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Knowledge Practices Laboratory

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Contributor(s):	Kai Hakkarainen, Minna Lakkala, Sami Paavola, Seppo Toikka (UH) Heidrun Allert, Christoph Richter (FH-OÖ) Anne Moen, Anders Morch (UiO) Patrick Sins (UU) Klas Karlgren (Karolinska) Merja Bauters (EVTEK) Comments and suggestions for improvement: Vassilis Christophides (FORTH)
Editor(s):	Sami Paavola (UH)
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Executive summary

The present deliverable gives a perspective to the KP-Lab's technology development as well as theoretical and pedagogical approach in relation to central relevant trends in educational technology (and related fields). First, we compare the KP-Lab approach to some important trends in computer-supported collaborative learning (CSCL) tradition as well as in relation to Knowledge Management (KM) approaches. The KP-Lab approach has important influences from both of these areas of research and development. Then we shortly present how discussions on semantic (and pragmatic) web and Web 2.0, as well as user's "tool ecology" give a basis for understanding the KP-Lab tools. We explicate through some examples how knowledge practices in various contexts have given direction to the development of KP-Lab technology and related knowledge practices. Lastly we explicate in more detail the special focus areas in the KP-Lab technology. The essential characteristics of the KP-Environment supporting collaborative knowledge creation and the trialogical approach are presented.

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1 Introduction

The *knowledge-creation metaphor* of learning is a central starting point for the research and development activities in the KP-Lab project. This approach is especially drawing on insights from the knowledge building approach (Bereiter, 2002), expansive learning and activity theory (Engeström, 1987) and organizational knowledge conversion (e.g., Nonaka & Takeuchi, 1995; Hakkarainen, Palonen, Paavola & Lehtinen, 2004). Collaborative 'knowledge creation' and trialogical approach to learning[1] refer to processes where communities *a)* work for developing epistemic artifacts supported by collaborative technology (advancing ideas, such as questions and explanations, which are highlighted by knowledge building), *b)* engage in reflection and transformation of practices, which are *c)* mediated by tools and instruments (highlighted by activity theory).

A distinguishing feature of KP-lab project is that it aims at developing models and technology in relation to collaborative, creative work both with "epistemic artefacts" (or knowledge objects, like documents, ideas, conceptual models, visualizations, diagrams, etc), and with practices and processes of working. In our approach, we focus on how individuals and communities organize their efforts for developing and creating shared objects systematically, and in such efforts the role of educational technology and knowledge management approaches still need to be developed. While human beings have taken part in knowledge production activities since the beginning of their very history (Clark, 2003; Donald, 1991; Vygotsky, 1978), the development of technology-mediated learning environments appears to significantly assist the process. Collective knowledge creation practices cannot easily be taken part in without appropriate technologies that help the participants to create and share, elaborate and transform, organize and visually model diverse epistemic artifacts in conjunction with making visible, reflecting on, and transforming knowledge practices. Such supportive technologies being developed within the frame of KP-Lab project shall provide tools for creating, organizing, structuring, commenting, linking knowledge artifacts and making visible, reflecting on, modeling and transforming knowledge practices.

The KP-Lab project examines in what sense we can talk about 'trialogical technology'. One central starting point in this line of discussion has been that technology enhances learning through transformed practices. In order to make the theory relevant for learning and knowledge intensive work, we need to address knowledge practices, i.e., practices related to working with knowledge. But this does not undermine the role of technology. On the contrary, it puts new demand on technology. Trialogical technology refers to the technology that provides *affordances* for (i.e. supports in a fluent way) collaborative knowledge-creation processes. These affordances we highlight in chapter 5.

The challenge of KP-Lab is to elicit expansion and elaboration of the objects of educational and/or professional activity. In this regard, an essential role will be played by the KP-Lab environment that will provide (novel) instrumentalities required for trialogical activities, including creation, management, sharing, and working with complex, incomplete, and often messy and fluid objects (Engeström & Blackler, 2005; Law & Singleton, 2005; Miettinen & Virkkunen, 2005). Sophisticated environments based on ICT are needed to provide novel tools for sustained working with elaborated, spatially and temporally expanded, and collectively

[1] The notions "(collaborative) knowledge creation" and "trialogical approach to learning" are used almost interchangeably in the document. Knowledge creation refers to processes analyzed in various theories of learning highlighting how people organize their work for developing something together. Trialogues means those processes where people develop some concrete things (like conceptual artefacts, product plans, practices) together in long term processes.

distributed objects of activity (compare Engeström, Puonti, & Seppänen, 2003; Engeström et al., 2002).

The aim of this deliverable is to compare the KP-Lab approach and technology development with recent trends in educational technology and related approaches and development trends. To do this extensively would be an enormous task because there are so many issues relevant to the KP-Lab's technological and pedagogical approaches. So we have been selective and bring here out only some of the most central ways of understanding the basis for the KP-lab approach.

2 Trialogical technology in relation to other approaches

In order to cope with the increasing complexity of problems encountered in modern work, professionals have to create various epistemic artifacts for re-mediation of their activity. The KP-Lab investigates students of higher education, people in teacher training, and professionals in their workplaces as they engage in collective knowledge creation and practice transformation. They develop, interact with, use and reuse objects. These concrete objects are not ends themselves but assist in deeper pursuit of epistemic objects (Knorr-Cetina, 1999; Miettinen & Virkkunen, 2005). After being given an externalized and material existence (as digital or paper-based entities), the concrete artifacts stabilize and could function as partially invisible instruments of subsequent activity, and get embedded in growing collective knowledge network. Across projects and courses emerge new knowledge resources that guide and constrain the participants' activities.

2.1 From the perspective of CSCL

The specific emphases within KP-Lab's trialogical approach can be demonstrated by comparing it with two other approaches to knowledge-creating learning within computer-supported collaborative learning (CSCL) research, i.e., Bereiter's (2002) knowledge-building approach and Stahl's (2006) situated-interaction approach. Such comparison reveals interesting controversies concerning technology-enhanced learning which trialogical approach aims at solving (see Table 1).

Trialogical approach emphasizes that technology should support sustained, collaborative knowledge creation in "object oriented" activity (e.g. they support creative work around shared objects). In this sense it differs from many of the current approaches to educational technology that usually emphasize either cognitive/conceptual or participatory aspects. When one follows a cognitive approach, certain phenomena, such as social practices, become invisible. Foregrounding mental or conceptual representations and processes makes many interesting and relevant socio-cultural phenomena disappear from the focus of learning activity. Focusing on situated interactions appears to make invisible those concrete activities that students engage in while producing knowledge to CSCL environments' databases, and collective knowledge networks tend to disappear.

Table 1. Comparison between three approaches to knowledge-creating learning

	Knowledge building	Situated interaction	Knowledge creation practices
Theory of	Idea-driven theory	Indexical theory of	Dialectical theory of meaning (dynamic

meaning	of meaning	meaning	interaction between material and conceptual signs and objects)
Epistemic entities foregrounded	Conceptual artifacts	Personal and group perspectives	Hybrid objects involving conceptual, practical and material dimensions
Temporary scope	Long-term knowledge advancement	Joint meaning-making in here-and-now interactions	Long-term knowledge advancement tightly coupled to transforming practices.
Social practices	No theory of social practices beyond descriptive characterizations	Phenomenological account of unfolding practices	Knowledge practices embedded in activity systems and historically located settings in which epistemic mediation plays an essential role
Preferred technology mediation	Knowledge-building environments	Conferencing, chat, discussion forum	Knowledge creation technology supporting multimediation (see below)

Published research reports across several conferences of CSCL reveal that many researchers examine technology-mediated learning in terms of short interactive episodes, in which people struggle to create common ground and achieve mutual understanding. Detailed studies of interactive and situational processes help the CSCL research community to understand, with substantial depth, complex interactive processes of joint activity among the participants. Among others, Stahl's (2006) approach relies on such a tradition being, simultaneously, framed in terms of creating and building knowledge through certain "collaborative moments" investigated in detail. However, it remains unclear what knowledge was created, how it was done, and what happened to the produced knowledge after the interactive moment was over. From the knowledge-building perspective (Bereiter, 2020), something essential appeared to be missing from this characterization of situational collaborative learning process, i.e., (acknowledgement of) genuine shared, epistemic objects that learners have to work on in order for understanding to move ahead. A species specific characteristic of humans appears to be that they are able to collaboratively create such epistemic artifacts embodying their knowledge and understanding; this appears to be the only humanly possible way of tackling truly complex problems.

The knowledge-building approach diverges substantially from the situated-interaction, in foregrounding the role of shared epistemic artifacts rather than immediate dialogic interactions. This approach examines knowledge-creation as a production process focused on idea improvement and advancement of shared conceptual artefacts as iterative efforts taking place across long-periods of time. There are, however, some basic weaknesses in that approach, too. Knowledge building emphasizes conceptual artifacts and idea improvement, and, thereby, neglects other (non conceptual) elements of knowledge creation. It is not supported by a theory of social practice for understanding collaborative knowledge creation. The effect of this is that it is hard to explain success and failure with knowledge building.

The situated-interaction approach has been criticized for not being able to to manage *epistemic mediation* (Beguin & Rabardel, 2000) involved in the pursuit of knowledge artifacts. This phenomenon is not yet well conceptualized in other approaches either; for example, the cultural-historical activity theory tends to address simple rather than complex mediation (Bodker & Andersen, 2005) involved, for instance, in creating whole epistemic systems (Hughes, 1998; 2004). Expert-like knowledge practices are mediated by artifacts and complex information infrastructures (Bowker, 2005). Collaborative processes need to take into account a multimodal perspective (written, oral, conceptual, material and practical interaction). The trialogical approach examines ideas as hybrids, encompassing both conceptual and material artefacts and aspects. By relying on a dialectical approach to epistemology, it examines knowledge advancement and transformation of social practices as tightly coupled processes.

2.2 From the perspective of Knowledge Management

In contemporary knowledge work time is spent on solving open, poorly-defined problems and encouraging non-routine approaches guided by professionals' expertise to construct knowledge and solve problems. In related work the authors point out new dynamic, creative, and open-ended, question-generating activities adding to the stabilizing effects of rules, routines, embodied (taken for granted) skills and established division of labor (Knorr Cetina, 2001; Miettinen & Virkkunen, 2005). Therefore, in contemporary Knowledge Management (KM) approaches presented in the literature we observe similar shifts in emphases; e.g. the use of KM tools in workplaces that are complemented by second generation KM, epistemic objects, socio-material infrastructures, and techniques for knowing in practice (e.g. Ahonen, Engeström & Virkkunnen, 2000, Gherardi, 2006; Knorr Cetina, 2001; Lipponen, Lallimo, & Lakkala, 2006). Based on our survey of KM approaches in D10.3 (Moen, Toiviainen, et al. 2008), we suggest a distinction between three perspectives: 1) technical, 2) socio-technical and 3) socio-cultural (Mørch, Moen, Hauge, & Ludvigsen, 2008).

