormunen, E. (2000). Learning information retrieval through an educational game. Is gaming sufficient for learning? *Education for Information*, 18(4), 289-311.
- Hamalainen, R. (2008). Designing and evaluating collaboration in a virtual game environment for vocational learning. *Computers & Education*, 50(1), 98-109.
- Hankala, M. (2007). From traditional literacy to media literacy: How to bring up media literate citizens? In P. Linnakylä & I. Arffman (Eds.), *Finnish reading literacy. When quality and equity meet*. (pp. 249-268). Jyväskylä, Finland: Institute for Educational Research, University of Jyväskylä.
- Hannafin, M. J., & Land, S. M. (1997). The foundations and assumptions of technology-enhanced student-centered learning environments. *Instructional Science*, 25, 167-202.
- Hanoch, Y., & Vitouch, O. (2004). When less is more information, emotional arousal and the ecological reframing of the Yerkes-Dodson Law. *Theory & Psychology*, 14(4), 427-452.
- Harpel, R. L. (1978). Evaluating from a management perspective. *New Directions for Student Services*, 1(1), 19-33.
- Harré, R., & Secord, P. F. (1972). *The explanation of social behaviour*. Totowa, NJ: Blackwell.

Compilation of References

- Hartmann, T., & Klimmt, C. (2006). Gender and computer games: Exploring females' dislikes. *Journal of Computer-Mediated Communication*, 11(4), 910-941.
- Hasselbring, T. S., & Glaser, C. W. (2000). Use of Computer Technology to Help Students with Special Needs. *Children and Computer Technology*, 10(2) – fall/winter 2000.
- Hauge, M. R., & Gentile, D. A. (2003). *Video Game Addiction Among Adolescents: Associations with Academic Performance and Aggression*. Paper presented at the Society for Research in Child Development Conference, Tampa, Finland.
- Hayes, E. (2005). Women and video gaming: gendered identities at play. In *Games, Learning & Society Conference*, Madison, WI, June 2005.
- Hays, R. T. (2005). The Effectiveness of Instructional Games: A Literature Review and Discussion. *NAVAIR Technical Report* 2005-004
- Heinström, J. (2003). Five personality dimensions and their influence on information behaviour. *Information Research*, 9. Available at: <http://informationr.net/ir/9-1/paper165.html>.
- Henderson, J. (2006). *Serious Games by Serious Instructional Designers*. NTSA
- Hendrick, C. (1977). Role-taking, role-playing, and the laboratory experiment. *Personality and Social Psychology Bulletin*, 3, 467-478.
- Hijon R., & Carlos R. (2006). E-learning platforms analysis and development of students tracking functionality. *In proceedings of the 18th World Conference on Educational Multimedia, Hypermedia & Telecommunications*, (pp. 2823-2828).
- Hill, J. M. D., Ray, C. K., Blair, J. R. S., & Curtis A. Carver, J. (2003). Puzzles and games: addressing different learning styles in teaching operating systems concepts. *ACM SIGCSE Bulletin*, 35(1), 182-186.
- Hjorth, L. (2006). Playing at being mobile: Gaming and cute culture in South Korea. *Fibreculture Journal Issue 8*. Retrieved 30 April, 2007 from http://journal.fibreculture.org/issue8/issue8_hjorth.html
- Hoffman, H. G., Garcia-Palacios, A., Carlin, C., Furness, T. A. I., & Botella-Arbona, C. (2003). Interfaces that heal: Coupling real and virtual objects to cure spider phobia. *International Journal of Human-Computer Interaction*, 15, 469-486.
- Hollan, J. D., Hutchins, E. L., & Weitzman, L. (1984). STEAMER: An Interactive Inspectable Simulation-Based Training System. *AI Magazine*, 2, 15-27.
- Holley, W., Armenakis, A., & Feild, H. (1977). Effects of Role-Playing on Perceptions of Union Leaders. *Journal of Management*, 3(2), 41-46.
- Holman, D., Pavlica, K., & Thorpe, R. (1997). Rethinking Kolb's theory of experiential learning: The contribution of social constructivism and activity theory. *Management Learning*, 28.
- Honebein, P. C. (1996). Seven goals for the design of constructivist learning environments. In Wilson, B. G. (Ed.) *Constructivist Learning Environments: Case Studies in Instructional Design*. Englewood Cliffs, NJ: Educational Technology Publications.
- Honey, P., & Mumford, A. (1982). *The manual of learning styles*. Maidenhead: Peter Honey.
- Hopko, D. R., Ashcraft, M. H., & Gute, J. (1998). Mathematics anxiety and working memory: support for a deficient inhibition mechanism, *Journal of Anxiety Disorders*, 12, 343-55.
- Hopson, J. (2001). Behavioural game design. Gamasutra, April 2001. Available at: http://www.gamasutra.com/features/20010427/hopson_pfv.htm
- Horn Abbot Ltd. (2004) *Trivial Pursuit*. Available at www.trivialpursuit.com. Last access in November 16th, 2005.
- Huizinga, J. (1971). *Homo Ludens*. UK: Beacon Press.
- Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence*. Retrieved June 10, 2008, from <http://www.cs.northwestern.edu/~hunicke/MDA.pdf>

- Hunicke, R., LeBlanc, M., & Zubek, R. (2004). MDA: A Formal Approach to Game Design and Game Research. *Proceedings of the Challenges in Game AI Workshop, Nineteenth National Conference on Artificial Intelligence 2004*. Retrieved 18 March 2008 from <http://www.cs.northwestern.edu/~hunicke/MDA.pdf>
- Hunsley, J., Lee, C. M., & Wood, J. M. (2004). Controversial and questionable assessment techniques. In S. O. Lilienfeld, J. M. Lor & S. J. Lynn (Eds.), *In Science and Pseudoscience in Clinical Psychology* (p. 65). Guilford, ISBN 1-59385-070-0.
- Hutchby, I., & Wooffit, R. (1998). *Conversational Analysis*. Cambridge: Polity Press.
- Iksal, S., & Choquet, C. (2005). An open Architecture for usage analysis in a e-learning context. *In International Conference on Advanced Learning Technologies*. (pp. 177-178). Kaohsiung, Taiwan.
- Inkpen, K., Uptis, R., Klawe, M., Lawry, J., Anderson, A., Ndunda, M., Sedighian, K., Leroux, S., & Hsu, D. (1994). We have never forgetful flowers in our garden: Girls' responses to electronic games. *Journal of Computers in Math and Science Teaching*, 13(4), 383-403.
- Irvine, C. E., Thompson, M. F., & Allen, K. (2005). CyberCIEGE: Gaming for Information Assurance. *IEEE Security and Privacy*, 3(3), 61-64.
- Ivory, J. D. (2006). Still a man's game: Gender representation in online reviews of video games. *Mass Communication & Society*, 9(1), 103-114.
- Jacklin, C. N., Maccoby, E. E., & Dick, A. E. (1973). Barrier behaviour and toy preference: sex differences and their absence in the one year-old child. *Child Development*, 44, 557-569.
- Jackson, C. (2003). Motives for "Laddishness" at school; fear of failure and fear of the feminine. *British Educational Research Journal*, 29(4), 583-598.
- Jackson, C., & Lawty Jones, M. (1996). Explaining the overlap between personality and learning style. *Personality and Individual Differences*, 20, 293-300.
- Janis, I., & King, b. (1954). The Influence of Role Playing in Opinion Change. *Journal of Abnormal and Social Psychology*, 49, 211-218.
- Jansz, J. (2005). The emotional appeal of violent video games for adolescent males. *Communication Theory*, 15(3), 219-241.
- Järvinen, A. (2003). Making and breaking games: A typology of rules. In M. Copier & J. Raessens (Eds.). *Proceedings of Level Up: Digital Games Research Conference* (pp. 92-99). Utrecht, Country: University of Utrecht.
- Jayakanthan, R. (2002). Application of computer games in the field of education. *The Electronic Library*, 20(2), 98-102(105).
- Jenkins, H. (2003, January 15). Transmedia storytelling. *Technology Review*. Retrieved March 11, 2008, from <http://www.technologyreview.com/Biotech/13052/>
- Jenkins, H., & Squire, K. (2003) Understanding Civilization (III). In *Computer Games Magazine*. September 2003. Richmond, USA. Available at <http://www.educationarcade.org/modules.php?op=modload&name=Sections&file=index&req=viewarticle&artid=44&page=1>. Last access in November 15, 2005.
- Jenkins, H., Klopfer, E., Squire, K., & Tan, P. (2003, October 2003). Entering The Education Arcade. *Computers in Entertainment (CIE)*, 1, 17-17.
- Jiménez-Díaz, G., González-Calero, P., & Gómez-Albarán, M. (2007). Using Role-Play Virtual Environments to Learn Software Design. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 143-152). Paisley, UK: Academic Conference Limited.
- JISC. (2004). Effective Practice with e-Learning - A good practice guide in designing for learning. Retrieved 5 July, 2008, from http://www.jisc.ac.uk/elearning_pedagogy.html
- Johnson, D. W., & Johnson, F. P. (2006). *Joining Together: Group Theory and Group Skills*. Boston: Allyn & Bacon.

