Building Communities among Software Engineers: The ViSEK Approach to Intra- and Inter-organizational Learning

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Abstract. The paper presents the concepts of the Distributed Center of Competency in Software-Engineering (ViSEK): a German national initiative to encourage intra- and inter-organizational learning in the software industry. Taking a socio-cultural stance, learning is understood as enculturation in a community of practice. So community building becomes an important objective when fostering intra- and inter-organizational learning. The ViSEK-project encourages community building among software-engineers at three different levels: between leading research groups, between research groups and practitioners, and among practitioners from different small and medium size enterprises (SMEs). We describe two approaches for community building more in detail: (a) an internet portal which presents software engineering knowledge and offers functionality for community support, (b) a regional network of SMEs which stimulates learning among its members in the field of usability engineering.

1 Introduction

The field of Software-Engineering develops rapidly. Furthermore software development knowledge is very specialized and fast out-of-date. Especially for small and middle-sized enterprises (SMEs) it is hard to keep pace with actual software trends and the requirements of dynamically changing markets. SMEs typically have neither own divisions for personal development nor enough time and financial resources to visit expensive and time-consuming seminars. To be in business with big software competitors SME have to meet two challenges: First they have to stay up-to-date with theoretical software engineering knowledge; second they need practical experiences in state of the art technologies and methods to decide if it is worth to learn a new engineering method or to pay for a development tool. In other words: SMEs need expert knowledge and practitioner experience to fit the requirements of their markets.

Due to the fact that SMEs play a major role in the German software industry (Broy et al. 2001), the Federal Ministry of Education and Research funded the ViSEK Consortia to support German SMEs in coping with these two challenges. ViSEK is the acronym for "Virtual Software-Engineering Competence-Center". ViSEK has two main goals. First, it should consolidate the state of the art in software- engineering and develop an internet portal which presents practical relevant knowledge in a repository structure (cf. Feldmann and Pizka 2002). Second, it should build up a lively software engineering community that brings together SMEs from the software and media and industries with researchers from the field of Software Engineering.

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Effective learning and knowledge creation does not take place in social isolation.

In fact, learning is a constructive and socio-cultural process (see Bateson 1983; Lave and Wenger 1991; Wenger 1998). Therefore, the ViSEK portal offers besides the knowledge repository options to discuss and exchange knowledge. These community features enable SMEs not only to collaborate with researchers but also with colleagues from other software companies. Such a conjunction between research institutes and SMEs holds mutual benefit. On the one hand SME practitioners gain insights into state of the art of software engineering knowledge. On the other hand researchers get feedback to focus their work towards challenges which are relevant in practice. The exchange and collaboration of different SME triggers inter-organizational learning effects. This is very important, since SMEs have to focus on their core competences. Learning should therefore include aspects of network building to cope with complex problems and projects.

2 Learning as Enculturation in Communities

ViSEK as a learning platform stands on two pillars: software engineering repository and community. We believe that according to recent learning studies pure repository approaches grasp to short in supporting people to learn effective and efficiently (Davenport and Prusak 1998; Ackerman, Pipek, and Wulf 2003).

Pure repository approaches are based on an "instructionist" understanding of learning. The learner is seen as receptive system, which stores, recalls and transfers knowledge. This understanding was criticized from theoretical and practical point of view (see Collins et al. 1989, Schulmeister 1997). Thus recent scientific approaches favor constructionist and socio-cultural concepts of learning. Based on the work of Piaget and Bateson (1983) learning is seen as an active and constructive process (cf. Prenzel & Mandl 1993). Learning means not just transferring knowledge. Learning is rather the permanent construction of knowledge, based on former experiences. Hence knowledge is linked to real world problems.

In the last decade constructionist theories of learning played an important role in the development of new computer-based learning-forms (Duffy und Jonassen 1992, Gräsel et al. 1997).

Socio-cultural learning theories refer to Vygotsky (1962). They are based on ethnographical studies in different cultures (Lave und Wenger 1991). Those theories take learning as a collective process and linked to specific contexts of action. Knowledge emerges in communities of practice by discursive assignment of sense. Communities of practice are characterized by common conventions, language, tool usage, values and standards. Learning is understood as the gradual inclusion or insertion into a community of practice (enculturation).Enculturation is consolidates by "cognitive apprenticeship" (Collins et al. 1989, Lave and Wenger 1991; Wenger 1998).

3 Software Engineering in Germany

The current situation in the German software industry is characterized by lacking social networks especially among different SMEs and lack of exchange between software engineering practitioners and researchers. Looking at the SE-research insti-

tutions, we find quite some groups of excellent researchers, spread over Germany. However, these groups are poorly connected; especially what concerns the operational level. They focus on different topics, following different research agendas and paradigms. Moreover, innovative highly interdisciplinary fields such as usability engineering are not well enough connected with the traditional SE groups.