The *technical perspective* on KM is rooted in information systems and computer science that emphasized systems to manage information (rather than knowledge), its collection, retrieval and data exchange (Huysman & Wit, 2003). From this perspective, approaches to knowledge management draw from three related disciplines: 1) databases (document management systems), 2) information systems (information management), and 3) artificial intelligence and expert systems (knowledge engineering). The goal is *representation of information*, as in commoditisation of knowledge, and treating knowledge as an asset. This characterizes an information processing view of knowledge, which is an mentalistic vision of knowledge in organizations. These initiatives adopted a technical approach creating repositories to support "*management of information*", to distribute, disseminate and leverage knowledge to enhance organization's performance (Easterby-Smith & Lyles, 2005). It includes various formats for data storage and protocols for data interchange needed for networked information systems. A technique that was developed on this technology is knowledge mapping. This is accomplished in a two-phase process: 1) discover what kind of knowledge exists at the start of a knowledge intensive project and 2) build a map of the relationships between communities involved in knowledge creation and sharing.

The *socio-technical perspective* on KM illustrates further developments of the technical perspective by including a user-centred perspective and being informed by research in computer-supported cooperative work (CSCW). The focus is geared towards how to utilize KM for *sharing information* with others and connecting people in an organization (Ackerman, Pipek & Wulf, 2003; Easterby-Smith & Lyles, 2005). This perspective has many similarities with trends towards more interactive systems, exemplified by dynamic web pages and on-line transactions in e-business and e-commerce, and most recently Web 2.0 applications for social networking, collaborative creation and updating of personal and/or shared information, e.g. Facebook, LinkedIn, blogs and wikis. Still shortcomings referred to as the *"knowledge activation problem"* or in short form "*problem of enactment*" (Fischer & Ostwald, 2001) points to problems from constrained access to information when needed in knowledge-creation activities or in new or not anticipated contexts.

The *socio-cultural perspective* on KM includes how people appropriate and utilize available resources in mediated action, bringing the *social aspects of information* and knowledge sharing with tools to the forefront. This is about supporting what people actually do, and then augmenting their *'knowing in practice'* emphasizing the different artefacts and representations they actually use, to understand knowledge creation and practice transformation. Routines, procedures, and methods are embedded in artefacts that influence KM-practices. The ultimate goal of this approach, as we see it, is when KM tools become invisible to the knowledge worker and seamlessly form "infrastructures for object-oriented activities" (Engeström, 2007; Ahonen et.al. 2000). As pointed out in D10.3 (Moen, Toiviainen, et al. 2008) this development can be associated with the *"pervasiveness of knowledge,"* where knowledge and associated practices are tightly integrated and mediated by KM tools supporting knowledge-creation. This highlights that knowledge creation and learning is a social and participative activity, where knowledge creation focus on epistemic objects and organizational routines in their effort to serve as resources for analyzing how practices, or critical aspects of a practice, can be made into an object of inquiry and produce novel and alternative ways of acting, with the ultimate aim to transform the practice.

The figure 1 below characterizes development of the conceptions of KM as representation (first generation or a technical approach to KM), to sharing and activating (second generation or socio-technical approach to KM), to 'knowing-in-practice'. This point to knowledge, knowing and doing contextualized in workplaces and networks where it is created and used for knowledge-creation and production processes.

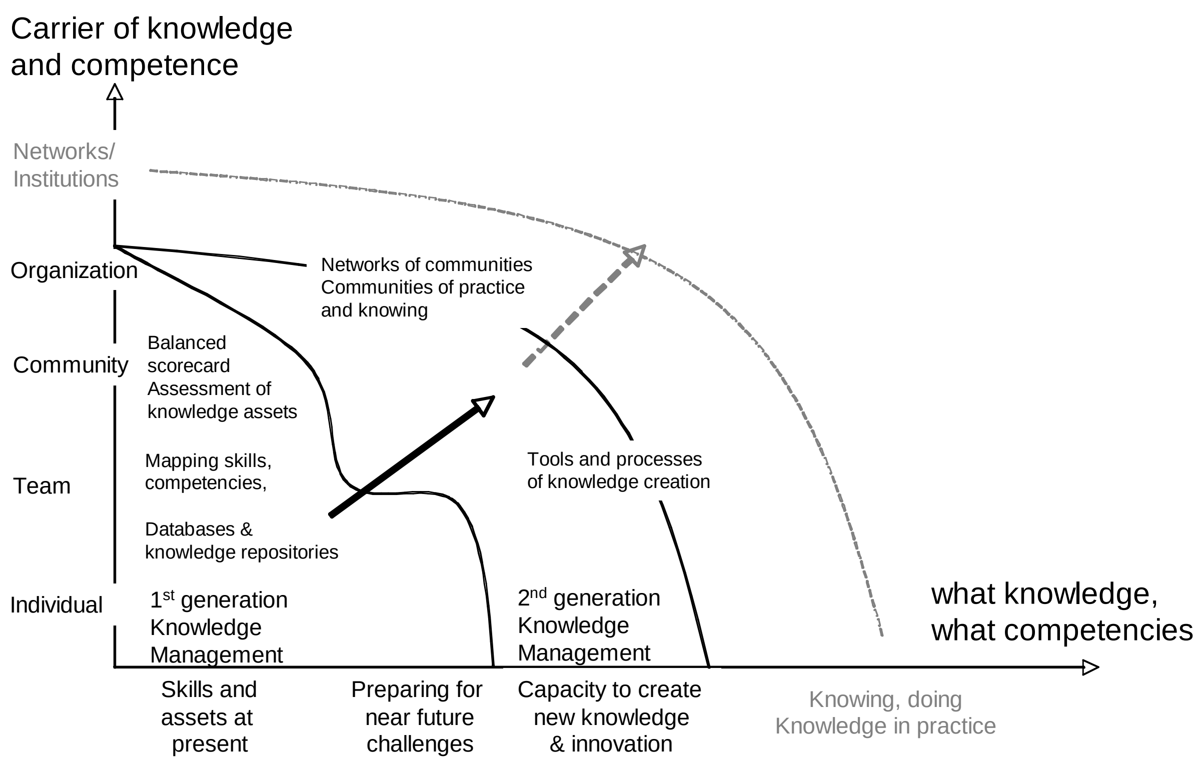

Figure 1. Development of KM perspectives (developed from Ahonen et al, 2000)

For KM to inform trialogical-learning knowledge practices should emphasize the situated and context dependent aspects of knowledge (e.g., Ahonen et al., 2000: Gherardi, 2006) and the historical, object-oriented and collective nature of human activity and knowledge (e.g., Engeström & Miettinen, 1999). Strong emphasis on the complexity and interplay of knowledge types, e.g., propositional, experiential, and/or under-articulated, and their interplays in the ongoing case studies of knowledge practices point to further elaboration of strategies and methodological approaches, and requirements to services and functionality for more appropriate tool-support. To do so, the notion of *socio-material infrastructure* becomes useful particularly when we draw on perspectives from socio-technical and socio-cultural approaches to KM to understand, design and manage interconnectedness of people, material elements of work and heterogeneous work settings. Put brief, *socio-material infrastructures* refer to a network of social and material relationships and facilities developed to support a wide range of human activities (Lipponen et al., 2006; Star, 1999).

The creation of KP-environments as arenas for collaborative knowledge creation can be an example of socio-material infrastructures as a proper tool to support practice transformations. When professionals interact in knowledge production and explore affordances of tools, services and infrastructures at their disposal, these resources provide instrumentalities that mediate their individual expertise and the collective knowledge creation. Such settings can be seen as rich environments or hybrid, shared spaces where the participants create, modify, adapt or extend objects as they interact f2f or with material and conceptual artefacts in the available infrastructure; e.g., Change Laboratory® Tool, or 3rd party tools like PPS-EQS[2], tools for CRM[3] or instrumentation in leading edge research fields like nanotechnology. Across these cases, findings from exploration of their tools use show experimentation with available services as incremental changes and co-evolving processes in their production processes. The professionals' on-going appropriation of tools and services to perform their work, points to socio-material infrastructures as promising to support the professionals' KM. Framed in KP-Lab vocabulary we observe a shift from KM approaches that align with the "acquisition" metaphor and the "participation" metaphor, towards tools supporting knowledge creation and production processed for practice transformation, where requirements for social architectures of knowledge and socio-material infrastructures come into play.

2.3 Semantic web – Pragmatic web – Web 2.0

Nova Spivack (2007) has created a vision concerning the Metaweb that arise from increased social (social software) and information connectivity (semantic web). The Metaweb is partially a projection of current possibilities, and partially imagined and postulated reality. The vision of the emerging Metaweb embodying collective intelligence is truly attractive; there certainly are phenomena that hint toward such a direction. The metaweb vision is bold and inspiring in nature; it appears, however, to rely on such an ideology of semantic web where intelligence would miraculously emerge from the two trends mentioned.

A crucial limitation of the vision is, however, an examination of information connectivity and the social connectivity separated from social practices that are missing from the Metaweb vision. We may continue pursuing increased social and information connectivity forever without getting very far if the technologies are not developed with an inseparable integration between technologies and social practices. Rather than being an end in itself, The Metaweb should co-evolve with collective knowledge practices. Complex knowledge flows through IT-

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[2] Practical Procedures for the nursing Service – Extended Quality System

[3] Customer Relation Management

saturated channels embedded in shared social practices (Brown & Duguid, 2001). Deliberate focus on epistemic but yet materially embodied knowledge practices separates KP-Lab from many other more technologically driven projects. From here arises the KP-Lab slogan according to which technology enhances human intelligent activity through transformed social practices, and that is why there should be special focus on the interaction between these two.

The argument of KP-Lab is that social practice plays a key role in meaningful utilization of the Semantic web or the emerging Metaweb in personal and collective efforts of knowledge advancement. Both idea-driven approach on technology enhanced learning and situated-interaction approach (see chapter 2.1 above) lead to pretty narrow focus, respectively, either on conceptually clear ideas or shallow social communication without substantial depth. The KP-Lab emphasizes technologies and practices of using technologies that elicit systematic, long-term, and deliberate efforts of knowledge advancement. Such efforts cannot be merely based on pursuit of conceptual ideas because knowledge advancement and transformation of knowledge practices are parallel processes in nature.