Compilation of References

- Johnson, W. L. (2007). Serious use of a serious game for language learning. In *Procs. Artificial Intelligence in Education, AIED'07*.
- Jonassen, D. (1994). Thinking Technology: Towards a Constructivist Design Model. *Educational Technology, (April, 1994)*, (pp. 34-37).
- Jonassen, D. H., & Wang, S. (1993). Acquiring Structural Knowledge from Semantically Structured Hypertext. *Journal of Computer-Based Instruction*, 20(1).
- Jonassen, D. H. (1999). Designing constructivist learning environments. In Reigeluth, C. M. (Ed.), *Instructional Design Theories and Models: Their Current State of the Art*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Jones, S., & Myhill, D. (2004). Troublesome boys and compliant girls: gender identity and perceptions of achievement and underachievement. *British Journal of Sociology of Education*, 25, 547-561.
- Jones, T. (2003). Let the games begin: Gaming technology and entertainment among college students. *Pew Internet and American Life Project*. Retrieved 10 October 2006, from http://www.pewinternet.org/pdfs/PIP_College_Gaming_Reporta.pdf.
- Juul, J. (1998, November). *A clash between games and narrative*. Paper presented at the Digital Arts and Culture conference, Bergen, Norway. Retrieved December 13, 2007, from http://www.jesperjuul.net/text/clash_between_game_and_narrative.html
- Juul, J. (2001). Games telling stories? A brief note on games and narratives. *Game Studies*, 1(1). Retrieved December 13, 2007, from <http://www.gamestudies.org/0101/juul-gts/>
- Kafai, Y. B. (2001). The educational potential of electronic games: From games-to-teach to games-to-learn. In *Playing by the rules: The cultural policy challenges of video games*. Chicago, EEUU.
- Kafai, Y. B. (2006). Playing and making games for learning: Instructionist and constructionist perspectives for game studies. *Games and Culture*, 1, 36-40.
- Kalantzis, K. (1985). *Didactics of Special Educational Schools, for mentally retarded children*. Karavias. Athens. (in Greek)
- Kambouri, M., Thomas, S., & Mellar, H. (2006). Playing the literacy game: a case study in adult education. *Learning, Media and Technology*, 31(4), 395-410.
- Kamradt, T. F., & Kamradt, E. J. (1999). Structured Design for Attitudinal Instruction. In C. M. Reigeluth (Ed.), *Instructional Design Theories and Models: A New Paradigm of Instructional Theory, Volume II* (pp. 563-590). Mahwah, NJ: Lawrence Erlbaum Associates.
- Kankaanranta, M. (2007). Digital games and literacy. In P. Linnakylä and I. Arffman (Eds.) *Finnish reading literacy: When quality and equity meet* (pp. 281-307). Jyväskylä, Finland: Institute for Educational Research, University of Jyväskylä.
- Kasper, D., Welsh, S., & Chambliss, C. (1999). Educating Students about the Risks of Excessive Videogame Usage.
- Ke, F. (2006). Classroom goal structures for educational math game application. In *Proceedings of the 7th International Conference on Learning Sciences. ICLS '06*, Publisher: International Society of Learning Sciences.
- Ke, F., & Grabowski, B. (2007). Gameplaying for maths learning: cooperative or not? *British Journal of Educational Technology*, 38, 249-259.
- Kearney, P. R. (2005). Playing in the Sandbox: Developing games for children with disabilities. *Proceedings of DiGRA 2005 conference: Changing Views... Worlds in Play*, June 16th - 20th, 2005
- Keefe, J. W. (1988). *Profiling and utilizing learning styles*. Reston: NASSP (National Association of Secondary School Principals).
- Keirse, D. (1998). *Please understand me II, temperament, character, intelligence*. Prometheus Nemesis Book Company.
- Keith, C. (2007). SCRUM RISING – Agile development could save your studio. *Game Developer*, 14(2), 22-26.

- Kelleher, C. (2006). *Motivating. Programming.: Using. storytelling.to.make.computer.programming.attractive.to.middle.school.girls*. Unpublished Technical Report, Carnegie Mellon University.
- Keller, J. M. (1987). Development and use of the ARCS model of motivational design..*Journal.of Instructional. Development*, 10(3), 2-10.
- Kemp, J., & Livingstone, D. (2006). Putting A Second Life "Metaverse" Skin On Learning Management Systems. In D. Livingstone & J. Kemp (Eds.), *Second.Life. Education.Workshop.at.SLCC*. San Francisco.
- Kernan, M. C., & Lord, R. G. (1990). Effects of valence, expectancies, and goal-performance discrepancies in single and multiple goal environments. *Journal.of.Applied.Psychology*, 75, 194-203.
- Khan, R., & Kellner, D. (2004). New media and internet activism: from the 'Battle of Seattle' to blogging. *New. Media.&.Society*, 6(1), 87-95.
- Khoo, A., & Gentile, D. A. (2007). Problem-based Learning in the World of Digital Games. In O.-S. Tan (Ed.), *Problem-based.Learning.in.eLearning.Breakthroughs* (pp. 97-129). Singapore: Thompson Learning.
- Kian-Sam, H., & Chee-Kiat, K. (2002). Computer anxiety and attitudes toward computers among rural secondary school teachers: A malaysian perspective. *Journal.of.Research.on.Technology.in.Education*, 35(1), (pp. 27-49).
- Kiesler, S., Sproull, L., & Eccles, J. E. (2002). Pool halls, chips and war games: women in the culture of computing. *SIGCE.Bulletin*, 34(2), 159-164.
- Kiili, K. (2005). Digital game-based learning: towards an experiential gaming model. *The.Internet.and.Higher. Education*, 8, 13-24.
- Kiili, K. (2005). Digital game-based learning: Towards and experiential gaming model. *Internet. and. Higher. Education*, 8, 13-24.
- Kimura, D. (1999). *Sex.and.Cognition*. The Massachusetts University Press.
- Kinchin, I., & Alias, M. (2005). Exploiting variations on concept map morphology as a lesson-planning too for trainee teachers in Higher Education. *Journal. of. In-service.Education*, 31(3).
- King, A. (1993). From Sage on the Stage to Guide on the Side. *College.Teaching*, 41(30). Retrieved June 24th, 2008, from <http://www.questia.com/googleScholar.qst;jsessionid=LhmfD5DS05RYcptnByT3TnFG9phhkyMG9n7cLKfz7MyStt6GrXdk!-766956787?docId=94305197>
- King, J. A., & Evans, K. M. (1991). Can we Achieve Outcome-based Education? *Educational. Leadership*, 49(2), 73-75.
- Kinshuk, S., & Patel, A. (1996). Intelligent tutoring tools: Redesigning ITSs for adequate knowledge transfer emphasis. In *International.Conference.on.Intelligent.and. Cognitive.Systems*, (pp. 221-226).
- Kirjavainen, A., Nousiainen, T., & Kankaanranta, M. (2006). *Prototyping.in.Educational. Game.Design*. Positioning paper for the CHI 2006 conference.
- Kirkley, S. E., Tomblin, S., & Kirkley, J. (2005). Instructional Design Authoring Support for the Development of Serious Games and Mixed Reality Training. *Presented. at.Interservice/Industry.Training,.Simulation.and.Education.Conference*.
- Kirkley, S., Tomblin, S., & Kirkley, J. (2005). *Instructional.Design.Authoring.Support.for.the.Development.of.Serious.Games.and.Mixed.Reality.Training*. Paper presented at Interservice/Industry Training, Simulation, and Education Conference (I/ITSEC), 2005. Retrieved 27 March 2008 from http://www.informationinplace.com/Hot/SeriousGames/Kirkley_Tomblin_Kirkley_Authoring_Game_MR.pdf
- Kirkpatrick, D. L. (1994). *Evaluatingtrainingprograms.: the.four.levels*. San Francisco, CA, Berrett-Koehler.
- Kirkpatrick, D. L. (1998). *Evaluatingtrainingprograms.: the.four.levels. (2nd.Ed.)*. San Francisco, CA, Berrett-Koehler.
- Kirriemuir, J. (2002). *The.relevance.of.video.games.and.gaming.consoles.to.the.higher.and.further.education.learning.experience*. UK: Techwatch Report.

Compilation of References

- Kirriemuir, J. (2008). *A.spring.2008. "snapshot".of.UK. Higher.and.Further.Education.Developments.in.Second. Life*. Bath: Eduserv Foundation.
- Kirriemuir, J., & McFarlane, A. (2004). Literature review in games and learning (Futurelab Series Report 8). Retrieved March 17, 2008 from Futurelab Website http://www.nestafuturelab.org/research/reviews/08_01.htm.
- Klastrup, L., & Tosca, S. (2004). Transmedial worlds: Rethinking cyberworld design. In *Proceedings International Conference on Cyberworlds.2004* (pp. 409-416). Washington, DC, USA: IEEE Computer Society.
- Kleer, J. de, & Brown, J. S. (1984). A physics based on confluences. *Artificial Intelligence*, 24, 7-83.
- Klingman, A. (1982). Persuasive Communication in Avoidance Behaviour: Using Role Simulation as a Strategy. *Simulation.& Games*, 13(1), 37-50.
- Klopfer, E., Yoon, S., & Rivas, L. (2004). Comparative analysis of Palm and wearable computers for Participatory Simulations. Blackwell Publishing Ltd 2004 *Journal of Computer Assisted Learning*, 20, 347-359
- Kluger, A. N., & DeNisi, A. (1996). The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory. *Psychological Bulletin*, 119, 254-284.
- Knowles, M. (1998). *The Adult Learner. (5th. edition)*. Houston, TX: Butterworth-Heinemann.
- Koerber, A., Crawford, J., & O'Connell, K. (2003). The effects of teaching dental students brief motivational interviewing for smoking-cessation counseling: a pilot study. *Journal of Dental Education*, 67(4), 439-447.
- Kolb, D. (1984). *Experiential Learning*. New Jersey, Prentice-Hall Inc.
- Kolb, D. A. (1976). *The Learning Style Inventory: Technical Manual*. Boston, MA: McBer.
- Kolb, D. A. (1984). *Experiential Learning. Experience as The Source of Learning and Development*. New Jersey: Prentice Hall.
- Kolb, D. A. (1984). *Experiential Learning: Experience as the Source of Learning and Development*. New Jersey, NJ: Prentice Hall.
- Kolb, D. A., Boyatzis, R. E., & Mainemelis, C. (2000). Experiential Learning Theory: Previous Research and New Directions. In R. J. Sternberg and L. F. Zhang (Eds.), *Perspectives on cognitive learning and thinking styles*. New Jersey: Lawrence Erlbaum.
- Komisarczuk, P., & Welch, I. (2007). Web based board game for teaching aspects of internet engineering. ACTA/ IASTED, *International Journal of Advanced Technology for Learning on Games-based Learning*, 4(4).
- Koper, R., Oliver, B., & Anderson, T. (2003). *IMS Learning Design Information Model, version 1.0*. IMS Global Learning Consortium, Inc.
- Koster, R. (2004). *A Theory of Fun for Game Design: Paraglyph*.
- Kraiger, K., Ford, J. K., & Salas, E. (1993). Application of cognitive, skill-based, and affective theories of learning outcomes to new methods of training evaluation. *Journal of Applied Psychology*, 78, 311-328.
- Krathwohl, D. R., Bloom, B. S., & Massai, B. B. (1964). *Taxonomy of educational objectives: The classification of educational goals*. White Plains, NY: Longman.
- Kreijns, K., Kirschner, P. A., & Jochems, W. (2003). Identifying the pitfalls for social interaction in computer-supported collaborative learning environments: A review of the research. *Computers in Human Behavior*, 19, 335-353.
- Kriz, W. C. (2003). Creating Effective Learning Environments and Learning Organizations through Gaming Simulation Design. *Simulation and Gaming*, 34(4), 495-511.
- Kruijver, I., Kerkstra, A., Kerssens, J., Holtkamp, C., Bensing, J., & Van de Wiel, H. (2001). Communication between nurses and simulated patients with cancer: evaluation of a communication training programme. *European Journal of Oncology Nursing*, 5(3), 140-150.