We believe that diversity is the motive power of scientific progress. However, diversity only contributes to scientific advance, if there are explicit links and discourses among the different research groups. This requires mutual understanding and the development of shared concepts. Consistent software engineering concepts are so far out of sight. A consistent terminology is still missing. Same terms (e.g. "interface" or "component") mean in different sub areas completely different things; in other cases different terms have the same meaning. For theoretical and practical reasons, we do not believe that a unified language is achievable for a heterogeneous research field such as Software-Engineering. However, we believe that a more intense scientific discourse between the different subfields would lead to new insights. Moreover, an unreflected use of terms leads to particular confusion in collaboration with practitioners.

Looking at the relation between SMEs in the software and media industry, we find a lacking culture of trust and cooperation. This may be explained by their fear of competition. However, without inter-organizational cooperation SMEs have severe problems to handle big and complex projects, to keep pace with software trends, and to follow requirements of dynamic markets.

Therefore, ViSEK faces three main challenges: The first challenge is to strengthen the German scientific software-engineering community. The second challenge is to trigger cooperation among the SMEs of the software and media industry, and the third challenge is to bridge between sciences and practice.

4 The Approach Taken by ViSEK

The scientific consortium of ViSEK consists of eight research institutes: five Fraunhofer Institutes and three groups based at research universities[1]. The different knots of the network cover the different regions of Germany rather well.

To prepare for community building on the national level, all partners work together in organizing press conferences or other public relations activities to communicate the need for cooperation among SMEs and IT-research.

More importantly, the joint design of the web-based portal triggers community building among the scientific institutes. While the implementation of the portal is carried out by one of the partners based on an existing content management system, the scientific consortium has to cooperate closely in the design of the portal. Designing a SME-oriented presentation of software-engineering knowledge is a complex process with lots of interrelated cooperative activities. Here we will focus on three activities the scientific consortia is concerned with: (a) creating a joint classification scheme for software engineering knowledge as a basis for the main navigation structure of the portal, (b) establishing a common terminology as a basis for a joint index,

[1] Fraunhofer IESE, Kaiserslautern; Fraunhofer FIT, Sankt Augustin; Fraunhofer FIRST, Berlin; Fraunhofer IITB, Karlsruhe; Fraunhofer ISST, Berlin and Dortmund; Technical University of Munich; OFFIS at the University of Oldenburg; Technical University of Cottbus.

(c) reviewing each others content for the repository to ensure quality standards and readability. All these activities support community building effects among the scientific institutions, since they are forced to refer to each others work in achieving the common goal.

The scientific partners agreed to apply the SWEBOK 0.95 classification scheme of software engineering knowledge to be the starting point for creating a navigation structure inside the portal. So each partner started classifying his specific knowledge according to the SWEBOK scheme. This activity leads to intense discussions among the partners, since they had to refer to each others contributions as well as to agree on modifications of the SWEBOK classification scheme. The creation of a classification scheme for navigation is a highly political activity because it influences the accessibility of the different partners content.

As we assume that SMEs produce software for specific application domains, we designed two domain-specific access modes for the portal: E-Business Applications and (Safty) Critical Systems. The different partners have to integrate their content into this domain-specific structure where possible. This way they have to discuss and agree on a domain-specific coverage of the field, as well.

Another challenge is the elaboration of a knowledge index. In the different schools and subfields of software-engineering, there exist various meanings of the same terms. How to deal with this problem? One possible solution would be to use only a high level definition of these terms. The disadvantage of high level definitions is the fact that these definitions are not very meaningful to users, especially from SMEs. So the consortium agreed that, in specific cases, it would be better to allow different well-defined concepts in parallel. The joint reflections during the portal building process triggers mutual learning among the scientific research communities and connects the individual German research institutes more closely.

Additionally to German-wide community activities the scientific partners organize community building activities on the local level. This is very important since we cannot hope to create a SE-community on the national level in a first step. People exchange knowledge only in case they trust each other. It is very helpful in establishing confidence, when people can easily meet each other and discuss, without having to bridge big distances. As a first step we decided not to build a pure online-community. We use the web-based portal as a medium to organize real world communities, which may meet in the virtual space, as well.

In the following we exemplify the local community building activities undertaken by one of the ViSEK partners: the Fraunhofer FIT in the Bonn region. Similar activities are initiated by other ViSEK partners.

4.1 Building Local Communities

The Bonn region is characterized by a high density of SMEs in the software and media industry. Many of them provide services or market products to the local telecommunications, television, and insurance industries. Recently the research group at Fraunhofer FIT has organized a series of social events for regional SMEs from the software and media industry. The target groups of these events were managers and software developers.