From KP-Lab's perspective the emerging ideas of *pragmatic web* are very interesting. While the present syntactic web relies on HTML-based web pages, the semantic web capitalize on XML and RDF that allow much richer description of meaning (semantics) amenable for automated information processing. From *syntax* (logical forms and symbol structures) and *semantics* (meaning of symbols), the World Wide Web is moving toward *pragmatics* in terms of addressing the context of using symbols. It is focused on developing tools, practices, and theories concerning why and how people use knowledge rather than mere addressing logical forms or symbolic meaning of information. The emergence of the pragmatic web does not mean disappearance of the semantic one; many investigators assume that semantics will thrive as a function of pragmatics becoming more powerful.

In the context of the pragmatic web, information usage/activation rather than mere search or transmission is the central concern. This implies that users, their communities and networks, as well as their evolving epistemic practices become essential. The pragmatic web is oriented toward special needs of customers and user communities. Toward that end, centralized solutions are giving space for co-development of services based on customer-provider negotiations, radical customization of products, and cultivation of long-term customer relations. An increasingly high degree of customization characteristic of our time is indication of moving from mass customization toward co-configuration of products within networks of producers, and customers.

Users function within their own communities of interest, knowledge, and practice. They create their collective knowledge networks that guide and constrain further activity. The pragmatic web implies that the role of user communities in interpreting, sharing, applying, and creating knowledge becomes essential. Rather than simply assimilating already existing knowledge, user communities engage in active negotiation and interpretation of meaning grounded of their prevailing practices and epistemic objectives. Toward that end, such communities adapt ontologies for their evolving epistemic needs and purposes. A central aspect of pragmatic web is to put change, transformation, and creation of knowledge and associated practices into the centre. Pragmatic web implies the emergence of constellations of tools that constitute the environment of professional activity adapting to end-users needs and requirements.

KP-Lab is about facilitating the participants' self-directed and active role in working with knowledge. It follows that those instruments and practices are relevant that engage the users in externalizing and developing knowledge, stretch their abilities and working at the edge of their competence. Semantic web technologies that assist, for instance, in identifying conceptual connections between otherwise separated discourses, could support such practices. It is, however, the facilitation of the users own synthetic efforts rather than merely providing information that brings relevant learning processes about. An important aspect of pragmatics of using ICTs, is the process of instrumentation through which artifacts become instruments of human activity. Such developmental processes involve co-evolution between human activity and the mediated technologies.

The notion “Web 2.0” is nowadays often used to refer to what is maintained to be a second-generation approach to the World Wide Web which emphasize collaborative construction and sharing of content between users. There has been a lot of discussion about the actual content of this notion, or if it is really something new compared to the old ideas of the Web. It does not refer so much to any technical innovations but rather to novel ways of using the Internet. The term was taken into use by Tim O’Reilly and Dale Dougherty in a conference at the end of 2004 to describe new phenomena and web services like Flickr, del.icio.us, wikis, blogging, tagging, etc. emerging at that time forcefully to the use, and having similar, underlying characteristics with each other (O’Reilly 2005). It is hard to find any clear definition of the term ‘Web 2.0’ because it encompasses a variety of meanings with various emphases. O’Reilly defined (or gave an “attempt at a brief definition”) by writing that:

> *“Web 2.0 is the business revolution in the computer industry caused by the move to the internet as platform, and an attempt to understand the rules for success on that new platform. Chief among those rules is this: Build applications that harness network effects to get better the more people use them. (This is what I've elsewhere called "harnessing collective intelligence.")” (O’Reilly 2006)*

The basic idea behind Web 2.0 is that these new applications make better use of the unique features of the Internet, like networking effects and global audience to build services on that basis (“the web as a platform”). So, instead of being just information sources, these services build on effects produced by easy production and sharing of data, tags, links, networks etc. by the users themselves, and dynamic use of these services for the benefit of networks of users. Within the educational context, Web 2.0 refers mostly to the use of such tools as blogs, wikis, RSS feeds, and tag-based folksonomies to support learning activities.

The notion “Web 2.0” is interpreted a bit differently by various writers but it seems to have aspects both from the participation and knowledge-creation metaphors of learning (cf. Paavola & Hakkarainen 2005), emphasizing participatory aspects. The KP-Lab technology builds much on Web 2.0 for supporting knowledge creation and transforming knowledge practices.

2.4 Hybrid and personal working and learning environments

In close connection with the developments described above, there is also a trend towards more open and flexible tools, which can be used concertedly and be tailored to the user’s particular needs. Ubiquitous computing, Activity-Based Computing, or Personal Learning Environments are just a few buzzwords that mark this trend.

Existing collaborative learning and working environments that have been designed as more or less monolithic applications, designed around well-defined scenarios prescribing the users’ interaction with the system, seem to be more and more at odds with the evolving practices in workplaces and higher education. For example, Ballesteros (2006) states that new organizational structures, which come along with new working practices such as virtual or nomadic teamwork are hardly supported by existing working environments, which often do not provide ubiquitous access or allow for more flexible work processes combining synchronous and asynchronous communications. Similarly, Sharma and Fielder (2004) argued that current learning management systems, such as Blackboard or WebCT are aimed to anticipate and control the instructional environment and do not support open-ended and self-organized learning activities. In the same vein, some researchers have argued that closed systems bound to an educational institution are hardly capable and even hinder sustained and inter-contextual learning activities (cp. Wilson et al., 2006; Attwell, 2007).

In contrast with the dedicated but closed and rigid collaborative learning and working environments, knowledge workers and learners now have access to a plethora of lightweight applications that can be used for communication and collaboration purposes in a quite flexible manner. Even though most of these tools are still not interoperable in a technical sense, many users have already created their own "personal learning and working environments" including tools for synchronous communication such as ICQ and Skype, asynchronous collaboration, e.g. email and blogs, networking, e.g. Facebook, but also tools for document centred collaboration and project-based work such as Google docs and Zoho applications. These new learning and working environments not only make use of new tools but also have an impact on the working practices as well as distribution of power and control among the participants. While current working and learning environments are basically controlled by the company or educational institution where the user is enrolled in, personal learning and working environments are centred around the user. Even though these tools are still application centred and not yet activity-based in that they force the user to co-ordinate their use and shift data from one application to another (cp. Bardram, Bunde-Pedersen & Soegaard, 2006), they capitalize on the user who operates at the intersection of multiple contexts rather than the boundaries defined by the organisation. This trend is also backed up by recent studies on students' use of technology. For example, as a study on students experiences of technologies funded by Joint Information Systems Committee (JISC) (Conole et al., 2006) found that many students dislike the existing Learning Management Systems offered by the educational institution, while at the same time they make extensive use of various technologies for their study work. Instead of the prefabricated Learning Management System, they thereby rely on an individual combination of tools that suits their needs.

These technological trends have several important implications for the development and usage of KP-Environment. First of all, the already existing changes in tool usage among knowledge workers and students require a shift in a focus away from the application and its functionalities as such towards a deeper understanding of the users' tool "ecologies", i.e. the set of tools, resources and activity patterns at the users disposal, and the way new tools would fit these ecologies (cf. Barron 2006). With regard to collaborative working and learning environments this also requires understanding of the mechanisms that foster or hinder the collective appropriation of tools by groups and teams. From a technology design perspective there is a clear need for open and flexible architectures, which enable the user to use KP-Environment in concert with other tools and to adapt the tool to the groups' needs. Finally, as the use of a collaborative environment cannot be predicted but rather evolves in time, there is a need to foster, support and examine the development and exchange of new usage patterns of working groups and teams.

3 Trialogical approach as a vehicle to innovation

The purpose of KP-Lab is to develop knowledge practices prevailing in educational and professional communities toward trialogical direction by relying on technology-mediated instruments and practices. Such an approach based on design-based research is the foundation of KP-Lab rather than simple testing or implementation of the trialogical framework.

The KP-Lab project is not tied to certain pedagogical approaches to be developed further. The pedagogical studies and cases have aspects from various pedagogical approaches emphasizing collaborative and inquiry-like aspects on learning such as *knowledge building, project-based learning, learning by design, problem-based learning,* or *progressive inquiry learning.* Some approaches highlight conceptual aspects of inquiry and idea-centered work very much (especially knowledge-building approach, as well as progressive inquiry model[4]), other pedagogical approaches highlight pragmatically oriented project work (some versions of learning by design and project-based learning) without much support for idea-centered or epistemic work. Many learning models and environments focus on work within classroom and within specific courses, and do not support long-term work over or between courses, or aim at breaking boundaries between educational and professional institutions. KP-Lab system gives support for collaborative, knowledge creation processes, and is applicable for the purposes of various more specific pedagogical approaches. The trialogical approach aims at providing tools and methods for strengthening aspects of collaborative knowledge creation. Rather than attempting to replace any of these widely adopted pedagogical approaches, it can be used to give new focuses and aspects for development on existing pedagogical approaches and models. Pedagogical models to be developed in the KP-Lab has this kind of a logic of developing existing practices and models further in relation to various contextual needs. The aim of KP-Lab is to see connections between these various aspects of knowledge creation and to give support for flexible use of them.

In this chapter we present with examples of KP-Lab's studies how technology and knowledge practices are developed to support knowledge creation and trialogical approach within the project.

3.1 Bachelor thesis course UU

The following example describes work done mainly within the Working Knots 1 ("Shared Space and Common Tools), 3 ("Process Management and Analysis), and 5 ("Document Centered Collaboration"). The Bachelor thesis is a third-year Bachelor course that is offered at the Department of Educational Sciences of Utrecht University, the Netherlands. The main aim in this course is to support students to learn more about conducting research within the social sciences, and to develop skills in collaborative academic writing. Students are required to collaboratively plan, conduct and report on research projects related to topics that are relevant within the field of education, supported by a team of educational scientists. The final products are a collaboratively written research report in article format and a presentation of the report during a congress day. Knowledge creation and knowledge practices transformation is reflected at product as well as at process level, while the pedagogical set-up offers opportunities for the team members to work together on shared artifacts (research plan, preliminary research report, final research report, data collection instruments) which serve to feed into their main epistemic object: the research report. Team efforts are required when making decisions, conducting analysis, processing data, when reporting on the collected data or brainstorming for constructing the data collection instrument. Knowledge creation is enhanced by the fact that students write a research report collaboratively. Students are challenged to apply research knowledge from previous courses in a new and more complex

[4] Progressive inquiry model is a pedagogical model developed in the University of Helsinki with a related learning environment (Future Learning Environment / FLE) and it has been one important basis for the trialogical approach to learning.

research situation and this is an incentive for creation of new understanding of the researched issues and topics.