- Kürşat, Ç., & Kaplan, G. (2006) *An Instructional Design/Development Model for the Creation of Game-like Learning Environments: The FIDGE Model in Affective and Emotional Aspects of Human-computer Interaction: Game-based and Innovative Learning Approaches: 1. (Future of Learning)* IOS Press, US
- LaBar, K., & Cabeza, R. (2006) Cognitive neuroscience of emotional memory. *Nature*, 7, 54-63.
- Labov, W. (1972). *Language in the Inner City*. Oxford, Blackwell.
- Ladousse, G. P. (1987). *Role-play*. Oxford, UK: Oxford University Press.
- Laflaquiere, J., Settouti, L. S., Prie Y., & Mille, A. (2006). Trace-based framework for experience management and engineering. In *10th. international conference on knowledge-based intelligent information and engineering systems* (pp. 1171-1178), Bournemouth, UK, Lecture Notes in Computer Science.
- Lakoff, G. (1987). *Women, Fire and Dangerous Things: What Categories reveal about the Mind*. Chicago, IL, University of Chicago Press.
- Lambert, N., M., & McCombs, B., L. (2002). *How students learn: reforming schools through learner-centered education*. Washington DC: American Psychological Association.
- Land, S. M., & Hannafin, M. J. (2000). Student-centered learning environments. In D. H. Jonassen & S. M. Land (Eds.), *Theoretical Foundations of Learning Environments*. Mahwah, NJ: Lawrence Erlbaum Associates.
- Langer, A. (1985). Personal computers and people with disabilities. *Australian Disability Review*, 15(4), 28-33.
- Laughlin, D., Roper, M., & Howell, K. (2007). NASA eEducation Roadmap: Research Challenges in the Design of Massively Multiplayer Games for Education & Training. Retrieved 10 August, 2008, from http://www.fas.org/programs/ltp/publications/roadmaps/_docs/NASA%20eEducation%20Roadmap.pdf
- Laurillard, D. (1998) Multimedia and the learner's experience of narrative. In *Computers in Education*, 31, 229-243.
- Lave, J., & Wenger, E. (1991). *Situated learning: Legitimate peripheral participation*. Cambridge: Cambridge University Press.
- Lawrence, R. (2004). Teaching data structures using competitive games. *IEEE Transactions on Education*, 47(4), 459-466.
- Lawton, C. A., & Morrin, K. A. (1999). Gender differences in pointing accuracy in computer simulated 3D mazes, *Sex Roles*, 40(1/2), 73-92.
- Lazzaro, N. (2004). *Four keys to more emotions in games*. Available at: http://www.xeodesign.com/xeodesign_whyweplaygames.pdf
- Leadership-in-Action Project Management Simulation. (2008). Retrieved August 22, 2008, from <http://forio.com/lead.htm>
- Lee, A. C. K. (2003). Undergraduate students' gender differences in IT skills and attitudes. *Journal of Computer Assisted Learning*, 19, 488-500.
- Lee, J., LeBaron Wallace, T., & Alkin, M. (2007). Using Problem-Based Learning to Train Evaluators. *American Evaluation Association*, 8(4), 536-545.
- Lee, S. H., & Boling, E. (1999). Screen design guidelines for motivation in interactive multimedia instruction: a survey and framework for designers. *Educational Technology*, 39, 19-26.
- Leemkuil, H. (2005). *Is it all in the game? Learner support in an educational knowledge management simulation game*. Unpublished doctoral thesis. University of Twente, Enschede, The Netherlands.
- Leemkuil, H. (2006). *Is it all in the game? Learner support in an educational knowledge management simulation game*. Unpublished doctoral thesis. University of Twente, Enschede, The Netherlands.
- Leemkuil, H., & de Hoog, R. (2005). Is support really necessary within educational games? In C. Conati & S. Ramachandran (Eds). 18-22 July 2005, Amsterdam, Netherlands. *Workshop on educational games as intelligent learning environments, 12th International Conference on Artificial Intelligence in Education (AIDE 05)* (pp. 21-31).

Compilation of References

- Leemkuil, H., de Jong, T., & Ootes, S. (2000). *Review of educational use of games and simulations* (IST-1999-13078 Deliverable D1). University of Twente, Enschede, The Netherlands.
- Lennon, J. L. (2006). Debriefings of web-based malaria games. *Simulation & Gaming*, 37(3), 350-356.
- Leont'ev, A. N. (1977). *Activity and Consciousness* (N. Schmolze & A. Blunden, Trans.): Progress Publishers.
- Lepper, M. R. (1988). Motivational considerations in the study of instruction. *Cognition and Instruction*, 5(4), 289-309.
- Lepper, M. R., & Malone, T. W. (1987). Intrinsic motivation and instructional effectiveness in computer-based education. In R. Snow, & M. Farr (Eds.), *Aptitude, Learning and Instruction, III: Cognitive and Affective Process Analysis*. Hillsdale, NJ: Lawrence Erlbaum Associates.
- Lessig, L. (2004). *Free Culture: How Big Media Uses Technology and the Law to Lock Down Culture and Control Creativity*. New York: Penguin.
- Lester, J. (2006). Brigadoon, An innovative online community for people dealing with Asperger's Syndrome and Autism. *Project Brigadoon, BrainTalk Communities, Inc.* Available: URL http://braintalk.blogs.com/brigadoon/2005/01/about_brigadoon.html (last accessed Jul 7, 2008).
- Leu, D. J. Jr., Kinze, C. K., Coiro, J. L., & Cammack, D. W. (2004). *Toward a theory of new literacies emerging from the Internet and other information and communication technologies*. Retrieved December 4, 2006 from <http://www.reading.org/Library/Retrieve.cfm?D=10.1598/0872075028.54&F=bk502-54-Leu.pdf>
- Levine, J. (1999). *The Enneagram intelligences: understanding personality for effective teaching and learning*. Bergin and Garvey Publishers.
- Lightbody, P., & Durndell, A. (1996). Gendered career choice: is sex-stereotyping the cause or the consequence? *Educational Studies*, 22(2) 133-146.
- Ligorio, M. B., & Pugliese, A. C. (2004). Self-positioning in a text-based virtual environment. *Identity: An International Journal of Theory and Research*, 4(4).
- Lim, C. P., Nonis, D., & Hedberg, J. (2006). Gaming in a 3D multi-user virtual environment: engaging students in Science lessons. *British Journal of Educational Technology*, 37(2), 211-231.
- Lindgren, A. (1981). *Ronja, ryövärintytär*. [English translation here]. Juva, Finland: WSOY.
- Lindley, C.A. (2003). *Game Taxonomies: A High Level Framework for Game Analysis and Design*. Retrieved March 17, 2008 from Gamasutra Website. http://www.gamasutra.com/features/20031003/lindley_01.shtml.
- Lindley, C.A. (2004). Narrative, game play, and alternative time structures for virtual environments. In S. Göbel, U. Spierling, A. Hoffman, I. Iurgel, O. Schneider, J. Dechau & A. Feix (Eds.), *Lecture Notes in Computer Science: Vol. 3105. Technologies for Interactive Digital Storytelling and Entertainment* (pp. 183-194). Heidelberg: Springer Berlin.
- Linell, P. (1998). *Approaching Dialogue: Talk, interaction and contexts in dialogical perspective*. Amsterdam, Benjamins.
- Linnakylä, P. (2000). Lukutaito tiedon ja oppimisen yhteiskunnassa [English translation here]. In K. Sajavaara & A. Piirainen-Marsh (Eds.), *Kieli, diskurssi ja yhteisö* (pp. 107-132). Jyväskylä, Finland: Centre for Applied Language Studies, University of Jyväskylä.
- Livingston, S. A. (1970). *Simulation Games and Attitude Change: Attitudes Toward the Poor (Questionnaire Study I)*. Report No. 63. The John Hopkins University, Center for the Study of Social Organisation of Schools.
- Livingstone, D., & Kemp, J. (Eds.) (2007). *Proceedings of the Second Life Education Workshop at SLCC*, Chicago, August 25th-26th. San Francisco.
- Livingstone, D., & Kemp, J. (in press). Integrating Web-Based and 3D Learning Environments: Second Life Meets Moodle. *Upgrade: The European Journal for the Informatics Professional*.
- Livingstone, S. (2003). The changing nature and uses of media literacy. MEDIA@LSE Electronic Working Papers 4. Retrieved June 23, 2008, from <http://www>.

- lse.ac.uk/collections/media@lse/pdf/Media@lseE-WP4_july03.pdf
- Lockee, B., Moore, D., & Burton, J. (2004). Foundations of Programmed Instruction. In D. H. Jonassen (Ed.), *Handbook of Research on Educational Communications and Technology. 2nd Edition* (pp 545-569). Mahwah, NJ: Lawrence Erlbaum Associates.
- Loewenstein, G. (1994). The psychology of curiosity: a review and reinterpretation. *Psychological Bulletin*, 116(1), 75-98.
- Loghin, G. C., Carron, T., Marty, J. C. (2005), A Method for Enabling a Better Comprehension of User Behaviour. In *Proceedings of CELDA'05 (Cognition and Exploratory Learning in Digital Age Conference)*, (pp. 349-354).
- Loghin, G. C., Carron, T., Marty, J. C., & Vaida, M. (2008). Observation and adaptation of a learning session based on a multi-agent system : An experiment. In *proceedings of IEEE International Conference on Intelligent Computer Communication and Processing* (to be published). Cluj-Napoca, Romania.
- Lucas, K., & Sherry, J. L. (2004). Sex differences in video game play: A communication-based explanation. *Communication Research*, 31(5), 499-523.
- Magnussen, R. (2005). Learning games as a platform for simulated science practice. In *Proceedings of the Digital Games Research Association 2005 Conference*, Vancouver, Canada.
- Malkin, M. J., & Rabinowitz, E. (1998). Sensation seeking and high-risk recreation. *Parks and Recreation*, 33(7), 34-39.
- Malone, T. (1980). *What makes things fun to learn? A study of intrinsically motivating computer games*. Technical Report CIS-7, Xerox Parc.
- Malone, T. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 4, 333-369.
- Malone, T. W. (1980). *What makes things fun to learn? heuristics for designing instructional computer games*. Paper presented at the Proceedings of the 3rd ACM SIGS-MALL symposium and the first SIGPC symposium on Small systems, Palo Alto, California, United States.
- Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science*, 4, 333-369.
- Malone, T. W., & Lepper, M. R. (1987). Making learning fun: a taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning, and Instruction*, 3, 223-253. Cognitive and Affective Process Analyses. Hillsdale, NJ: Erlbaum.
- Malone, T. W., & Lepper, M. R. (1987). Making Learning Fun: A Taxonomy of Intrinsic Motivations for Learning. In R. E. Snow & M. J. Farr (Eds.), *Aptitude, Learning, and Instruction* (Vol. 3): Lawrence Erlbaum Associates.
- Malone, T., & Lepper, M. R. (1987). Making learning fun: a taxonomy of intrinsic motivations for learning. In R. E. Snow & M. J. Farr, (Eds.), *Aptitude, Learning, and Instruction, III: Cognitive and Affective Process Analysis*. Hillsdale, NJ: Erlbaum.
- Marquardt, C. G., Becker, K., & Ruiz, D.D. (2004). A pre-processing tool for web-usage mining in the distance education domain. In *international database engineering and applications symposium* (pp. 78-87). Coimbra, Portugal.
- Marsh, J. (2002). Popular culture, computer games and the primary literacy curriculum. In M. Monteith (Ed.) *Teaching primary literacy with ICT*. Buckingham, UK: Open University Press.
- Marshall, E. M. (1995). The Collaborative Workspace. *Management Review*, 24.
- Martel, E. (2006). An Analysis of Far Cry Instincts' Anchor System. In S. Ravin (Ed.), *AI Game Programming Wisdom III*. (pp. 555-566) Charles River Media.
- Marton, F. (1981). Phenomenography – describing conceptions of the world around us. *Instructional Science*, 10, 177-200.
- Marty, J. C., Heraud, J. M., Carron, T., & France, L. (2004). A quality approach for collaborative learning scenarios. In *Learning Technology Newsletter of IEEE Computer Society*, 6(4), (pp. 46-48).