A goal was to make the ViSEK initiative known and to involve the local SMEs into the design of the web-based portal in which practically proven software engineer-

ing knowledge will become accessible (see section 4.2). We also intended to foster inter-organizational learning and cooperation among local SMEs. Finally, we wanted to strengthen our ties with industries to enable knowledge transfer into practice and to align our research efforts more closely with industry needs.

These social events were organized in form of topic centered workshops and focused on the subfield of usability engineering. Why did we focus on only one topic and why did we choose usability engineering out of different other subfields of software engineering our institute works in?

We assumed that setting a focus leads to more tangibility and thus to more attractiveness. If we had invited the SMEs to discuss software engineering in general, it would be more difficult to communicate the usefulness of the events. We assumed that SME do not want to spend their time to talk globally without a predefined goal. The goal we defined was to encourage learning in a specified niche to increase competitiveness in the market. We chose "usability engineering" since this topic demands interdisciplinary team work. Moreover, usability activities are normally not well established in software SMEs in these days. This makes learning effects easy measurable. One indicator for the learning success may be the augmentation of acceptance and the growth of a positive attitude towards usability. At the same time many software SME refuse to spend money and time to build up usability departments in their enterprises, since they cannot easily evaluate the economic outcome.

For each of the three workshops all regional SMEs were invited by means of a letter sent to their management. More than 500 letters were distributed to a list of companies provided by the local chamber of commerce. At each workshop we attracted between 30 and 45 participants. There was a core of about five to seven companies which participated in all of the events. Besides this, we had a rather big group of actors who only took part in one or two of the events.

The procedure of the workshops was as follows: First researches gave talks about usability relevant issues. The auditorium had the possibility to ask questions and to discuss these issues with the speaker right after the talk. We found a lively interest in discussion and collaboration with researchers. For SMEs it seems to be very attractive to promote their products and services by demonstrating cooperation with well-known research institutes. However, our experiences so far indicate that SMEs are more interested in "decorating" scientific contacts than in the actual state of the art in research. So we have to work out strategies to augment their interest in the topic itself.

After the talks and following discussions we invited for a reception where the SMEs and the IT-researchers could network in a more informal way. Concerning the network-building among SMEs, we noticed an interesting phenomenon: when we first confronted them with the idea of learning from each other and cooperating with each others, they reacted negatively. They argued that they are in mutual competition and that it would be short witted to give away their in-house knowledge that ensures their advantages in the market. But when the managers talked to each other in small groups of three or four people, they became aware that they suffer from similar problems. Under these circumstances they were easily willing to exchange information and advice. From a psychological point of view we learned that for community building it is essential to create a joint awareness of common problems, so that the SMEs feel that there is a common goal to achieve. As a next step, we involved the management of this core group in founding an association which is supposed to become the institutional base for the ongoing regional networking activities.

We will draw on this insight gained from building local communities when trying to build online-communities in the portal. Additionally other core prerequisites for multidisciplinary exchange and cooperation between SMEs must be taken into account and be realized by ViSEK portal. Whittaker et al. (1997, p. 137) identified the following core attributes:

1. Members have a shared goal, interest, need, or activity that provides the primary reason for belonging to the community.
2. Members engage in repeated, active participation; often, intense interactions, strong emotional ties, and shared activities occur among participations.
3. Members have access to shared resources, and policies determine the access to those resources.
4. Reciprocity of information, support, and services among members is important.
5. There is a shared context of social conventions, language, and protocols.

In combination with the knowledge repository of the ViSEK portal FIT embraces to this attributes by organizing regularly social activities in "real world". The challenge is the transfer of these attributes in the virtual world of the ViSEK portal.

4.2 Building a Community-Centered Portal

The ViSEK portal is based on two pillars: a knowledge repository and online communities. The goal of the repository structure is to provide an easy and fast access to the most actual software engineering knowledge. In this way it creates an interesting place in the virtual world which attracts attention by people interested in innovations in software-engineering methods, tools and processes. So far the eight scientific partner organizations made their software engineering knowledge available to the SMEs by creating content for the knowledge repository (cf. Feldmann and Pizka 2002). While it may create an interesting space in the virtual world, a repository by itself does not support the emergence of communities. Hence additional efforts must be undertaken: functionality for community-support needs to be included.

To realize the portal in a resource-efficient manner, we chose the content-management system *WebGenesis* which was provided by one of the scientific partners (Fraunhofer IITB). This system offered extensive functionality to input, edit, structure and display the knowledge repository. Moreover, it contained some community-oriented functionality, such as discussion groups. However, the basic functionality of the content management system does not yet provide a tide enough integration of repository and community-building functionality. For instance, we would like to allow users to annotate certain aspects of the content which then should be displayed to the other users. This way discourses with regard to the content of the portal could be supported. With regard to functionality for community-support, we were forced to initiate a software development process to extent the given platform.