In general, the existent tools in the Bachelor thesis course (e.g. Blackboard) did not always prove suitable for offering proper support for collaborative scientific work and especially for collaborative writing. The needs for better technological support were identified at two levels: content-related scientific activities, such as collaborative writing and management of collaborative work. Thus, based on the perspective of knowledge creation and on needs for transforming students' practices in the course, KP environment should offer the following main affordances:

- Supporting groups to explicate their knowledge on research, research methodology and writing of scientific texts;
- Supporting planning of preparing, conducting and reporting the groups' empirical endeavours;
- Supporting groups in the collaborative writing of scientific texts;
- Supporting groups to semantically comment on their peers' contributions;

Technological support for knowledge creation and transformation of social practices in the Bachelor thesis course

To more specifically demonstrate the ways in which the knowledge creation processes and transformations in the Bachelor thesis course can be supported by means of KP-Lab technology, an outline of students' practices during the Bachelor thesis course is provided. This is a generic description of the chronology of these practices but the sequence and nature of the practices may vary depending on the topic and type of research each student group will be conducting.

1. *Project Initiation*

The project initiation takes place at the beginning of the course where students are familiarized with the aims of the course. Students form groups and select a research topic themselves. At this point in the course, students can plan to work on a research topic they have chosen based on their interests or the tutor can offer students with several possible research domains. Each research topic can be represented by a KP-environment inside the course space and students can register as members of the shared space they are interested in. The KP-environment community view offers support for students to get acquainted with the other group members and increases awareness of their peers' activities. Groups or individual students who could not make a choice can use the shared space as a mind mapping tool to generate ideas and make a selection of possible topics. Literature sources can be uploaded as content items.
The KP-environment supports students to sketch their ideas directly in their space in the content item view employing the note-editor tool. The students can compare the versions of the ideas they have produced, since they can be viewed in parallel. The note-editor also allows students to synchronously view notes while another student is editing it, supporting true collaborative writing. In addition, notes can be linked to other relevant material such as articles students have taken into consideration related to the subject that they are discussing about. Moreover, students are afforded to rise above previous ideas generated by other groups' members. This gives the chance to rise above the concrete level of brainstorming and commenting. Such discussions, within the context and in relations to their semantic relations, enable collaborative idea generation already from the start of their project. The idea for having such features in KP-Environment came from the end-users of previous field trials and were elaborated further in working knot work. Students reported that existing tools did not give them sufficient means for idea generating tasks. Thus, the note-editor tool (together with the

other functionalities) exemplifies how the KP-environment allows students to collaboratively create, organize and advance their work on knowledge artifacts which increase their sense of ownership and agency over the activities they perform.

2. Preparing the research

The second phase in conducting the project is that students are going to plan and design their research activities. This phase includes writing a research proposal and plan, working out the research problem and elaborating on the theoretical foundations of the research and the sketching of a research design. These artifacts represent the first deliverables of the project. All knowledge necessary for producing these artifacts is collected into the shared space in the form of notes and various kinds of documents (i.e. content items) that can be added, re-arranged, tagged and linked with each other.

In addition, in a previous course teachers indicated difficulties to keep track of groups' work progress, because they used various tools. The KP-environment allows the tutor(s) to review and monitor the student groups' shared spaces so that he/ she can provide feedback on the artifacts that were created by them. The feedback received from the tutor and from possible other student groups will be used by each team for adjusting and improving the provisional research plans.

3. Conducting the research

In this phase of the Bachelor thesis scenario student groups perform activities necessary for the execution of their research. A number of artifacts will be delivered by students, such as data collection instruments, methods for data analysis, data analyses and interpretation reports. For initiating data collection activities a research instrument is needed, therefore brainstorming between the members of the student groups is eminent. In addition, students have to think about the design of their research, the nature of the empirical data they require and the ways in which they are going to analyze this data. Moreover, students have to plan and elaborate on the nature of their empirical endeavors and the ways in which they are going to extract and analyze data.

The KP-environment supports these practices by means of functionalities offered by the GANTT chart in the process view and creation, tagging and commenting on content items. At this stage teams also must work on making a report plan and on writing a provisional research report. This means that they can make intensive use of the note editing tool. In addition, the KP-environment also affords the student group to write collaboratively in a Wiki. The Wiki can be created as content item in the content item view and offers the possibility to write in the same document. The progress and changes made to the document are visible to all group members.

4. Delivery

The delivery phase is dominated by the activities for writing the final research report. All the artifacts created by the student group served to feed into the final research report. The tools offered in the KP-environment enables students to view all the artifacts produced, how they related to each other, their semantics and their creation process. The research report is constantly collaboratively revised and commented upon in the student groups' shared space. The collaborative writing activities prevail in this project phase which means that the collaboration tools in the KP-environment such as the note editor, the Wiki, the commenting and semantic tagging tools are important during this period. The GANTT chart in the process view of the KP-environment provides an insight in the advancement of the groups collaborative object-related work. In the end, the report is published and tutors and other student groups give evaluative feedback on the artifacts produced and on the main object delivered.

3.2 Trialogical seminars

The following example describes how the trialogical approach has been used for developing knowledge practices and technology in *research seminars* in university education. This is work done mainly within the Working Knot 5 ("Document Centered Collaboration") but concerns also other WKs. The starting point for this motivating scenario is an actual, on-going research seminar of a research group in the KP-Lab consortium (The Research Centre for Networked Learning and Knowledge Building, University of Helsinki), and for that reason it has not been investigated but used only as a basis for testing and developing KP-Lab ideas and tools further. The scenario resembles the Bachelor Thesis case (see ch. 3.1) in many respects but emphasizes more the collaboration around texts and support for writing research papers.

Existing knowledge practices

The research seminar in question is a quite typical in Finnish universities. It is, however, a joint research seminar for the researchers of the research group as well as for undergraduate and postgraduate students collaborating with the research group. The seminar sessions are organized during the term usually every second week (two hours each). During a session, drafts of papers produced by each participant are analyzed and commented on. Papers are drafts for master theses, journal articles, research plans, or some other research papers. Papers are made mostly by one person. For the seminar session, papers are sent to all participants by an e-mail a couple of days before, and each participant is expected to mark some comments on it. During the seminar session, the paper is discussed. The presenter of a paper takes notes (by pencil or with a computer) and tries to apply them for the next version of the paper. Sometimes the discussion continues somewhat after the seminar session, or by e-mails. This is a permanent seminar of the research group and it continues yearly; many participants coming back to present a newer version of their research. Technology used by the seminar participants are mostly basic tools for producing research papers (text processing, figures/graphical tools, tools for producing statistical tables, etc.), making presentations, or sending e-mail, and paper and pen or a computer with a text processing programme (making notes), and a whiteboard (for drawing figures or structures). Virtual learning environments have not been used (before) because it is considered to take too much resources from the actual work compared to the added value of it.

There are then various knowledge practices which are learned within these seminars, like:

- Various ways of commenting (giving and taking comments into account)
- Producing and writing various kinds of research papers; reflecting and revising the structure and ways of presenting things in accordance with various needs and contexts
- Organizing and planning one's research
- Developing research questions and research ideas further
- Searching, collecting, and using various scientific materials and references
- Considering and focusing essential questions, problems, and points of development in one's papers

Trialogical aspects of research seminars

This kind of a research seminar already has many trialogical elements in it (which makes it apt for further development). It focuses the work on "authentic", or "real" research objects; for example, the papers produced and research questions dealt with are meant for later use and not just for educational purposes. It brings out long-term work with knowledge objects with many versions that are developed through iterative phases during several terms. It cross-fertilizes professional and educational practices; researchers of the research group (some of them doing their own doctoral theses) and students are commenting each others' work. This seminar (unlike otherwise quite similar seminars in the university) encompasses various actors and fields of studies and disciplines, still the research themes, methodological and theoretical questions and puzzles, problems of writing and structuring the papers are shared areas of interest for the participants.

The knowledge practices in question, however, emphasize more monological and dialogical than trialogical elements. Papers done by students are usually done by one person. Exceptions are collaboratively produced papers prepared by the researchers of the research group. Activities within the research seminar itself concentrate on having discussions on the papers, and giving comments, that is, on "dialogical" activities. There are strong institutional and cultural conventions which must be taken into account while developing these kinds of seminars further (for instance, master theses are mostly done by one person). There exist, however, many aspects where trialogical activities can be developed further.

Problems with existing knowledge practices

Very often participants do not have enough time to read the material before the session because they become available so late through e-mail. Commenting during the seminar session is not very focused, and after the session participants do not comment on papers much (except sometimes privately face-to-face or by email), and many promising ideas emerged during the session discussions are not saved or developed further. Similar research themes and problems (concerning, for example, ways of presenting typical sections in various kinds of papers) are discussed and reflected repeatedly in the seminars but this knowledge is not explicated or made available for the subsequent use. Papers presented or other research material related to them (web-links, articles, original data etc.) are not made systematically available for the subsequent use, and for the whole group of participants, or not organized systematically.

Transforming the practices towards more trialogical with KP-Environment

Many basic functionalities of the KP-Environment give support for more trialogical knowledge practices in the research seminar, like easy ways to group and link the material in the shared space, to visually see the general overview and conceptually analyze and link the connections between materials, and search different versions of the papers. There are various ways and special features which can support more improved trialogical practices in the research seminar (these planned practices have been one central input for the working knot work within WK5 concerning these research seminars):

- Semantic tagging for helping to group and find related materials and common areas of interest, or to analyze the structure of the papers produced, or existing research papers as exemplaries; tags can be created and edited by participants, or to be taken from ready-made vocabularies
- Flexible ways of defining "sub-projects" within the seminar (around various themes and issues) and re-defining the tasks and themes within the seminar
- Comments added attached directly to all kinds of content items in shared space (not as separate discussions or email messages), which allows the building upon previous comments and collecting the often occurring problem areas and issues in one place and sharing them between the participants; avoiding redundancy in the commenting of the papers

- Develop commenting practices towards more co-writing: instead of separate commenting, the commentator could add the suggestion and contribution directly to the text by re-writing it – joint rules and good versioning practices are important here
- Quick brainstorming with note editor and sketchpad, and production of ideas and simple figures that can be added anywhere in the shared space, as well as be co-edited, compared, printed, linked with other content items, etc. to support collaborative creation of scientific texts that the improved practices promote
- Forming vocabularies, ontologies, and "templates" of the often used concepts and structures that raise discussions about their meaning. These concepts could be elaborated further by using the semantic wiki, for adding and building on the previous descriptions of the "problematic concepts". The descriptions and relations of these negotiated concepts built up a vocabulary or an ontology that is embedded in the practices of collaborately writing in wiki, and in the organising the contents in shared space content view. The semantic structuring of written documents provides scaffolding for writing different kinds of papers and texts by enabling searching of the different parts of the documents, for examining previous productions of the users and by providing pre-structures for collaborative writing.
- Sharing commonly produced explanations, definitions etc. to be used in various texts
- Easy "publishing" of some of the wikipages or texts to be viewed outside the research seminar
- Outside experts could easily be added as members to participate in certain seminar sessions for commenting papers and developing ideas about the topic; or participating to the seminar by video conferencing
- Collaborating with other seminars that have similar research themes (by giving access to each others' shared spaces)

3.3 Collaborative Design Projects

The following example outlines how the trialogical approach could be used for developing knowledge practices and technologies to support knowledge creation in collaborative design projects. This example and the related research cases provide especially background for the work done in the working knots 1 ("Shared Space and Common Tools"), 2 ("Management and Analysis of Complex Knowledge Structures"), and 3 ("Process Management and Analysis").