Compilation of References

- Marty, J. C., Heraud, J. M., Carron, T., & France, L. (2007). Matching the performed activity on an educational platform with a recommended pedagogical scenario: A multi-source approach. In *Journal of Interactive Learning Research*, 18(2) (pp. 267-283), special issue usage analysis in learning systems: Existing approaches and scientific issues.
- Maslow, A. (1968). Some educational implications of the humanistic psychologies. *Harvard Educational Review*, 38(4), 685-696.
- Mason, B. J., & Bruning, R. (1999). Providing Feedback in Computer-based Instruction: What the Research Tells Us. Retrieved November 29th, 2006, from <http://dwb.unl.edu/Edit/MB/MasonBruning.html>
- Mason, H., & Moutahir, M. (2006). Multidisciplinary Experiential Education in Second Life: A Global Approach. Paper presented in the Proceedings of the Second Life Education Workshop at SLCC, San Francisco.
- Maxwell, C. (2007). Team Play – Using Computer Games to Engage Learners in Teamworking. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 193-196). Paisley, UK: Academic Conference Limited.
- Mayer, I. S., Bockstael-Blok, W., & Valentin, C. (2004). A building block approach to simulation: an evaluation using containers adrift, *Simulation & Gaming*, 35(1), 29–52.
- Mayes, T., & de Freitas, S. (2007). Learning and e-Learning: The role of theory. In H. Beetham & R. Sharpe (Eds.), *Rethinking pedagogy in the digital age*. London: Routledge.
- Mazza, R., & Dimitrova, V. (2005). Generation of graphical representations of student tracking data in course management systems. In *9th IEEE international conference on information visualisation* (pp. 253-258). London. ISBN 0-7695-2397-8.
- McConnell, D. (2000). *Implementing Computer Supported Cooperative Learning*. London, UK: Kogan Page Ltd.
- McConnell, D. (2006). *E-learning Groups and Communities*. Milton Keynes: Open University Press.
- McCrae, R., R., & Costa, P., T. (1989). Reinterpreting the Myers-Briggs Type Indicator from the perspective of the Five-factor model of personality. *Journal of Psychology*, 57, 17-40.
- McCroskey, J.C., & McCain, T.A. (1974). The measurement of interpersonal attraction. *Speech Monographs*, 41(3), 261-266.
- McFarlane, A., & Kirriemuir, J. (2003, November). Use of Computer and Video Games in the Classroom. Presented at the DiGRA conference, Holland.
- McFarlane, A., Sparrowhawk, A., & Heald, Y. (2002). *Report on the educational use of games, an exploration by TEEM of the contribution which games can make to the education process*. Teem Publication. Available at: http://www.teem.org.uk/publications/teem_games-ined_full.pdf
- McLean, A. (2003). *The Motivated School*. Paul Chapman Publishing.
- McLelland, D. C. (1961). Methods of measuring human motivation. In J. W. Atkinson (Ed.), *The Achieving Society* (pp. 41-43)...Princeton, N.J.: D. Van Nostrand.
- McMahon, M., & Pospisil, R. (2005). *The Role of Ubiquitous Mobile Technology in Supporting the Needs of Millennial Students*. Paper presented at Educause Australasia 2005: 'The next wave of collaboration'. Auckland, New Zealand, 5-8 April 2005.
- McNabb, R., Pal, S., & Sloan, P. (2002). Gender difference in educational attainment: the case of university students in England and Wales. *Economica*, 69, 481-503.
- Michael, D., & Chen, S. (2006). *Serious games: Games that educate, train, and inform*. Boston, MA.: Thomson Course Technology.
- Michelet, S., Adam, J. M., & Luengo, V. (2007). Adaptive learning scenarios for detection of misconceptions about electricity and remediation. In *International Journal of Emerging Technologies in Learning*, 2(1), (pp. 195-199).
- Microsoft. (2006). Bicycle games board. from <http://www.microsoft.com/games/bicycle/board/>

- Microsoft. (2006). Flight Simulator X. from <http://www.microsoft.com/games/flightsimulatorx/>
- Mitchell, A., & Savill-Smith, C. (2004). *The use of computer and video games for learning: A review of the literature*. UK: Learning and Skills Development Agency.
- Moller, L.C., Hymel, S., & Rubin, K. H. (1992). Sex typing in play and popularity in middle childhood. *SexRoles*, 26, 331-353.
- Montet, V. (2006). Games For Seniors Vision. *AustralianIT*. 3 October 2006.
- Moore, J. W. (1998). Education versus Training. *Journal of Chemical Education*, 75(2), 135.
- Moreno, J. (1946). *Psychodrama*. Beacon, NY: Beacon House.
- Morris, C. S., Hancock, P. A., & Shirkey, E. C. (2004). Motivational effects of adding context relevant stress in PC-based game training. *Military Psychology*, 16, 135-147.
- Morris, D., & Rollings, A. (2000). *Game Architecture and Design*. New York: Coriolis Group
- Mory, E. H. (1996). Feedback Research Revisited. In D. H. Jonassen (Ed.), *Handbook of research for educational communications and technology: A project of the Association for Educational Communications and Technology* (pp. 745-774). New York, USA: Macmillan.
- Murray, M., & Kliman, M. (1999). Beyond point and click: The search for gender equity in computer games. *ENC focus*, 6(3), 23-27.
- Murray, T. (1999). Authoring intelligent tutoring systems: An analysis of the state of art. *International Journal of Artificial Intelligence in Education*, 10, 98-129.
- Museums Libraries Archives Council (2004). *Inspiring Learning For All*. Retrieved 30 April, 2007, from <http://www.inspiringlearningforall.gov.uk>.
- Myers, I. B., & Myers, P. B. (1980). *Gifts differing: understanding personality type*. Mountain View, CA: Davies-Black Publishing.
- Najjar, L. J. (1998). Principles of educational multimedia user interface design. *Human Factors*, 40(2), 311-323.
- Narayanasamy, V., Wong, K. W., Fung, C. C., & Rai, S. (2006). Distinguishing Games and Simulation Games from Simulators. *Computers in Entertainment (CIE)*, 4, Article No. 9.
- Nelson, B. (2007). Exploring the Use of Individualized, Reflective Guidance In an Educational Multi-User Virtual Environment. *Journal of Science Education and Technology*, 16(1), 83-97.
- Nelson, M. J., & Mateas, M. (2008). An interactive game-design assistant. In *Procs. Intelligent User Interfaces 2008*, (pp. 90-98).
- Nevala, H. (2007). *Narratiivit. pelisuunnittelijan työkaluina* [Narratives as tools for game designer]. Unpublished Master's Thesis, Department of Mathematical Information Technology, University of Jyväskylä, Finland.
- New Media Consortium. (2007). *NMC 2007 Educators in Second Life Survey Results Summary: New Media Consortium*. Retrieved January 12, 2008, from <http://www.nmc.org/pdf/2007-sl-survey-summary.pdf>
- Newby, T. J., Stepich, D. A., Lehman, J. D., & Russell, J. D. (1999). *Instructional Technology for Teaching and Learning, 2nd Edition*. Englewood Cliffs, NJ: Prentice Hall.
- Nieborg, D. B. (2004). *America's Army: More Than a Game*. Paper presented at the Transforming Knowledge into Action through Gaming and Simulation, Munchen: SAGSAGA.
- Niederle, M., & Vesterlund, L. (2007). Do women shy away from competition? Do men compete too much? *The Quarterly Journal of Economics*, 122(3), 1067-1101..
- Nielsen, J., & Molich, R. (1990) Heuristic evaluation of user interfaces. Seattle, WA 1-5 April. In *Proceedings of the ACM HI'90 Conf.*, (pp. 249-256).
- Nimwegen, C. v., Oostendorp, H. v., Schijf, H. J. M., & Burgos, D. (2005). The Paradox of the Assisted User: Guidance Leads to more Shallow Behavior. *Proceedings*