Community-centered development focuses on the communities needs prior to making decisions about the technology (cf. Preece 2001). With regard to user-centered interaction design, different techniques are already worked out (e.g. Preece and Rombach 1994; Kreitzberg, 1998; Shneiderman, 1998a). In accordance with HCI approaches, we identified first the needs of SMEs from the software and media industries for learning and knowledge exchange. We created more than 40 textual scenarios for the portal's use and an early prototype to present our vision to representatives of

software SMEs primarily taken from our local network. Based on this feedback we derived requirements for the design of the ViSEK portal, especially the community-supporting functions.

We realized an early version of the portal based on the content management system. This version contained only limited community-oriented functionality. It was presented on a workshop of the local network and on the CeBIT 2002 (a major trade-show for information and telecommunications technology) to gain additional feedback from our target group. By means of the user-centered design process, we identified the following needs for community support in the portal:

- ✓ *Exchange practical experience*

  It is one thing to read something about a new method or a new technology. The other thing is to establish this method or technology in your own enterprise. The implementation of new technologies normally comes along with significant changes in the whole organization. Changes often cause diminished turnovers in the first step. Therefore it is useful to be preliminary informed about possible disadvantages at first hand. So the ViSEK portal should not only offer scientific information about innovative software engineering methods and tools. Additionally practitioners should have the possibility to annotate these methods by reporting about their own practical experiences. Different experiences could be related towards each other. So practitioners are able to discuss among themselves the pros and cons of to the deployment of an innovative method, tool or process in their software engineering practice.

- ✓ *Discuss in an asynchronous mode*

  One can distinguish between two modes of computer-mediated communication: synchronous and asynchronous. Synchronous information exchange means communication in real time. Participants have to be present at the same time, though not necessarily in the same place, so that comments can be followed up instantly within the communication. One realization of synchronous discussions would be chat-rooms. Asynchronous conversation does not require participants to be available at the same time. For the ViSEK portal we decided to provide primarily asynchronous communication channels among the SMEs, because almost none of the SME employees we interviewed could imagine chatting in real time with other colleagues during a normal working day. We favor establishing electronic discussion groups. We still have to analyze which topics to choose for initial discussion rounds.

- ✓ *Refer to experts*

  In knowledge management it is a well known fact that certain types of knowledge cannot be expressed verbally (so called tacid knowledge, according to Polanyi,1983). Users in the portal may not express their knowledge textually due to the efforts involved. Some experts may also hesitate expressing their knowledge fully in a portal because they would like to market it (cf. Davenport and Prusak 1998; Ackerman, Pipek, and Wulf 2003). Implicit knowledge is definitely needed with regard to the moderation of organizational change in software-engineering processes. Therefore, a community-based portal needs to provide reference to experts. The portal will offer expert profiles (“yellow pages”) with contact information so that SMEs are able to find the fitting expert for their problems. The experts' yellow pages will also be linked to those parts of the repository their

expertise refers to. Moreover, we will implement functions which match actors with similar interests and learners with experts via appropriate algorithms and strategies for visualization (cf. Becks, Reichling, and Wulf 2003). In this way the portal can serve as a platform to match experts with actors who look for a solution to their problems. Additionally ViSEK experts and famous software engineering professionals will be available in chat rooms at pre-defined points in time. Representatives of SMEs stated, that they are interested in synchronous communication with experts in case it does not happen too frequently and does not take too much of their time. In contrast they preferred asynchronous exchange with colleagues.

5 Conclusions

Socio-cultural theories stress the importance of communities of practice in the process of learning. Seen from this perspective, repository approaches which are based on the assumption that relevant knowledge can be explicated, represented, and diffused via electronic networks are problematic (cf. Basili et al. 1994). They need to be augmented by approaches which foster community building. In the software industry, community building will always require an integration of technical and social activities. These findings have to be always taken into account when reflecting on learning software organizations.

Based on our theoretical background, we have described approaches to community building within the German software industry. The current situation in the German software industry is characterized by insufficient networks among researchers, between practitioners and researchers, and among practitioners. The ViSEK project aims to establish a culture of inter- and intra-group cooperation by means of an internet portal and local social events. The internet portal offers state of the art software engineering knowledge and provides functionality to build (online) SE- communities.

We are in the midst of a complex process with challenges on the social as well as on the technical side. In this paper we have presented our conception and some early results. Yet it is unclear whether and to which extend this conception will turn out to be successful. The different social and technical measures for community building need to be evaluated carefully. Moreover, one has to investigate how to treat online-communities in the framework of socio-cultural theories of learning.

One of the biggest practical challenges is to establishing a culture of trust and cooperation among SMEs, and especially among their managers. Right now a competitive culture seems to dominate their relationships, which hinders knowledge exchange, mutual learning, and inter-organizational cooperation.

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