Collaborative design projects are an integral part of many study programs in design and engineering education (cp. Dym et al., 2005) and quite naturally meet the design principles put forward by KP-Lab project. Nevertheless, re-conceptualizing design as a process of knowledge creation gives rise to a new perspective on collaborative design projects and provides direction for improving current pedagogical models and technologies. The motivating scenario presented below is based on a third-year project-based course in the study program Engineering for Computer-Based Learning at the University of Applied Sciences Upper Austria.

Existing knowledge practices

The Media Production Project in question is part of the standard curriculum and quite common to many study programs of universities of applied sciences and polytechnics. As such the course is a typical example of a capstone project in a design or engineering program focussed on the integrative use of knowledge and skills to solve a real-world problem. In this case the projects are carried out for an external client who defines the scope and purpose of the project (Usually the development of a web-based application). Furthermore, each project-team of 3-4 students is assigned a project coach, who meets the teams on a regular basis, attends the meetings with the customer, and provides input on questions of project management. In addition the teams can approach a small group of experts (faculty at the university) in case they have specific questions for example on programming, interface design or pedagogy. The projects usually last for an entire term period (4 month); some of them are continued by other teams in subsequent terms.

The students' work covers the entire project-lifecycle, ranging from problem definition and requirements analysis over conceptual design and implementation to evaluation and delivery (the project management is based on professional practices of project engineering in software development, (e.g. Mayr, 2005). The teams are asked to assign a project manager who functions as the contact person for the client and to develop a project plan to be affirmed by the client as well as the projects' coach.

The project work also entails the creation and maintenance of corresponding documents, including a final project report. To support document and project management the project teams typically use a variety of tools such as email and applications for file exchange but also web-based project management tools such as Zoho-Projects[5]. In addition, especially email and instant messaging tools are used for asynchronous and synchronous communication and coordination in between the face-to-face meetings.

Even though the way the projects are actually carried out varies based on the assignment as well as the project-teams' preferences and working styles, the following knowledge practices routinely appear to be relevant:

- Analyzing and understanding the client's problem and underlying needs
- Searching, collecting, using materials and references relevant to the project
- Create networking contacts and acquire needed expertise
- Creating, communicating and evaluating design options
- Planning, coordinating and monitoring project activities
- Documenting and communicating project achievements
- Evaluating (intermediate) outcomes of the project
- Reflecting on the work processes and deriving lessons learned for future projects

Trialogical aspects of collaborative design projects

Collaborative design projects actualize quite many trialogical elements. The design projects are focused on shared objects of activity in the form of concrete products or services aimed to address some "authentic" needs. The problems to be solved thereby are usually non-trivial, requiring the students to develop a good understanding of the problem space and produce viable solutions. Organized as teamwork, design projects require both individual as well collective efforts on knowledge advancement. Internal division of labor also requires continuous communication and collective learning. Being in contact with external clients as well as networking with various experts provides an important prerequisite for cross-fertilization across organizational boundaries. Furthermore, the ill-structured and often wicked nature of the design problems as well as the collaborative natures of the projects requires students to explicate, negotiate and adapt their ideas and concepts continuously. Towards this end teams work with different types of artifacts and representational forms such as narratives, sketches, checklists, glossaries, mock-ups, prototypes, program code and the like in order to develop new solutions through transformation and reflection.

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5 http://projects.zoho.com/

While collaborative design projects put a strong emphasis on trialogical elements, especially the collective work on a shared object of activity, they not necessarily lend themselves to knowledge creation. Limiting factors we currently see in collaborative design projects include among others a strong orientation of students towards finding a solution instead of more in depth analysis of the problems and needs at stake, a tendency to work in a rather linear fashion, as well as lack of systematic knowledge advancement. As a consequence, sustained and longer standing pursuit of knowledge advancement is limited.

Problems with existing knowledge practices

Even though collaborative design projects are usually highly appreciated by our students and most often result in considerable products or services, current practices also indicate shortcomings from a knowledge creation perspective. Quite often project teams are very eager to go into a "productive mode" spending only little efforts on understanding and scrutinizing the client's problem and underlying needs. Taking problems and requirements as objective rather than socially constructed entities often limits the team's understanding of the problem space. Similarly, many teams also do not manage to explore and evaluate alternative design options in a systematic fashion. Rather than weighing the pros and cons of different options they often strive for the first promising idea. These problems are aggravated by restrictive timelines and rigid as well as strictly linear program/project plans. While general process models might be useful to scaffold students' activity they can at the same time impair the knowledge creation process as they do not foresee to revisit prior stages of the process and are often only partially compatible with a more explorative approach to design. As a consequence project teams often stick to their original plans even if their understanding of the project's aim and the problem they are going to address changes fundamentally. In the same vein, many documents are primarily used for archiving results but not as mediating artifacts for the advancement of the team's ideas. Furthermore, the projects usually end with the delivery of the product to the client, providing little possibility for evaluating the products viability in the context it was designed for. Finally, by focusing on the product as the main outcome, lessons learned from misconceptions, failures, or poorly implemented ground-breaking ideas are hardly recognized nor appreciated, hence impairing both learning as well as knowledge creation.

Pedagogical and technological implications

Based on the preliminary analysis provided above, the following implications for new pedagogical and technological means for fostering knowledge creation in collaborative design projects can be derived:

Emphasizing design as knowledge creation: Even though skill and competency development are important outcomes of collaborative design projects, the systematic advancement of knowledge deserves a much more prominent role from a trialogical perspective. Towards this end students should be provided with frameworks and scaffolds that conceptualize design as knowledge creation and inquiry.

Integration of multiple feedback cycles: In order to support the incremental evaluation of design ideas, to probe the understanding of the problem space as well as to evaluate the viability of the product, multiple feedback cycles are required at various stages of the project. Towards this end students need to be able to comment, revise and link documents and artifacts in a meaningful way. Furthermore, mechanisms are needed that allow users to freeze and unfreeze documents when needed but also support awareness about the current status.

Supporting multiple foci and perspectives: As design problems are often ill-structured or wicked in nature, there is hardly a single correct conceptualization of the problem at stake. Furthermore, different roles or interests in the project usually come along with different perspectives and foci. Consequently, methods but also tools should allow depicting the multiplicity of foci and perspectives rather than forcing the team to stick to a single view and conceptualization.

Supporting flexible work processes: Despite the need for co-ordination and organization of project-activities, innovation oriented design processes can be predicted only to a certain extend. As a consequence project teams quite often have to adapt or even reorganize their plans while the project enfolds. Simultaneously, all partners need to be informed about and involved into the current state of affairs and the next steps foreseen.

Open and flexible tools: As design projects differ with regard to their objective and scope but also with their participants' skills and preferences it is hardly possible to foresee a collaborative working environment that suits all projects. Rather than striving for a single and all encompassing environment it seems more important the users can appropriate and extend the environment so that it meets their particular needs. Furthermore, in order to create and maintain networking contacts the environment should be open and easily customizable by its users. The openness and flexibility of tools also includes the possibility for an easy transition between individual and collective workspaces.

Appreciation of failures: Finally, conceptualizing design as a process of knowledge creation also implies that learning from failures might be as important as the creation of a working product. Hence, pedagogical methods and tools are needed that help project teams to understand and learn from their failures. Tools that allow to trace back the projects' history and the evolution of artifacts involved might be of great help here.

3.4 Medical Simulations

The example below describes how the trialogical approach has been used for developing knowledge practices and technology in a case of *simulation training* of medical teams. This example uses explicitly *design principles* of the trialogical approach (see "D3.1 Recommendations for Design Principles of Trialogical Technologies"). The starting point for this scenario was a course given through Karolinska Institutet at the Center for Education in Pediatric Simulators (CEPS) in Stockholm and has been used as a basis for developing KP-Lab ideas and tools. The scenario concerns mainly work within the Working Knot 7 ("Multimedia Annotation").

Existing knowledge practices

The simulation courses in question are intensive one-day courses concerning neonatal resuscitation starting with lectures and followed by simulations and debriefing and feedback sessions. The participants have different professional backgrounds and are typically pediatricians, anesthesiologists, obstetricians, nurses, and midwives. In the simulations, the course participants work in inter-professional teams to practice solving complex, authentic cases: the medical teams provide newborns (a small mannequin) arriving from the delivery room with intensive care. Immediately after each simulation, the teams are debriefed and video recordings of the simulations are analyzed together with the instructors. This procedure is iterated several times during the course.

The overall objective of the course is to achieve greater patient safety. Much emphasis is on learning the medical guidelines, resuscitation procedures, and equipment. But an objective is also to create better and more efficient medical teams and therefore the importance of wellfunctioning teams with good communication is strongly emphasized as a necessary condition for efficient medical teamwork. During debriefings immediately following each simulation, video recordings of the simulations are viewed and the teams analyze the teamwork with their instructors with the goal of creating more constructive teamwork with a clearer leadership.

Trialogical aspects of research seminars

Since these courses are so short and intense they are not the typical course addressed by the trialogical approach with its emphasis on long-term work with knowledge objects. Despite this, these courses already have some trialogical aspects: there is much focus on "authentic" cases and authentic work: the participants are supposed to act, talk, dress, and behave exactly as they would do normally at work and relate to the patient (the mannequin) as if it were a real patient. Everything - except for the patient - including the environment, equipment, treatments etc. are the same as normally work. Moreover, the course setup with its balancing between lectures, practical work in simulations, and, reflection during debriefings could be viewed as a case of transformation and reflection between various forms of knowledge and practices which is something emphasized by the trialogical approach.

Problems with the existing knowledge practices

To a large degree, the course participants lack a 'shared object' to develop knowledge-creation practices around when it comes to the teamwork and communication aspects in neonatal resuscitation. There is in many cases unawareness as to gaps in the teams' knowledge of efficient teamwork and communication which is detrimental for the participants' long-term work with analyzing and thereby improving the participants' medical teamwork: learners cannot develop over time unless they know that improvement is necessary and how the improvement may be made.