Compilation of References

- of SIGCHI conference on Human factors in computing systems. April 22 - 27, Montreal, Quebec, Canada: ACM Press.
- Norman, D. A. (1993). *Things that make us smart..Defending human attributes in the age of the machine*. New York: Addison-Wesley.
- Norman, W. T. (1963). Toward an adequate taxonomy of personality attributes: replicated factor structure in peer nomination personality ratings. *Journal of Abnormal and Social Psychology*, 66, 574-583.
- Nova, N., Dillenbourg, P., Wehrle, T., Goslin, J., & Bourquin, Y. (2003). The impacts of awareness tools on mutual modelling in a collaborative video-game. In J. Favela & D. Decouchant (Eds.), *Lecture Notes in Computer Science: Vol. 2806. Groupware Design, Implementation, and Use* (pp. 99-108). Heidelberg: Springer Berlin.
- Novak, J. D., & Musonda, D. (1991). A twelve-year longitudinal study of science concept learning. *American Educational Research Journal*, 28(1).
- NSF. (2000). *Women, Minorities, and Persons with Disabilities in Science and Engineering*. 2000, National Science Foundation report. Retrieved 10 October 2006, from <http://www.nsf.gov/cgi-bin/getpub?nsf00327>.
- Nullmeyer, R. T., Spiker, V. A., Golas, K. C., Logan R. C., & Clemons, L. (2006, December). *The effectiveness of a PC-based C-130 crew resource management aircrew device*. Paper presented at the meeting of the Interservice/Industry training, simulation, and Education Conference, Orlando, FL.
- Nunez, D. & Blake, E. (2003). A direct comparison of presence levels in text-based and graphics-based virtual environments. *Proceedings of the 2nd international Conference on Computer Graphics, Virtual Reality, Visualisation and Interaction in Africa*, 53-56.
- O'Brien, K. S., & O'Hare, D. (2007). Situational awareness ability and cognitive skills training in a complex real-world task. *Ergonomics*, 50, 1064-1091.
- O'Hara, K. P., & Payne, S. J. (1999). Planning and the user interface: The effects of lockout time and error recovery cost. *International Journal of Human-Computer Studies*, 50(1), 41-59.
- O'Neil, H. F., Wainess, R., & Baker, E. L. (2005). Classification of learning outcomes: Evidence from the computer games literature. *The Curriculum Journal*, 16, 455-474.
- Oblinger, D. (2004). The next generation of educational engagement. *Journal of Interactive Media in Education*, 8.
- Oblinger, D., & Oblinger, J. (2005). *Educating the Net Generation*. Boulder CO: Educause.
- Ochs, E. (1988). *Culture and Language Development: Language Acquisition and Language Development*. Cambridge: CUP.
- OECD. (2006). Evolution of Student Interest in Science and Technology Studies - Policy Report, Organisation for Economic Co-operation and Development - Global Science Forum. Retrieved 5 July, 2008, from <http://www.oecd.org/dataoecd/16/30/36645825.pdf>
- Ogle, G. J. (2002). *Towards a Formative Evaluation Tool*. PhD Thesis submitted to Virginia Polytechnic Institute and State University. Retrieved March 28 2007, from <http://scholar.lib.vt.edu/theses/available/etd-04262002-161146/unrestricted/etd.pdf>
- Oh Navarro, E., & Van der Hoek, A. (2005). Design and Evaluation of an Educational Software Process Simulation Environment and Associated Model. In *Proceedings of the Eighteenth Conference on Software Engineering Education and Training*, Ottawa, Canada.
- Olazar, I. (2007). The Use of Online Games in Business Education: The IE Business School Experience. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 205-214). Peasley, UK: Academic Conference Limited.
- Oliver, M. B., Weaver, J. B., & Sargent, S. (2000). An examination of factors related to sex differences in enjoyment of sad films. *Journal of Broadcasting and Electronic Media*, 44(2), 282-300.

- Olson, C. K., Lawrence, S. D., Kutner, A., Warner, D. E., Almerigi, J. B., Baer, L., Nicholi, A. M., & Beresin, E. V. (2007). Factors Correlated with Violent Video Game Use by Adolescent Boys and Girls. *Journal of Adolescent Health, 41*, 77–83.
- Oxland, K. (2004). *Gameplay and Design*. Essex, UK: Addison Wesley.
- Padgett, L. S., & Strickland, D. (2006). Case Study: Using a Virtual Reality Computer Game to Teach Fire Safety Skills to Children Diagnosed with Fetal Alcohol Syndrome. *Journal of Pediatric Psychology, 31*(1), 65–70.
- Palloff, R. M., & Pratt, K. (2005). *Collaborating Online: Learning Together in Community*. San Francisco, CA: Jossey-Bass.
- Papert, S., & Harel, I. (1991). *Constructionism*. Ablex Publishing.
- Parachute Flight Training Simulator. (2008). Retrieved June 9, 2008, from <http://www.pia.com/fxc/vrweb1.htm>
- Parchman, S. W., Ellis, J. A., Christinaz, D., & Vogel, M. (2000). An evaluation of three computer-based instructional strategies in basic electricity and electronic. *Military Psychology, 12*, 73–87.
- Paris, S. G., & Winograd, P. (1990). How metacognition can promote academic learning and instruction. In B. F. Jones (Ed.), *Dimensions of thinking and cognitive instruction* pp.15-51). Hillsdale, Lawrence Erlbaum Associates.
- Park, I., & Hannafin, M. (1993). Empirically-based guidelines for the design of interactive multimedia. *Educational Technology Research and Development, 41*(3), 63–85.
- Parrott, W. G., & Spackman, M. P. (2000). *Emotion and memory*. In M. Lewis & J. M. Haviland-Jones *Handbook of emotions*. (2nd ed.). New York: Guilford Press.
- Pearce, C. (2006). Productive Play: Game Culture From the Bottom Up. *Games and Culture, 1*(1), 17-24.
- Piaget, J. (1962). *Play, dreams and imitation in childhood*. New York: Norton.
- Piaget, J. (1970). *Science of Education and the Psychology of the Child*. New York: Orion.
- Pillay, H. (2002). An investigation of cognitive processes engaged in by recreational computer game players: An implication for skills of the future. *Journal of Research on Technology in Education, 34*, 336–350.
- Pimenidis, E. (2007). Developing a Computer Game for University Library Induction. In D. Remenyi (Ed.), *European Conference on Game Based Learning* (pp. 215-222). Paisley, UK: Academic Conferences Limited.
- Pinker, S. (1999). *How the Mind Works*. Hammondsworth: Penguin Books.
- Pinker, S. (2008). *The Sexual Paradox: Men, Women, and the Real Gender Gap*. London: Atlantic Books.
- Pivec, M., & Dziabenko, O. (2004). Game-Based Learning in Universities and Lifelong Learning: “UniGame: Social Skills and Knowledge Training” Game Concept. *Journal of Universal Computer Science, 10*(1), 14-26.
- Polvinen, E. (2007). Educational Simulations In Second Life For Fashion Technology Students. In D. Livingstone & J. Kemp (Eds.), *Proceedings of the Second Life Education Workshop at SLCC*, Chicago, August 25th-26th, San Francisco.
- Pontecorco, C., & Paoletti, G. (1989). Computers, writing and metalinguistic abilities. *Rassegna Italiana di Linguistica Applicata, 21*(1-2).
- Potter, W. J. (1998). *Media literacy*. Thousand Oaks, CA: Sage Publications.
- Prabhala, A. (2007). Mental Retardation Is No More—New Name Is Intellectual and Developmental Disabilities. *American Association on Intellectual and Developmental Disabilities*. Available URL: http://www.aamr.org/About_AAIDD/MR_name_change.htm (last accessed Jul 7, 2008).
- Prensky, M. (2001). *Digital Game Based learning*. New York: McGraw-Hill
- Prensky, M. (2002). The Motivation of Gameplay or the REAL 21st century learning revolution. *On the Horizon, 10*, 1-14.

Compilation of References

- Prensky, M. (2005). "Engage me or Enrage me" What today's learners demand. *EDUCAUSE. Review.*, 40(5), 60-65.
- Prensky, M. (2005). Computer games and learning: Digital game based learning. In Raessens & Goldstein (Eds.), *Handbook of Computer Game Studies*. MIT Press.
- Prensky, M. (2007). *Digital Game-Based Learning*. St. Paul, MN: Paragon House.
- Price, C. B. (2008). Unreal PowerPoint: Immersing PowerPoint presentations in a Virtual Computer Game Engine World. *Journal. Computers. in. Human. Education..* (in press).
- Pronger, N. (1995). Micro-technology. In J. Hogg & J. Cavet (Ed.). *Making leisure provision for people with profound learning and multiple disabilities* (pp. 197-209). USA: Chapman & Hall Publishers.
- Provenzo, E. F. (1991). *Video. kids.: Making. sense. of. Nintendo*. Cambridge, MA: Harvard.
- Purdy, J. A. (2007). *Serious games: Getting serious about digital games in learning*. Retrieved on the 16 June 2007 at <http://www.corpu.com/newsletter%5Fwi07/sect2.asp>
- Quinn, C. (2005). *Engaging. Learning.: Designing. e-Learning. Simulation. Games*. Pfeiffer: San Francisco
- Radford, A. (2000). Games and learning about form in architecture. *Automation. in. Construction.*, 9(4), 397-384.
- Raiffa, H. (1982). *The Art and Science of Negotiation*. Cambridge, MA: Belknap Press.
- Randel, J. M., Morris, B. A., Wetzell, C. D., & Whitehill, B. V. (1992). The effectiveness of games for educational purposes a review of research. *Simulation. & Gaming*, 23(3), 261-276.
- Ravaja, N., Salminen, M., Holopainen, J., Saari, T., Laarni, J., & Järvinen, A. (2004). Emotional response patterns and sense of presence during video games: Potential criterion variables for game design. *Proceedings. of. the. Third. Nordic. Conference. on. Human-Computer. interaction*, 339-347.
- Raybourn, E. M., & Waern, A. (2004). Social Learning through Gaming. *Conference. on. Human. Factors. in. Computing. Systems.. CHI. '04. extended. abstracts. on. Human. factors. in. computing. systems* (pp. 1733-1734), Vienna, Austria: Workshops, Pages.
- Rees, C., Sheard, C., & McPherson, A. (2004). Medical Students' Views and Experiences of Methods of Teaching and Learning Communication Skills. *Patient Education. and. Counseling.*, 54, 119-121.
- Reiff, J. C. (1992). *Learning. styles*. Washington, DC: National Education Association.
- Revelle, G. L. (2003). Educating via entertainment media: the Sesame Street Workshop approach. *Computers. in. Entertainment.*, 1, 16-16.
- Rhyne V IV, T., & Barry, J. (2006). *Method for dynamic content generation in a role-playing game*. United States Patent 20060148545.
- Riddell, S. (2003). Gender and Scottish Education. In T. G. K. Bryce & W. M. Humes (Eds.), *Scottish Education, second edition. Post-devolution*. Edinburgh: Edinburgh University Press.
- Riding, R. (2002). *School. learning. and. cognitive. style*. London : David Fulton.
- Riding, R. J., & Wigley, S. (1997). The relationship between cognitive style and personality in further education students. *Personality. and. Individual. Differences*, 23, 379-389.
- Rieber, L. P. (1996). Seriously considering play: Designing interactive learning environments based on the blending of microworlds, simulations and games. In *Educational. Technology. Research. and. Development*, 44(2), 43-58.
- Robbins, S. (2007, 20th-21st November). *MUVEs and Web. 2.0: Using. Second. Life. to. Create. Real. World. Learning*. Paper presented at the JISC CETIS Conference 2007, Birmingham.
- Robertson, J., & Good, J. (2004). Children's narrative development through computer game authoring. Retrieved April 7, 2008, from <http://delivery.acm>.