Transforming the practices towards more trialogical with KP-Environment

Several of the trialogical design principles were used as inspiration for developing and refining the courses and to handle some of the problems. Using video-recordings of the simulations is a powerful tool in the debriefings, but actually identifying critical teamwork incidents and analyzing such problems in team behavior is difficult and requires much practice. The instructors have experience and training of various models and concepts for describing medical teamwork and communication which they make use of in their observations and analyses. The challenge is not that the participants do not understand the observations or analyses per se, but that they may not realize the basis for the instructors' comments or actively engage in making similar observations of critical events and incidents.

In order for the participants to be able to improve, they must therefore become better at actively doing their own observations and analyses of the simulations. The trialogical approach on learning and its design principles inspired us to promote a number of aspects (rather than others) and we were particularly inspired by the knowledge-creation metaphor and its emphasis on engaging learners in novel knowledge-practices.

- Design principle 1 focuses on trialogical activities around shared objects which has inspired us to emphasize on the processes of analyzing teamwork and communication that is (or is not) displayed by the teams participating in simulations – and these practices were therefore especially supported in the courses.
- Design principle 2 concerns fostering long term processes of knowledge advancement. In this case, because of the lack of a coherent theoretical framework to fall back on, the course participants are unlikely to continue analyzing teamwork and communication

after the course. Tools and practices were therefore introduced in an attempt to foster such long term processes of knowledge-advancement: a conceptual model which highlights the most crucial concepts of the course was created and used as a basis by the participants for continuously assessing their performance after each simulation. The simplicity of the model and the continuous use of it throughout the course are hoped to contribute to that participants continue these practices also after the course.

- Design principle 3 emphasizes development through transformation and reflection between various forms of knowledge and practices: this principle inspired us in creating knowledge-practices which encourage participants to reflect on their performance as well as goals which encourage refinement of their performance in practice. This was done by letting course participants assess a number of aspects of teamwork and communication issues continuously by giving a score to their own as well as the entire teams' performance.
- Design principle 4 suggests supporting interaction between personal and social levels which inspired us to extend the debriefings by arranging first individual assessment and scoring which is later followed by a collaborative activity where the individual views are negotiated and merged.

The work with this case also resulted in developing ideas for creating a tool for letting course participants annotate videos of simulations and which would thereby further provide opportunities to develop the trialogical approach brought up above. Some of the main ideas behind the tool (SMAT) are on the one hand to provide opportunities to engage in making analyses and also to be able to compare one's analyses with others'.

In the design work the design principles were used as inspiration. But as design principles are abstractions they need to be interpreted to become meaningful in new contexts in which they are put into use. Design principles do not in themselves fully specify when and how they should be implemented in a new case. In this simulation context various design decisions needed to be made – many others are of course also conceivable. Nevertheless, the design principles were used as an inspiration for modifying and refining the practices in the educational setting and for creating novel tools.

To capture observations of some of the design choices, design patterns were developed describing the solutions and the problems that they solve. Design patterns are abstractions on a different level than the design principles and consist of three-part rules describing a solution, problem(s) solved by it, and the context(s) in which the solution is appropriate or works. Three design patterns describing key issues in the simulation case were suggested.

1. *Highlight the essentials* which describes the value of offering a simple model of the most important concepts to support learners overwhelmed by a new domain and which draws on organizing trialogical activities around shared objects and long-term processes.

2. *Analyze and score performance continuously* suggests a way of letting course participants (and not only instructors) take part in actively analyzing practices and draws on both transformation between forms of knowledge and long-term practices as well as organizing trialogical activities around shared objects.

3. *First individually, then with the group* proposes a way of allowing and combining individual and collaborative analyzing and draws on the personal/social levels principle.

While all patterns are based on design principles, there is not a simple 1:1 mapping between the design principles and the design patterns. The patterns can be based on one or several principles. And several different patterns can draw on the same design principle but suggest different solutions resolving different problems which are usable in different contexts. Design patterns are generalizations from solving specific problems in specific contexts and provide solutions usable in similar cases.

3.5 Change Laboratory

The following example concerning Change Laboratory describes work done mainly within the Working Knot 6 ("Change Laboratory") but concerns also especially Working Knot 1 ("Shared Space and Common Tools"), and Working Knot 7 ("Multimedia Annotation"). Change Laboratory (CL) is an established method for inducing and promoting organizational learning. It provides means for analysis of working practices and the organizational learning process. Focus of KP-Lab is to design technology that features functionalities towards these aims and that can be used in Change Laboratory of other settings for organizational learning.

Existing knowledge practices

In contrast to most change management methods where the goal is to implement a predetermined solution to an acute problem, CL adopts an explorative approach to form a new working concept for the organization. It is an explorative bottom-up process to identify historically formed contradictions within the organizations working practices, to analyze them and to find new innovative solutions. From organizational learning point of view, CL has two goals. First is the formation and piloting of new working practices on the basis of reflective analysis done in the process. Second is the adoption of CL as a continuous means for long-term development within the organization.

Change Laboratory consists of iterative phases starting with the gathering of data about the working practices following with analysis of practices and the organizational learning process. Practices are analyzed as historically formed activity systems in order to decompose the observed problems in the current practice as contradictions within certain elements of the working practice. Further, analysis of organizational learning process is done to support the planning and implementation of new practices. Piloting and dissemination of the new working practices is followed and a possible new iteration of CL process is started.

Trialogical aspects of Change Laboratory

CL and it's background theories of Activity Theory and Expansive Learning are closely related to Trialogical learning. Therefore, many trialogical features can be identified in CL method.

Development through transformation and reflection. Main goal of CL is organizational development through reflection and deliberate transformation of working practices.

Long-term working with objects. Further, CL is a long-term process where analysis and implementation of new practices takes several months and, if adopted as a continuous method within the organization, supports sustained work with knowledge objects for considerably longer periods.

Cross-fertilization. Another central aspect in CL is that it requires the participation of all practitioners representing different practices in the organization (e.g. production, designers, management, sales etc.). This provides a forum for cross-fertilization across the different practices. *Interactions between personal and social levels of activity.* Collaborative analysis in CL also functions as a forum for representing different personal views, and acts as a link between personal and social level of shared new working practices.

Problems with the existing knowledge practices

Current changes in the organizational structures, such as networked and distributed work set a challenge for organizational learning. Organizational working practices revolve more and more around ICT and developmental methods need to adapt. This calls for methods and technology that support reflection and transformation of practices within global organizational networks. Current Knowledge Management software or Learning Environments do not offer means for supporting reflection and sustained development of practices. Software such as Moodle has been piloted but experiences suggest that it does not provide sufficient support for bottom-up work and reflection.

Transforming the practices towards more trialogical with KP-Environment

Basic functionalities of the KP-Environment support adapting the CL method for networked organizations. Visual grouping and linking of material in the shared space can be used to visually see the general overview and conceptually analyze and link the connections between materials. Providing flexible support for managing the process will be integrated with the Change Laboratory Tool (CLT) plug-in for functionalities that specifically support reflection and transformation of practices.

- CL-Plugin is used for visually analyse and categorize the content of produced material, analysis is supported with specific functionalities, such as possibility to create semantically linked four-fields and models on the basis of the material produced
- Multimedia annotation is used to collaborative analyse working practices and to annotate material for presentation in CLT
- Several parallel analyses can be made to support different views. Further, these results can be discussed and collaboratively merged to a shared analysis
- Semantic tagging is used in shared space and CLT for helping to group and find related materials and to analyze the structure of the materials produced; tags can be created and edited by participants, or to be taken from ready-made CL-specific vocabularies
- Flexible ways of defining “sub-projects” or smaller iterations within a CL process
- Comments added attached directly to all kinds of content items in shared space (not as separate discussions or email messages), which allows the building upon previous comments and collecting the often occurring problem areas and issues in one place and sharing them between the participants
- Easy “publishing” of some of the wikipages or texts for piloting and dissemination of new practices
- Collaborating with other development processes with overlapping organizational goals (by giving access to each others’ shared spaces)

4 Theory (– practices) - technology link in the KP-Lab: From Design principles to Driving objectives

KP-Lab technology being developed will emerge through co-design processes with several cycles to integrate theoretical perspectives, research-based pedagogical ideas, and technological development. The KP-Lab learning system is modular and extensible rather than monolithic and fixed in nature. A central weakness of traditional approaches in technology-enhanced learning was to design monolithic systems with pre-determined structures and functions that were taken to user communities for implementation (Engeström, in press). In order to avoid such limitation, KP-Lab technologies have been developed in a close interaction between carrying of empirical case studies of innovative knowledge practices (in educational and professional communities) and developing, theoretically, the trialogical approach. Many investigations carried out are *design experiments* (Brown 1992; Collins, 1999) involving cycles of a) developing tools and application, b) piloting these technologies in educational and professional knowledge practices, and c) collecting empirical data that guide further technological and theoretical development. Other investigations adds understanding from truly longitudinal studies, exploring how knowledge creation and tool-mediated production processes plays out over time, as only seeds of triadic structures and practice transformation highlighted in the metaphor of trialogical learning.

Knowledge-practice driven co-design characterizes KP-Lab's pursuit of technology development. Innovative knowledge practices are likely to emerge through co-design between the KP-Lab technologies and the practices in question. The tools evolve to support innovative ways of working with knowledge that are in themselves in a process of transforming. Toward that end, the project focuses on developing "co-configurational" technologies (Victor & Boynton, 1998; Engeström, 2005) that can be customized, tailored, and extended to the heterogeneous needs of user communities. The project is committed to open-source, so that the main part of tools and applications being developed will be available to external research and development in open-source terms. The co-configurational nature of KP-Lab technology is a deliberate design choice. The trialogical approach is a kind of metatheory of innovative knowledge practices; it gives direction for transforming existing pedagogical practices in various contexts towards more sustained, collaborative knowledge creation mediated by technology.

KP-Lab has gone through several phases of the co-design where various intermediate abstractions and also ways of instantiating theoretical ideas have been used to guide the co-design process (See "D3.2 A comprehensive research strategy" for a more detailed description). At the start of the project pedagogical scenarios and Design Principles of trialogical learning were produced. *Design principles* were aimed at defining general characteristics of trialogical learning for the KP-Lab courses and knowledge practices. They are based on the theoretical accounts on the knowledge-creation metaphor of learning and on previous experiences on conducting research and technology development on collaborative technology. Design principles of trialogical approach highlight that collaborative activities are organized around developing shared object (collaborative knowledge creation as well as transformation of knowledge practices) in sustained processes and with flexible tools for supporting these processes (See "D3.1 Recommendations for Design Principles of Trialogical Technologies").

The design principles have, however, not been enough for directing and giving scope to the technical development in the project. In order to do that, *Driving objectives* for technology development have been defined. Driving objectives are produced on the basis of a long list of High level requirements and abstracting these requirements to broader groups for giving overall direction to technology development. High level requirements were collected and defined on the basis of research cases and studies for explicating desirable functionalities of the KP-Lab technology from the end-users' point of view. Driving objectives were also connected to *User tasks* which provide an overall view of core activities that are supported by the KP-Lab technology (see the whole table of User tasks, Driving objectives, High level requirements, with expected benefits of the technology in the DoW3.1, Table 4 in Chapter 6).

How Driving Objectives are then connected to the knowledge creation approach and trialogical approach developed in the KP-Lab project? Driving objectives are basically defined starting from requirements within KP-Lab studies, which are planned to implement the design principles of the trialogical learning.

Fourteen Driving objectives (DOs) under five User tasks (UTs) have been defined in the DoW3.1:

UT1. Organising shared objects and collaborative tools

- **DO1.** Provide an *environment* where users can work on shared objects in one place,
- **DO2.** Provide flexible tools for working on shared objects,
- **DO3.** Supporting the collaborative development and re-use of shared objects and structures through iterative and incremental cycles,
- **DO4.** Users can semantically and/or visually describe objects and their relations,
- **DO5.** Enable users to contribute to shared-work in the shared environment (shared space application) from situated but distant places,

UT2. Modifying the content of the shared objects collaboratively (allowing also individual and personalised work)

- **DO6.** Provide users with possibilities to develop and integrate their own visual modelling languages, ontologies and vocabularies,
- **DO7.** Provide user with the possibility to create, use, comment, etc. various kinds of text-based documents collaboratively in a sustained manner,

UT3. Management and Organisation of Collaborative Work Processes

- **DO8.** Enable users to plan and manage tasks of the knowledge creation processes,
- **DO9.** Users are provided with history on content development and work process advancement,

UT4. Creating contacts, communicating and networking

- **DO10.** Provide user with possibility to be in contact with people occupying different roles and share and comment objects across the fields,
- **DO11.** Provide user with networking possibilities with clients and other communities, maintaining sustained contacts with potential clients and community members,
- **DO12.** Provide users with virtual meeting facilities,

UT5. Investigation and development of knowledge practices

- **DO13.** Provide users with means to capture, reflect, discuss and model their activity and to develop new models of working,
- **DO14.** Provides users with an opportunity to conduct long-standing activity sampling studies in pedagogical settings and working environments

The User tasks abstracted can be seen in relation to various types of mediation distinguished by Pierre Rabardel and his colleagues (Beguin & Rabardel, 2000), i.e., *epistemic mediation* related to creating and working with epistemic artifacts, *pragmatic mediation* related to organizing knowledge-creation projects and processes, *collaborative mediation* concerning building and managing networked communities required for carrying out knowledge-advancement efforts, and *reflective mediation* in terms of making visible, reflecting on, and transforming knowledge practices.

The Shared Space Application is actually a space of knowledge spaces in which users can pursue parallel trialogical projects. The first User task ("Organizing shared objects and collaborative tools") and related Driving objectives provide basic prerequisites for collaborative knowledge creation and trialogical processes. The second User task ("Modifying the content of the shared objects collaboratively") highlights *epistemic mediation* by providing tools for working both with text-based documents (Document-centered collaboration tools), and for visual modeling languages, ontologies and vocabularies (Visual modeling tools). Tailored View to be developed allows visual organization of particular selected knowledge artifacts for more intense and focused investigation.

The third User task ("Management and Organisation of Collaborative Work Processes") contains tools of process management and analysis, (such as interactive to-do list, calendar, and process view) and foster *pragmatic mediation* needed for pursuing well-organized and successful projects. The fourth User task ("Creating contacts, communicating and networking") gives support for *collaborative mediation* elicited in having various networking and community building tools that allow the users to interact (Chat) take part in joint meetings across boundaries (MAP-it meeting and conferencing tool) and follow the other users' activities through the corners of their eyes (Social awareness tools). And finally, the fifth User task ("Investigation and development of knowledge practices") supports *reflective mediation* by developing and exploring tools for reflection of interactive processes and in managing creation of knowledge and organizational transformations. History awareness tools, virtual Change-laboratory tools (modeling activity systems, reflecting of mirror material, engaging expansive learning processes) as well as semantic multi-media annotation tools (annotating video and audios in sophisticated way) are relevant in this regard.

To put it shortly, KP-Environment provides tools for collaborative knowledge creation around knowledge objects (UT2), and for knowledge transformations (UT5), as well as tools for process management (UT3) and participation and networking (UT4). In the background of the all end-user applications are basic functionalities (UT1), with semantic knowledge middleware (SKMW) and other applications of semantic web that provide a very sophisticated technical infrastructure for supporting object-oriented activities involved in various trialogical learning processes.

5 Essential characteristics of KP-Environment

In this chapter the tools of KP-environment are discussed by focusing on central characteristics of the environment that are in the current state of the environment but also those characteristics that are under development at the moment. Many of these features of KP-Environment are not genuinely new as such but when put together they provide a unique way of supporting collaborative knowledge creation and the trialogical approach to learning.

5.1 Multimediation / multifunctionality

The KP-Environment is designed to provide multi-mediation by providing a shared knowledge space that facilitates different modes of mediation, that is, it is designed to support both *epistemic mediation* (work with epistemic artefacts), *pragmatic mediation* (organizing knowledge-creation processes), *collaborative mediation* (managing networked relations), and *reflective mediation* (reflecting knowledge practices) (see above chapter 4). Not all types of mediation need to be present in all tools and functionalities but KP-Environment supports flexible use and combinations of various types of mediation within one workspace. Conventional learning environments appear to provide only restricted mediation (e.g., epistemic mediation through supporting threaded discussions, like in FLE3, or knowledge-advancement in terms of pursuing relatively simple knowledge artifacts, like in Knowledge Forum). Another limitation of these learning environments is the inflexible and limited nature of mediation provided that is pre-determined by structures and functions of the learning environment in question.

Report on industry-led FP7 consultations "New Collaborative Working Environments (CWE) 2020" presents in the summary that "*the characteristic of current CE is that they are not integrated and interoperational, that they support mainly point to point and not multipoint conferencing, that they are defined mainly for structured environment providing static artefacts and that they do not support the unstructured orchestration of activities using collaboration aware objects. Finally they focus primarily on peer communication and not flexible team interaction*."

KP-Environment with its tools can be seen as an attempt to overcome exactly these limitations. One advantage of KP-environment is the generality of tools supporting various practices, domains and purposes. This will be achieved via integrated and configurable tools providing multiple functionalities that are tightly and semantically integrated to serve the users in the best possible way by supporting flexible team interaction. Multipoint conferencing capabilities will be included by other tools developed in KP-Lab. Strong semantic integration of shared objects and processes in our Knowledge Practices Environment leads to effective support of flexible orchestration of activities within the knowledge creation processes.

The support for knowledge practices concretises in KP-Environment for example, by displaying the processes in two ways, i.e., within the content view and in the process view. In the content view the emphasis is on the relations of the tasks to other tasks and to the content items, and in the spatial organisation of the tasks and content items. Furthermore, the processes can be commented, discussed about, tagged, filtered by the semantic descriptions of the tasks, etc., in similar manner as the content items. This enables the users to have a holistic view into their knowledge process without separating it from the content. Further management of knowledge practices is enabled by the use of tailored views, into which the users can transfer selected parts of the process (tasks and content items, notes, links, etc.) to work in focused manner within a particular theme or phase of the process. The tailored view provides another visual manner to support organisation of the knowledge practices by enabling users to organise and arrange the tasks and content according to an image or a structure that presents the different parts or “themes” of the process (e.g. certain phases or tasks in a pedagogical approach used). The same tasks can then be viewed in process view in the form of GANTT chart (when a chronological perspective is needed). The awareness features provide support for the actual organisation and management of the collaborative practices among the participants and a possibility to reflect on the on-going process(es). This aspect will be effectively supported in the later releases of the KP-Environment by: 1) Awareness tools, which enables the users to keep track of the process progress and perceive what is going on with the shared objects, see what the others are up to, but also acquire off-line information by being notified about those events in the on-going process(es) that the users have selected to be in their interests. 2) Analysis tools that enable to look on the process from a historical perspective. Another possibility is to export the available data from knowledge repository, covering all changes made in the selected part of the KP-Environment at a specified period of time (Data export tool) and use external data analysis tools to evaluate the data. Third possibility will be to use Knowledge evolution analysis, which builds on data about all users' actions in the shared space. These actions are continuously logged. It includes, for example, identification of typical and/or interesting (deviating) patterns in the past and on-going knowledge processes. KP-environment provides thus in one space various ways to structure, discuss, annotate, re-organise, reflect, develop or transform the knowledge practices still keeping them contextualised and tied with the knowledge artefacts produced.

5.2 Flexible support for end-user appropriation

An essential requirement to support the trialogical approach is the flexibility of the tools. As mentioned above the tools should adapt to various practices, be suitable and utile to different domains of knowledge, support reflection, collaboration and smooth sifting between perspectives and representation of knowledge. From the above description it becomes clear that the collaboration enabled and supported by KP-Environment, synchronous and asynchronous use, with appropriate awareness features (see more on DoW 3.1 Chapter overview of the KP-Lab tools), different perspectives and representations of knowledge are essential (for trialogical approach). The flexibility can be seen to occur in different levels.

Firstly, as most of the tools of KP-environment are general in nature it allows user to use them in different domains, for different purposes and in different manners. The environment also allows the users to gradually take into use the different features and configure the tools to fit the needs of the use domain and purpose of use. The gradual appropriation of the KP-environment respecting the users' zone of proximal development is further enhanced by the adaptive and contextualised help system. The help material is organized according to the system user interface ontology. This is a model that captures the user interface semantics of the applications. As the Help interface is context sensitive it is embedded in the users' actions and therefore provides embodied means to structure the user's experience, and action (see more on DoW 3.1 Chapter overview of the KP-Lab tools). The KP-environment also provides means for the users to assign the access rights and roles to the members of their groups, communities, etc. This is highly important feature, since often the conventional teacher/student roles are felt to be restricting (not to mention that the trialogical approach underlines the boundary crossing across domains, interdisciplinary teams and groups). The collaborative web hosted environments offer this kind of user defined access rights and roles control as a default, which can be seen as one of the reasons why users are increasingly voting for the use of the collaborative web hosted environments (such as Google applications, Wikispaces, etc.) and not the existing learning environments (such as Moodle, Blackboard, etc.).