- org/10.1145/1020000/1017841/p57-roberston.pdf?key1=1017841&key2=4664757021&coll=GUIDE&dl=GUIDE&CFID=23200458&CFTOKEN=83234777
- Robinson, A. (2007, March). *Integrating Second Life into Design for Digital Media*. Paper presented at Massively Multi-Learner, University of Paisley.
- Rollings, A., & Adams, E. (2003). *Andrew Rollings and Ernest Adams on Game Design*. New Riders Publishing.
- Rommetveit, R. (1992). Outlines of a dialogically based socio-cognitive approach to human cognition and communication. In A. Wold (Ed.), *The dialogical alternative: Towards a theory of language and mind*. Oslo, Scandinavian Press.
- Rooms, M. (2000). Information and Communication Technology and Dyslexia. In J. Townend, & M. Turner, (Eds.), *Dyslexia in Practice: A Guide for Teachers*. New York: Kluwer Academic/Plenum Publishers.
- Rosenberg, B. H., Landsittel, D., & Averch, T. D. (2005). Can video games be used to predict or improve laparoscopic skills? *Journal of Endourology*, 19, 372–376.
- Rosenberg, K. E. (1974). Uses and gratifications a paradigm outlined. In J. G. Blumler and E. Katz (eds.) *The uses of Mass Communication: Current Perspectives of Gratifications Research*. (pp. 269-286). Beverley Hills, CA: Sage.
- Rosenbloom, A. (2004). Interactive immersion in 3D computer graphics. *Communications of the ACM*, 47(8), (pp. 28-31).
- Rosser, J. C., Lynch, P. J., Cuddihy, L., Gentile, D. A., Klonsky, J., & Merrell, R. (2007). The impact of video games on training surgeons in the 21st century. *Archives of Surgery*, 142, 181–186.
- Rosser, J. et al (2004). *Surgeons may err less by playing video games*. http://www.psychology.iastate.edu/faculty/dgentile/MMVRC_jan20_MediaVersion.pdf
- Roubidoux, M. A., Chapman, C. M., & Piontek, M. E. (2002). Development and evaluation of an interactive web-based breast imaging game for medical students. *Academic Radiology*, 9, 1169–1178.
- Rouse, R. (2001). *Game design: Theory and practice*. Wordware Publishing.
- Roussou, M. (2004). Learning by doing and learning through play: an exploration of interactivity in virtual environments for children. *Computers in Entertainment (CIE)*, 2, 10-10.
- Ryan, M-L. (2003, November). *Transmedial narratology and concepts of narrative*. Paper presented at the 2nd International Colloquium on Narratology Beyond Literary Criticism, University of Hamburg, Germany.
- Ryan, R. M., Rigby, C. S., & Przybylski, A. (2006). The motivational pull of video games: A self-determination theory approach. *Motivation and Emotion*, 30, 347–363.
- Ryder, M. (2003). *Instructional Design Models*. U of Colorado. Retrieved 10 April 2007, from http://carbon.cudenver.edu/~mryder/itc_data/idmodels.html.
- Rymaszewski, M., Au, W. J., Wallace, M., Winters, C., Ondrejka, C., & Batsone-Cunningham, B. (2007). *Second Life: The Official Guide*. New Jersey: John Wiley & Sons.
- Saari, L. M., Johnson, T. R., McLaughlin, S. D., & Zimmerle, D. M. (1988). A survey of management training and education practices in US companies. *Personnel Psychology*, 41, 731–743.
- Sacks, H., Schegloff, E., & Jefferson, G. (1974). A simplest systematics for the pragmatization of turn-taking for conversation. *Language*, 50.
- Sakiroglu, M., Riedel, J., & Pawar, K. (2007). Empirical Study of Creating Engineering Knowledge through Simulation Gaming – the case of COSIGA. In G. Goch, D.H. Müller, K.D. Thoben, & B. Sholz-Reiter (Eds.), *IFIP WG. 5.7. Special Interest Group on Experimental Interactive Learning in Industrial Management* (pp. 121-133). Bremen: University of Bremen.
- Salamon, E. K. M, Beaulieu, J, & Stefano, G. B. (2003). Sound therapy induced relaxation: Down regulating stress processes and pathologies. *Med.Sci.Monit* 2003, 9(5).

Compilation of References

- Salas, E., Dickinson, T. L., Converse, S. A., & Tannenbaum, S. I. (1992). Toward an understanding of team performance and training. In R. W. Sweezy & E. Salas (Eds.), *Teams: Their training and performance*. Norwood, NJ: Ablex.
- Salen, K., & Zimmerman, E. (2003). *Rules of play: Game design fundamentals*. Cambridge, MA: MIT Press.
- Salovey, P., & Mayer, J. D. (1990). Emotional intelligence, imagination. *Cognition and Personality*, 9, 1990.
- Salovey, P., Bedell, B. T., Detweiler, J. B., & Mayer, J. D. (2000). Current directions in emotional intelligence research. In M. Lewis, & J. M. Haviland-Jones (Eds.), *Handbook of emotions (2nd edition)*. New York: Guilford Press.
- Sandford, R., & Williamson, B. (2005). *Games and Learning*. Bristol: Nesta Futurelab.
- Sandford, R., & Williamson, B. (2005). Games and learning. *NESTA Futurelab*. [online], Available URL: http://www.nestafuturelab.org/download/pdfs/research/handbooks/games_and_learning.pdf (last accessed Jul 7, 2008).
- Sanford, K., & Madill, L. (2006). Resistance through video game play: It's a boy thing. *Canadian Journal of Education*, 29, 287-306.
- Satyen, L., & Ohtsuka, K. (2001). Strategies to develop divided attention skills through video game training. In D. Harris (Ed.), *Engineering psychology and cognitive ergonomics*, 6, 191 – 199. Aldershot, UK: Ashgate.
- Savery, J. R., & Duffy, T. M. (1995). Problem-based learning: an instructional model and its constructivist framework. *Educational Technology*, 35, 31–38.
- Sawyer, B., & Smith, P. (2008). Serious Games Taxonomy. Retrieved 26 March, 2008, from <http://www.dmill.com/presentations/serious-games-taxonomy-2008.pdf>
- Schalock R. L., Luckasson, E. A., & Shogren K. A. (2007). The Renaming of Mental Retardation: Understanding the Change to the Term Intellectual Disability. *Intellectual and Developmental Disabilities*, 45(2), 116–124.
- Schilling, D. (1996). *50 activities for teaching emotional intelligence*. Torrance: Innerchoice publishing.
- Schneider, E. F., Lang, A., Shin, M., & Bradley, S. D. (2004). Death with a story: How story impacts emotional, motivational, and physiological responses to first-person shooter video games. *Human Communication Research*, 30(3), 361-375.
- Schumacher, T. R. (1997). Simulation and attitude change: evolving the research model. *Proceedings of The Thirtieth Annual Hawaii International Conference on System Sciences* ISBN 0-8186-7862-3/97. IEEE.
- Schumann, P. L., Anderson, P. H., Scott, T. W., & Lawton, L. (2001). A framework for evaluating simulations as educational tools. *Developments in Business Simulations and Experiential Learning*, 28.
- Scott, G. (2007). *Games get down to business.. Simulations growing in popularity as younger workers move up the corporate ranks*. Retrieved on the 16 June 2007 at <http://www.theglobeandmail.com/servlet/story/RT-GAM.20070502.wgtgames0502/BNStory/GlobeTQ/home>
- Seay, A. F., Jerome, W. J., Lee, K. S., & Kraut, R. E. (2004). *Project massive: A study of online gaming communities*. Extended abstracts of the Conference on Human Factors in Computing Systems (pp. 1421-1424), Vienna, Austria.
- Seay, A. F., Jerome, W. J., Lee, K. S., & Kraut, R. E. (2004). Project massive: A study of online gaming communities. In Extended abstracts of the *Conference on Human Factors in Computing Systems*, Vienna, Austria, (pp. 1421-1424).
- SEGA. (2005). Rome. Total War. Barbarian Invasion. from www.sega.com.
- Senge, P. (1990). *The Fifth Discipline: The Art & Practice of The Learning Organization*. New York: Doubleday.
- Sfard, A. (1998). On two metaphors for learning and the dangers of choosing just one. *Educational Researcher*, 27(2).

- Sfard, A. (2008). *Thinking.as.Communicating: Human development, the growth of discourses and mathematizing*. Cambridge, CUP.
- Shaffer, D. W. (2006). Epistemic Frames for Epistemic Games. *Computers & Education*, 46(3), 223-234.
- Shaffer, D. W., Squire, K. D., Halverson, R., & Gee J. P. (2005). Video games and the future of learning. *Phi Delta Kappan*, 87(2), 104-111.
- Shaw, K., & Dermoudy, J. (2005). Engendering an empathy for software engineering. In *Proceedings of the 7th Australasian Conference on Computing Education*. - Volume 42. ACE. '05.
- Sheng, S., Magnien, B., Kumaragurg, P., Acquisiti, A., Cranor, L. F., Hong, J., & Nunge, E. (2007). Anti-Phishing Phil: The Design and Evaluation of a Game That Teaches People Not to Fall for Phish. *Proceedings of the 3rd symposium on Usable privacy and security. SOUPS*. '07. ACM Press.
- Sherwood, B. A. (1974). *The TUTOR language [Computer software manual]*. PLATO Publications, Computer-based Education Research Lab.
- Shin, N., Norris, C., & Soloway, E. (2006). Effects of Handheld Games on Students Learning in Mathematics. June 2006, *Proceedings of the 7th international conference on learning sciences. ICLS '06*, Publisher: International Society of the Learning Sciences.
- Si, M., Marsella, S., & Pynadath, D. V. (2007). Proactive Authoring for Interactive Drama: An Author's Assistant. In *Procs. IVA. 2007*, (pp. 225-237).
- Siang, A. C., & Rao, R. K. (2003). *Theories of Learning: A Computer Game Perspective*. Paper presented at the IEEE Fifth International Symposium on Multimedia Software Engineering, Taipei, Taiwan.
- Silberman, C. E. (1970). *Crisis in the classroom*. New York: Random House.
- Simonson, M., & Maushak, N. (2001). Instructional technology and attitude change. In Jonassen (Ed.), *Handbook of research for educational communications and technology* (pp. 984-1016). Mayway, NJ: Lawrence Erlbaum Associates
- Singer, J. A., & Salovey, P. (1988). Mood and memory: evaluating the network theory of affect. *Clinical Psychology Review*, 8, 211-251.
- Sjøberg, S., & Schreiner, C. (2006). How do students perceive science and technology? *Science in School* (1: Spring 2006), 66-69.
- Skinner, B. F. (1958). Teaching machines. *Science*, 128, 969-977.
- Slater, M. D. (2003). Alienation, aggression, and sensation seeking as predictors of adolescent use of violent film, computer, and website content. *Journal of Communication*, 53(1), 105-121.
- Slavin, R. R. (1997). *Research on cooperative learning and achievement: a quarter century of research*. Paper presented at the annual Meeting of Pedagogical Psychology, Frankfurt, Germany Sept 1997.
- Sleeman, D. H., & Brown, J. S. (1982). *Intelligent Tutoring Systems*. Academic Press, London.
- Smith, P. L., & Ragan, T. J. (2005). Chapter 14 Strategies for attitude learning. *Instructional Design*. Third edition, John Wiley & Sons.
- Song, S., & Lee, J. (2007). Key factors of heuristic evaluation for game design: Towards massively multi-player online role-playing game. *International Journal of Human-Computer Studies*, 65, 709-723.
- Spence, J. T., & Helmreich, R. L. (1978). *Masculinity and femininity: their psychological dimensions, correlates, and antecedents*. Austin, TX: University of Texas Press.
- Sperber, D., & Wilson, D. (1995). *Relevance: Communication and Cognition*. Oxford, Blackwell.
- Spiro, R. J., Coulson, R. I., Feltovich, P. J., & Anderson, D. K. (1988). Cognitive flexibility theory: Advanced knowledge acquisition in ill-structure domains. Technical Report 441. Champaign, IL. University of Illinois centre for the study of reading.
- Squire, K. & Barab, S. (2004). Replaying history: engaging urban underserved students in learning world history