Secondly, KP-environment is also an open system, i.e., it will allow the users to integrate KP-environments' tools into other tools such as IGoogle. This is valuable because the emerging trend is that users want to select their own tools, have their own combinations of tools or combine new tools with the ones they already have invested a lot of effort and which conform to their ecology of use to built their own combinations, to take advantage of the already built network contacts, or using other resources the users have attached to the third party tools. The openness provides better suitability to different knowledge domains and allows smooth development of existing practices towards trialogical ones. As such the KP-environment will be in the cutting edge in its openness and competes well with the emerging use of free and open source applications from Web.

Thirdly, the development of KP-environment is directed towards increased end-users development, meaning that with the openness of the system, it allows the users to develop their own gadgets and widgets (if they wish to do so and are interested on developing tools) and mash up tools just as this particular group of users has become accustomed to in the web-hosted environments. This openness is enabled by use the Google Open Social API. The awareness based on logs of events that will be implemented as independent tool may be used with any other third party type of collaborative tools (this will be provided by means of an architecture based on web services and own repository) that need to log into the events, make subscriptions, get notifications and/or perform more sophisticated analyses on logged events. The data exported from knowledge repository (data export tool) and from the awareness repository can be used in external analyzes tools for further research. G2CR (Gateways to

Content Repository, developed in WP4) provides unified access to external repositories of content which can be exploited within the KP-environment platform, KR (Knowledge Repository) and G2CR, which are based on the open specifications and standards (RQL/RUL - RDF Query Language/RDF Update Language), JSR170 (Java Specification Request). The integrated semantic and free term search is provided via the service, which can potentially be used also in other external tools, as well as by the separated User Interface of the tools from actual application logic. Therefore, these services can even be used by third party applications, not developed within KP-Lab, thus broadening the integration, suitability and ecology potential of KP-environment.

5.3 Visual organization / (Multi)contextual presentation / Embedded actions

One of the main and most distinctive features of KP-environment is the means for visualising and flexibly restructuring processes, relations, content and tasks in the working area. KP-environment is not based on folder structures or only hierarchical presentation of the content; it does not hide the content into folders, which detaches the content items from their relations. The folder and hierarchical presentation manner reflects the old manner of understanding information as pieces or detached parts of whole while KP-environment bases on a visualisation (or visual re-organizing) metaphor allows users to see all the content and tasks and keep the relations visible. The visual organisation of the content and tasks is supported by various mechanisms such as spatial arrangement of items, the filtering of items based on metadata and tags, the creation of user defined view ("tailored views") as well as the creation of visual models on top of existing views.

The visualisation is extended also into presentation of the process to allow the users to shift perspective into the work and content they are working with. The process view enables users to concentrate on the chronological aspects of their work still being attached to the whole. KP-environment supports different perspectives into the work at hand and all of them are presented in visual manner without loosing the holistic insight into the semantics and relations between parts of the process and its content. Therefore, as the trialogical approach emphasises, KP-environment enables the users to transfer between various forms of representing knowledge – not just parts of information. The visual metaphor also places emphasis on the object-orientedness of trialogical approach as it focuses on the "material" part of the conceptualisation and embeds these artefacts into the activities, in other words the conceptualisation are mediated by the shared objects of the collaborative work.

The activities (and execution manners of operations) of the users have to be contextualised and embedded in the shared objects, as habits/practices (habit formation) are essential for meaning making and provide the basis for problem solving and learning. This is also emphasised by the idea that practices evolve along the use of the tools (see ch. 2.4). For example, the KP-environment supports contextualisation by providing users with the contextual chat, Note-editor and sketchpad for brainstorming or commenting possibilities of the shared objects and tasks directly in the space. (see Trialogical seminars (ch 3.2 above) for the use of Note-editor, Sketchpad and commenting). This object-oriented aspect places KP-environment beyond the mere situated discussion forums, threaded notes or argumentative discussion support, which concentrate only on the dialogical aspect of learning, and so loosing the wholeness, i.e., the need to have individual contributions into the collaborative work that is organised around shared objects embedded and embodied in one shared space. The KP-environment also supports the embodiment in the operational level by having the user interface logic following the "in-place-editing" metaphor.

The need for embedded and embodied actions and conceptualisations has also been underlined by recent neuroscientific research as well as interdisciplinary approach into embodiment in consciousness and cognition (Damasio, 1994, 1999; Varela and Depraz, 2000; Clark, 1997; Gallagher, 2003; see also Pata, 2008, about embodiment and ecology), pointing out that embodiment and emotions play a central role in structuring experience, reflections, problem solving, and learning, through pre-reflective kinaesthetic-proprioceptive experiences. It is important to notice that the design of the main metaphor underlying the KP-environment is based on the recent studies on various disciplines, trialogical approach on learning being the main source.

5.4 Pragmatic use of semantic features

Another truly innovative aspect that goes beyond current learning environments is the use of metadata and semantic features (e.g. semantic information can be reused across tools). Many of the learning environments and hosted web collaboration environments provide means for tagging. However, these tags do not hold semantics as such. For example, if the user forgets the meaning of the tag there does not exist any means to find out what meaning the tag had. The tags / concepts that users give to the content are not implemented to the underlying technology in a way that it would allow search through the semantics or relation of the tag to other tags, neither are these transferable to other tools (see trialogical seminar (ch. 3.2) for an example of using tags and searching by using tags and other metadata). The advantage of KP-environment in relation to the other collaborative environments is that objects' description consists of two parts: 1) metadata (semantic information) that is saved into knowledge repository (semantic repository based on ontologies - SWKM) and 2) the content that is saved into content repository based on Java technologies and access to it is based on G2CR (gateways to content repositories). This is an important point since, the metadata is a crucial mean to achieve real semantic integration, i.e. the different tools are not only "co-located" in a single environment but also share the same semantics, e.g. all tools "know" what a task or content item is, hence this information can be reused across tools. It enables to work with one shared object (artefact) in different contexts and different processes. Furthermore, in KP-environment the tags can be edited using the tag-vocabulary editor (see trialogical seminar for an example), collaborative semantic modelling editor. In addition, the semantic wiki functionalities provide highly innovative functionalities to the user. These functionalities are building on the KP-Lab SWKM. Despite their different functionalities, all the three tools have in common that they allow the users to explicate and work with their own conceptual models while being engaged in a knowledge creation activity. In this sense these tools allow the users to create their own cognitive and conceptual tools and instruments based on the potentialities of the semantic web. These tools do not simply replicate existing semantic web applications but provide a kind of middle ground between those semantically poor but widely used tools such as those used for free-text annotation, diagramming or collaborative authoring, and those semantically rich but overly complicated tools mainly developed for (semi-) professional knowledge-engineers such as Protegé or OntoEdit. Towards this end, these tools aim to overcome some of the main obstacles, which hinder the broader adoption of semantic web technologies. Only recently Van Kleek et al. (2008) have argued that especially the following problems prevent the wider adoption of current semantic web applications: (1) A high knowledge barrier, i.e. most of the tools are designed for professional knowledge engineers rather than the common knowledge worker or student; (2) Ontological considerations have been emphasised while the work with instances (usually the main concern of the knowledge worker) has largely been ignored; and (3) The need for explicit and complete specification of ontologies has been overemphasized. Similar arguments have also been made by other author, for example McCool (2005) or Schoop, de Moor and Dietz (2006). Hence, what makes the tag-vocabulary editor, the collaborative semantic modelling editor or the semantic wiki interesting from a KP-Lab perspective is that they do not outsource intelligent reasoning to the tool but that they allow the user to create his/her own conceptual toolkit.

The semantic features of KP-environment allow the user to filter, constrain and search their content and task items according to the semantics – the meaning – of the tags (and other metadata associated to particular objects of activity) using the faceted search, which also follows the visual metaphor described above. These characteristics come important when users are engaged in sustained collaborative work and have a lot of resources in use (e.g. articles, papers, etc.) from variety of disciplines, i.e., it is a commonly known problem of having to copy the same file into many folders, thus, loosing the semantic relations of them. Grouping, filtering, clustering and classification are essential needs for focusing on different themes of the research/work. There are many semantic searches emerging but none of them so far have succeeded in the visualisation and in the integration of them into the actual work (see trialogical seminar (ch. 3.2)). In future the tagging, filtering, grouping and searching activities will be further enhanced by the text mining services that provide suggestions of tags according to the meaning of the text as well as the service can provide preliminary grouping of the content to provide support for the users to start their own grouping and relational organising of the content. This is also something that the learning environments do not provide in this extend neither do they provide support for the users appropriation within the use. The semantic search, in addition to be visual, provides users with different kind of search strategies to fit the different needs and conventions of searching, i.e., when the user knows what s/he is searching for s/he can explicitly specify constraints for search. KP-Lab support both semantic queries specified by the user with faceted interface and free text queries specified as the logical combination of the keywords/phrases. Or if the user does not know exactly what s/he is searching for the user can use the navigation controls to browse/discover the content and find interesting related knowledge. Both of the above search strategies can also be combined, i.e., the user can start with the free term search query, and then additionally specify facet constraints like classification ontology concepts or semantic meta-data properties. In addition, the results can be organised in many different ways to form the comprehensive view of the relevant content and tasks. For example, the text mining services can be used to cluster objects in the result according to the semantic tagging. Results can be then presented to the user as the map of the clusters annotated with the semantic tagging and user can continue in the search with the browsing strategy. The displaying of the results conform with the visual metaphor of the KP-environment bringing consistency into all usage and as such fitting better into the users' zone of proximal development.

Conclusions

Above is described how KP-Environment provides rich support for various kinds of knowledge creation and knowledge transformation processes. The document presents central theoretical backgrounds for understanding the focuses of KP-Environment, and needs arising from KP-Lab research cases, as well as central features of the environment. The trialogical knowledge creation approach emphasizes both

- collaborative work with knowledge artefacts ("epistemic mediation"), and
- transformation of knowledge practices ("reflective mediation")

According to the idea of multimediation (see ch. 5.1), KP-Environment provides flexible support for knowledge creation processes, and integrates these aspects although in some contexts collaborative work with knowledge artefacts is more prominent (see above ch. 3.1, 3.2, and 3.3) and in some other contexts transformation of knowledge practices (see above ch. 3.4, and 3.5). Semantic technology supports knowledge creation processes in general by providing support for integrated use of semantic functionalities (like tagging, filtering, grouping, searching), and also by giving users opportunities to create flexibly their own conceptual models and conceptualizations. At the next phase of the project the use of semantic technology to monitor and support the evolution of (transformation of) knowledge practices over time is emphasized (see D3.2 “A comprehensive research strategy”). This means specification of pedagogical approaches into semantic models. The combination of functionalities within KP-Environment, their openness, smooth integration and easy availability makes the system amenable for promoting learners and workers in various settings to change their practices of working and learning in more advanced and collaborative ways. The research studies of the use of KP-Lab technology and pedagogical approaches will give further means to describe and define the principal elements in technology which support trialogical knowledge-creation practices.

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