Compilation of References

- through computer simulation games. In *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.
- Squire, K. (2002). Video games in education. *International Journal of Intelligent Simulations and Gaming*, 2(1).
- Squire, K. (2002, July 2002). Cultural Framing of Computer/Video Games. *International Journal of Computer Game Research*. Retrieved 18 February, 2008, from <http://www.gamestudies.org/0102/squire/>
- Squire, K. (2003). Video Games in Education. *International Journal of Intelligent Games and Simulation*, 2(1), 49-62.
- Squire, K. (2005). Changing the Game: What Happens When Video Games Enter the Classroom? In *Innovate* 1(6). Florida: Nova Southeastern University. Available at <http://www.innovateonline.info/index.php?view=article&id=82>. Last access in November 15, 2005.
- Squire, K. (2006). From Content to Context: Videogames as Designed Experience. *Educational Researcher*, 35(8), 19-29.
- Squire, K. D. (2005). Changing the game: What happens when videogames enter the classroom? *Innovate*, 1(6).
- Squire, K., & Barab, S. (2004). Replaying History: Engaging Urban Underserved Students in Learning World History Through Computer Simulation Games. In Y. B. Kafai, W. A. Sandoval, N. Enyedy, A. S. Nixon, & F. Herrera (Eds.), *Embracing diversity in the Learning Sciences: Proceedings of the sixth international conference of the Learning Sciences* (pp. 505-512). Mahwah, NJ: Lawrence Erlbaum Associates.
- Squire, K., Barnett, B., Grant, J. M., & Higginbotham, T. (2004). Electromagnetism Supercharged! Learning physics with digital simulation games. *Proceedings of the international conference on Learning sciences*, 6, 513-520.
- Squire, K., Barnett, M., Grant, J. M., & Higginbotham, T. (2004). *Electromagnetism Supercharged! Learning Physics with Digital Simulation Games*. Paper presented at the 6th International Conference on Learning Sciences, Santa Monica, California.
- Ssemugabi, S., & de Villiers, R. (2007). A comparative study of two usability evaluation methods using a web-based e-learning application. Fish River Sun, Sunshine Coast, South Africa. *Proceedings of the 2007 annual research conference of the South African institute of computer scientists and information technologists on IT research in developing countries*, 2 - 3 October 2007.
- Stam, R. (2000). Beyond fidelity: The dialogics of adaptation. In J. Naremore (Ed.), *Film adaptation* (pp. 54-76). New Brunswick, NJ: Rutgers University Press.
- Standen, & Low, H. L. (1996). Do virtual environments promote self-directed activity? A study of students with severe learning difficulties learning Makaton sign language. In P. M. Sharkey (Ed.), *Proceedings of the First European Conference on Disability, Virtual Reality and Associated Technologies* (pp. 123-127). Maidenhead, UK.
- Standen, P. J., Cromby J. J., & Brown, D. J. (1997). Evaluation of the use of virtual environments with students with severe learning difficulties. *Proceedings of the British Psychological Society*, 10(8), 139.
- Steen, F. F., Greenfield, P. M., Davies, M., & Tynes, B. (2006). What went wrong with The Sims Online: Cultural learning and barriers to identification in a massively multiplayer online role-playing game. In P. Vorderer & J. Bryant (Eds.), *Playing Video Games: Motives, Responses, and Consequences* (pp. 307-324). Mahwah, NJ: Lawrence Erlbaum Associates.
- Stege, H., Tergwogt, M., & Koops, W. (1994). Positive and negative mood effects in children: the mediating influence of task characteristics. *Journal of General Psychology*, October 1994.
- Steinkuehler, C. A. (2004). Learning in massively multiplayer online games. In *Proceedings of the 6th International Conference on Learning Sciences*, Santa Monica, California.

- Stemler, L. K. (1997). Educational characteristics of multimedia: a literature review. *Journal of Educational Multimedia and Hypermedia*, 6(3-4), 339-359.
- Stone, R. J. (2008). *Human Factors Guidelines for Interactive 3D and Games-Based Training Systems Design*. Birmingham, UK: Human Factors Integration Defence Technology Centre.
- Subrahmanyam, K., & Greenfield, P. M. (1994). Effect of video game practice on spatial skills in girls and boys. *Journal of Applied Developmental Psychology*, 15, 13-32.
- Subrahmanyam, K., Kraut, R. E., Greenfield, P. M., & Gross, E. F. (2000). The Impact of Home Computer Use on Children's Activities and Development. *The Future of Children*, 10, 123-143.
- Sugimoto, M. (2007, 26 - 28 March). *What can Children Learn through Game-based Learning Systems?* Paper presented at the Digital Game and Intelligent Toy Enhanced Learning, Jhongli, Taiwan.
- Svendsen, G. B. (1991). The influence of interface style on problem solving. *International Journal for Man-Machine Studies*, 35.
- Sykes, J., & Brown, S. (2003). Affective gaming, measuring emotions through the gamepad. In *Proc. CHI.2003*, ACM, (pp. 732-733).
- Szafron, D., Carbonaro, M., Cutumisu, M., Gillis, S., McNaughton, M., Onuczko, C. et al. (2005). *Writing interactive stories in the classroom*. Retrieved March 1, 2008, from <http://www.imej.wfu.edu/articles/2005/1/02/index.asp>
- Talbot, S., & Courtin, C. (2008). *Trace analysis in instrumented learning groupware: An experiment in a practical class at the university*. To be published in the 10th IASTED international conference on computers and advanced technology in education.
- Talib, O., Matthews, R., & Secombe, M. (2005). Constructivist Animations for Conceptual Change: An Effective Instructional Strategy in Understanding Complex, Abstract and Dynamic Science Concepts. *Malaysian Online Journal of Instructional Technology (MOJIT)*, 2(3) 78-87.
- Tan, P-H., Ling, S-W., & Ting, C-Y (2007) Adaptive digital game-based learning framework. *Proceedings of the 2nd international conference on Digital interactive media in entertainment and arts*. Perth, Western Australia.
- Tanasa, D., & Trousse, B. (2004). Advanced data pre-processing for intersites web-usage mining. In *IEEE Intelligent Systems*, 19(2), 59-65.
- Tang, S., & Hanneghan, M. (2005). *Educational Games Design: Model and Guidelines*. Paper presented at the the 3rd International Game Design and Technology Workshop (GDTW'05), Liverpool, UK.
- Tang, S., Hanneghan, M., & El-Rhalibi, A. (2007). *Pedagogy, Elements, Components, and Structures for Serious Games Authoring Environment*. Paper presented at the 5th International Game Design and Technology Workshop (GDTW 2007), Liverpool, UK.
- Taylor, T. L. (2003). Multiple pleasures: Women and online gaming. *Convergence*, 9(1), 21-46.
- Telfer, R. (1993). *Aviation Instruction and Training*. Aldershot: Ashgate.
- Tessmer, M. (1993). *Planning and conducting formative evaluations*. London: Kogan Page.
- Tessmer, M., & Wedman, J.F. (1990). A Layers-of-Necessity Instructional Development Model. *Educational Technology Research & Development*, 38(2), 77-85.
- The Sims*. [Computer Software] (2000). Redwood City, California, USA: Maxis, Electronic Arts.
- Thiagarajan, S. (2003). *Laws of Learning: 14 Important Principles Every Trainer Should Know*. Retrieved February 12, 2008, from: <http://www.thiagi.com/laws-of-learning.html>
- Thomas, J. (1995). *Meaning in Interaction: An Introduction to Pragmatics*. London: Longman.
- Thorndike, R. L. (1949). *Personnel selection*. New York: Wiley & Sons.

Compilation of References

- Thurstone, L. L. (1934). The vectors of the mind. *Psychological.Review*, 41, 1-32.
- TPLD Ltd (2003) *The Games.Based.Learning.Essentials* Retrieved 28th February 2008. URL: <<http://tpld.net/main.php?page=1175>>
- Tumosa, N., & Morley, J. E. (2006). The Use of Games to Improve Patient Outcomes. *Gerontology.&.Geriatrics.Education*, 26(4) 2006.
- Turkle, S. (1995) *Life.on.the.screen:.Identity.in.the.age.of.the.internet*. New York: Simon&Schuster.
- TUTOR user's memo (1973). *Introduction.to.TUTOR*. [Computer software manual].
- Tuzun, H., Yilmaz Soylu, M., Karakus, T., Inal Y., & Kizilkaya, G. (2008, March). *The.effects.of.computer.games.on.primary.school.students'.achievements.and.motivation.in.geography.learning*. Paper presented at the meeting of the American Educational Research Association, New York, New York.
- Twining, P. (2007). *The.schome-NAGTY.Teen.Second.Life.Pilot.Final.Report* (No. KN9851). Milton-Keynes: The Open University.
- Tychsen, A., Hitchens, M., Brolund, T., & Kavakli, M. (2006). Live Action Role-Playing Games: Control, Communication, Storytelling,and MMORPG Similarities. *Games.and.Culture*,.1(3), 252-275.
- Urdu, T., & Midgley, C. (2001). Academic self-handicapping: what we know what more there is to learn. *Educational.Psychology.Review*, 13, 115-138.
- Van Hasselt, V., Baker, M., Romano, S., Schlessinger, K., Zucker, M., Dragone, et. al. (2006). Crisis (Hostage) Negotiation Training: A Preliminary Evaluation of Program Efficacy. *Criminal.Justice.and.Behavior*,. 33(1), 56-69.
- Van Ments, M. (1989). *The.effective.use.of.role.play:.A.handbook.for.teachers.and.trainers*. London: Kogan Page.
- Van Rosmalen, P., Vogten, H., Van Es, R., Van, P., H., Poelmans, P., & Koper, R. (2006). Authoring a full life cycle model in standards-based, adaptive e-learning. *Educational.Technology.&.Society*,.9(1), 72-83.
- Van Vugt, M., De Cremer, D., & Janssen, D. P. (2007). Gender differences in cooperation and competition: The Male Warrior Hypothesis. *Psychological.Science*, 18(1), 19-23.
- Velten, E. (1968). A Laboratory task for induction of mood states. *Behaviour.Research.and.Therapy*, 6, 473-482.
- Vera, L., Herrera, G., & Vived, E. (2005, June). Virtual reality school for children with learning difficulties. *ACM.SIGCHI.ACE05*.
- Verenikina, I., Harris, P., & Lysaght, P. (2003). Child's play: computer games, theories of play and children's development. *Proceedings.of.the.international.federation.for.information.processing.working.group.3.5.open.conference.on.Young.children.and.learning.technologies*. (pp. 99-106),.Sydney, Australia, Pages:.
- Vince, R. (1998). Behind and beyond Kolb's learning cycle. *Journal.of.management.Education*, 22.
- Virvou, M., & Katsionis, G. (2008). On the usability and likeability of virtual reality games for education: The case of VR-ENGAGE. *Computers.and.Education*,. 50(1), 154-178.
- Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational.Technology.&.Society*,.8(2), 64-65.
- Virvou, M., Katsionis, G., & Manos, K. (2005). Combining software games with education: Evaluation of its educational effectiveness. *Educational.Technology.&.Society*,.8(2), 64-65.
- Visual Purple. (2008). Retrieved August 22, 2008, from http://www.visualpurple.com/pdfs/press_kit.pdf
- Vogel, J. J., Vogel, D.S., Cannon-Bowers, J., Bowers, C. A., Muse, K., & Wright, M. (2006). Computer gaming and interactive simulations for learning: A meta-analysis. *Journal.of.Educational.Computing.Research*,. 34, 229-243.

- Vorderer (Eds.), *Media entertainment: The psychology of its appeal* (pp. 21-36). Mahwah, NJ: Lawrence Erlbaum Associates.
- Vorderer, P. (2000). Interactive entertainment and beyond. In D. Zillmann & P.
- Vorderer, P., Hartmann, T., & Klimmt, C. (2003). Explaining the enjoyment of playing videogames: the role of competition. *ACM. International. Conference. Proceeding. Series; Proceedings of the second international conference on Entertainment computing*, Pittsburgh, Pennsylvania, (pp. 1-9).
- Vygotski, L. S. (1934). *Language and Thought*. Gosizdat, Moscow.
- Vygotsky, L. (1978). *Mind in Society: The Development of Higher Psychological Functions*. Cambridge: Harvard University Press.
- Vygotsky, L. S. (1962). *Thought and language*. Cambridge, MA: M.I.T. Press.
- Walldén, S., & Soronen, A. (2004). *Edutainment.-From Television and Computers to Digital Television*: University of Tampere Hypermedia Laboratory.
- Walshe, D. G., Lewis, E. J., Kim, S. I., O'Sullivan, K., & Wiederhold, B. K. (2003). Exploring the use of computer games and virtual reality in exposure therapy for fear of driving following a motor vehicle accident. *CyberPsychology & Behavior*, 6, 329-334.
- Walton, D. (2000). The place of dialogue theory in logic, computer science and computer studies. *Synthese*, 123.
- Wang, X. C., Hinn, D. M., Kanfer, A. G. (2001). Potential of Computer-Supported Collaborative Learning for Learners with Different Learning Styles. *Journal of Research on Technology in Education*, 34(1).
- Waxberg, X. L., Schwaizberg, S. D., & Cao, C. G. L. (2005). Effects of videogame experience on laparoscopic skill acquisition. *Proceedings of the Human Factors and Ergonomics Society*, 49, 1047-1051.
- Weber, R. A. (2003). *Learning and Transfer of Learning with No Feedback: An Experimental Test Across Games*.
- Wegerif, R. (2007). *Dialogic Education and Technology: Expanding the Space of Learning*. New York: Springer-Verlag.
- Wegerif, R., & Dawes, L. (2004). *Thinking and Learning with ICT: Raising Achievement in Primary Classrooms*. London: Routledge Farmer.
- Wenger, E. (1987). *Artificial intelligence and tutoring systems: computational and cognitive approaches to the communication of knowledge*. Morgan Kaufmann Publishers Inc.
- Wertsch, J. (1994). The Primacy of mediated action in socio-cultural studies. *Mind, Culture and Activity*, 1.
- West, M. (2006, March). Evolve your hierarchy. *Game Developer*, 13(3), 51-54.
- Westermann, R., Spies, K., Stahl, G., & Hesse, F. W. (1996). Relative effectiveness and validity of mood induction procedures: a meta-analysis. *European Journal of Social Psychology*, 26, 557-580.
- Weusijana, B. K. A., Svihla, V., Gawel, D., & Bransford, J. D. (2007). Learning about Adaptive Expertise in a Multi-User Virtual Environment. In D. Livingstone & J. Kemp (Eds.), *Proceedings of the Second Life Education Workshop at SLCC*. Chicago, August 25th-26th, San Francisco.
- WFPFoodForce. (2008). Retrieved 20 February, 2008, from <http://www.food-force.com>
- White, B. Y., & Frederiksen, J. R. (1990) Causal model progressions as a foundation for intelligent learning environments. *Artificial Intelligence*, 42(1), 99-157.
- White, S. H., & Siegel, A. W. (1984). Cognitive Development in Time and Space. In B. Rogoff & J. Lave (Eds.) *Everyday Cognition: Its development in a social context*. London: Harvard University Press.
- Whitton, N. (2007). *An Investigation into the Potential of Collaborative Computer Game-Based Learning in Higher Education*. Unpublished doctoral dissertation, Napier University.

Compilation of References

- Whitton, N., & Hynes, N. (2006). Evaluating the effectiveness of an online simulation to teach business skills. *E-Journal of Instructional Science and Technology*, 9(1).
- Williams, C., Wright, B, Callaghan, G., & Coughlan, B. (2001). Do Children with Autism Learn to Read more Readily by Computer Assisted Instruction or Traditional Book Methods? *Autism*, 6, 71-91. The National Autistic Society, SAGE Publications.
- Williams, R. H. (1980). Attitude change and simulation games: The ability of a simulation game to change attitudes when structured in accordance with either the cognitive dissonance or incentive models of attitude change. *Simulation & Games*, 11(2), 177-196.
- Williams, R. H., & Williams, S. A. (1987). Levels of Identification as a Predictor of Attitude Change. *Simulation & Games*, 18(4), 471-487.
- Wilson, B. G. (1996). What is a constructivist learning environment? In B. G. Wilson (Ed.), *Constructivist Learning Environments: Case Studies in Instructional Design*. Englewood Cliffs, NJ: Educational Technology Publications.
- Wishart, J. (1990). Cognitive factors related to user involvement with computers and their effects upon learning from an educational computer game. *Computers & Education*, 15(1-3), 145-150.
- Wishart, J., Oades, C., & Morris, M. (2007). Using online role play to teach internet safety awareness. *Computers & Education*, 48(3), 460-473.
- Witmore, G. (2003). Design with music in mind: A guide to adaptive audio for game designer. Available at: http://www.gamasutra.com/resource_guide/20030528/whitmore_pfv.htm
- Wolf, M. J. P., & Baer, R. H. (2002). Genre and the Video Game. *The Medium of the Video Game*. University of Texas Press.
- Wong, W. L., Shen, C., Nocera, L., Carriazo, E., Tang, F., Bugga, S., & Narayanan, H. (2007). Serious video game effectiveness. *Proceedings of the international conference on Advances in computer entertainment technology*, (pp. 49-55).
- Woodcock, B. (2006). *An Analysis of MMOG Subscription Growth - Version 20.0*. Retrieved from: <http://www.mmogchart.com/>
- Woudhuysen, J. (2006). *Computer Games and Sex Difference*. Retrieved 23rd June 2008 from <http://www.woudhuysen.com/documents/ComputerGamesSexDifference.pdf>
- Wouters, P., Tabbers, H. K., & Paas, F. (2007). Interactivity in video-based models. *Educational Psychology Review*, 27, 327-342.
- Wouters, P., van der Speck, E., & van Oostendorp, H. (in press) Current practices in serious game research: A review from a learning outcomes perspective. In T. M. Connolly, M. Stansfield, E. Boyle (Eds.), *Games-Based Learning Advancements for Multisensory Human Computer Interfaces: Techniques and Effective Practices*. Hershey, PA: IGI Global.
- Yellowlees, P. M., & Cook, J. N. (2006). Education About Hallucinations Using an Internet Virtual Reality System: A Qualitative Survey. *Academic Psychiatry*, 30, 534-539.
- Young, A. (2007). *An investigation of possible gender differences in students' academic self-perceptions within a classroom environment*. Unpublished. Dissertation, University of Paisley.
- Yu, F. Y., Chang, L. J, Luit, Y. H., & Chan, T. W. (2002). Learning preferences towards computerized competitive modes. *Journal of Computer Assisted Learning*, 18, 341- 350.
- Yueh, H.-P., & Hsu, S. (2008). Designing a Learning Management System to Support Instruction. *Communications of the ACM*, 58(4), 59-63.
- Zagal, J. P., Rick, J., & Hsi, I. (2006). Collaborative games: Lessons learned from board games. *Simulation & Gaming*, 37(1), 24-40.
- Zaïane, O. R., & Luo, J. (2001). Towards evaluating learners' behaviour in a web-based distance learning environ-

- ment. In *IEEE international conference on advanced learning technologies* (pp. 357-360), Madison, USA.
- Zang, L. (2006). Thinking styles and the Big-Five personality traits revisited. *Personality and Individual Differences*, 40(2006), 177-1187.
- Zeaman, D., & House, B. (1963). The role of attention in retarded discrimination learning. In N. R. Ellis (Ed.), *Handbook of Mental Deficiency*, (pp. 159-223). New York, NY: McGraw-Hill.
- Zhang, J. (1997). The nature of external representations in problem solving. *Cognitive Science*, 21(2), 179-217.
- Zhang, J., & Norman, D. A. (1994). Representations in distributed cognitive tasks. *Cognitive Science*, 18, 87-122.
- Zhou, X., & Conati, C. (2003). Inferring user goals from personality and behaviour in a causal model of user affect. *International Conference on user interfaces*, Miami, Florida.
- Zimbardo, P. G., & Leippe, M. R. (1991). The psychology of attitude change and social influence. New York: McGraw-Hill.
- Zyda, M. (2005). From Visual Simulation to Virtual Reality to Games. *Computer*, 38, 25-32.

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About the Contributors

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