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KP-LAB

Knowledge Practices Laboratory

Integrated Project

Information Society Technologies

D 8.2 Summary of research on KP-Lab courses and technology in education. Research designs, pedagogical models, use of tools, and results of the first KP-Lab studies

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Executive summary

The present deliverable provides an integrative overview of the results obtained from the first studies on knowledge practices in higher education courses. This deliverable reports on the results obtained from courses that were designed by educators in the field as well as on those courses that resulted from the implementation of the scenarios reported in D8.1. The present deliverable can thus be viewed as the logical continuation of D8.1, in that it serves as an evaluation of the extent to which the implementation of the scenarios proved to support knowledge practices in education. The research reported in this document served co-design in the KP-Lab project, since it seeks to gain more insight into and to advance the conceptual premises of the perspective of trialogical approach on education. In addition, results obtained from these cases serve to contribute to the design of new pedagogical methods and technological tools for the KP-Lab project.

The seventeen research cases reported in this deliverable show a range in the knowledge practices they emphasize and in the nature of the activities students, their teachers, professionals and other stakeholders are engaged in. The priority areas that were described in the Description of Work 2.1 for months 13–30 were employed as a taxonomy to converge these cases to result in a coordinated research direction and to inform the theoretical analysis of knowledge practices.

The priority areas that proved to be relevant for the research cases reported in this deliverable are: Managing collaborative design in higher education, Retooling boundary crossing between education and work, Knotworking in complex learning environments, Ontology-based collaborative modeling, Developing technology-enhanced practices for scientific writing, Contextual investigation of knowledge practices in personal use of students. These priority areas attempt to coherently depict the various pedagogical contexts that show to actualize the KP-Lab design principles in particular ways and set the stage for determining tailored research questions and corresponding research strategies, methodologies and technologies.

For each priority area, the KP-Lab design principles were used as tools to select and to describe those results of the cases within that priority area that demonstrated the nature of and conditions fostering knowledge practices in education. Although technology played a central role in supporting students' knowledge practices in most cases, the results report the practices using existing technology because particular KP-Lab tools were not yet available.

Based on the results of the research cases, challenges and implications are derived regarding the conditions that serve to foster the transformation of knowledge practices. In addition, high-level user requirements for appropriate technological support for the investigated knowledge practices are suggested. Finally, considerations concerning the further advancement of our conceptualizations of the priority areas and KP-Lab design principles are provided.

Contents

1 Introduction

The present deliverable has been prepared from within the framework of the Knowledge Practices Lab (KP-Lab) project which seeks to understand learning in terms of how people create knowledge and transform their practices by developing and advancing common objects of activity. The term trialogical learning is employed to denote those activities where learners are collaboratively developing shared objects of activity, such as conceptual artefacts, practices, or products in a systematic fashion (Paavola & Hakkarainen, 2005). The main goal of the KP-Lab consortium is to develop theoretical models, pedagogical methods and technological tools that elicit the deliberate creation and advancement of knowledge as well as the corresponding transformation of knowledge practices in education and workplaces.

The design process in the KP-Lab project complies with a co-design approach which enables researchers, developers, and end-users to create a shared understanding of tools and knowledge practices. Through this shared understanding, new designs are envisioned and implemented, and innovative technological tools and pedagogical methods are evaluated. The co-design framework describes an iterative process wherein theory and research at the one hand and pedagogical and technological development at the other hand are integrated. As described in D2.2, the co-design process is organized into the following four layers: *Long-term analysis*, *Pedagogical design and intervention*, *Boundary layer* and *Software development*. While the activities on each layer form a self-contained unit of design and evaluation, they form an iterative loop of co-design with the activities performed on other layers.

The research performed within WP8 and the first results of which are reported in this deliverable, corresponds mainly to the activities in the layers: *Pedagogical design and interventions* and *Long term analysis*, since we are concerned with contributing to the understanding and the development of the knowledge practices in higher education through performing case studies and design experiments on these practices. Nevertheless, the outcomes of the research and evaluation activities also inform the specification of high-level end-user requirements carried out on the *boundary layer*.

Accordingly, in deliverable 8.1 we started with the creation and development of pedagogical scenarios to create an initial understanding of how the principles of trialogical learning (Paavola & Hakkarainen, 2005) could be actualized in certain practices in higher education. The scenarios provided representations of envisioned knowledge practices in the partners' courses, hypotheses for research and specification on the pedagogical design of the courses which were implemented in term 2006-2007. As such, these scenarios served as artefacts in the process of creating an initial shared understanding of how the principles of trialogical learning could be applied in concrete knowledge practices in our courses.

The courses investigated in WP8 during the first period of the project which are reported in the present deliverable have various backgrounds and purposes. Some of the research cases aim at examining whether and to which extent courses could be implemented as articulated in their respective scenarios but also to document the current stage of the knowledge practices, in order to investigate how and in what ways knowledge practices develop as a result of (the successive) implementation of KP-Lab design principles and technology. Other courses, that are designed and executed by practitioners in the field of higher education, have been selected by WP8 partners to investigate actual knowledge practices that exemplify particular features of the KP-Lab design principles. In most of these cases, the results report the implementation and evaluation of pedagogical methods using existing technology since KP-Lab tools were not yet available. The investigated cases represent diverse knowledge domains, ranging from psychology, speech therapy, and medical education; and from communication to media

engineering, media technology and digital engineering. Hence, different educational contexts have been studied resulting in a diversity and great width of research cases.

To obtain integration between theory, practice and technology in accordance with the terms of the co-design framework, results from these individual cases were organized employing the concept of priority areas (PA), which was launched in the Description of Work 2.1 for months 13–30. This means that the present deliverable deliberately focuses on reporting those results that relate to KP-Lab goals and that will feed into the co-design process in its present stage, although each case is a distinctive study with its own research agenda, questions, methods as well as contextual and theoretical specialties, rising from the researchers' approaches and which will be reported on separate scientific platforms (e.g., conferences and articles in scientific journals).

In D8.2 we made an attempt to report on those cases that were found to focus on similar knowledge practices and subsequently organized them according to priority areas. In selecting and reporting on the results of these cases, we attempted to construct generic, 'prototypical patterns' in the knowledge practices which can be used as models for developing knowledge practices and technology in education.

We will first consider the KP-Lab design principles that formed the theoretical basis of the process of creating the scenarios and which have been used in the present deliverable as a joint framework to describe the various cases within each priority area. The design principles served as conceptual tools that allowed us to explicate the kind of educational activities we want to emphasize and examine rather than strict standards that should be followed. Next, for each priority area we will report on the research questions, designs and preliminary results of the first KP-Lab studies. We will conclude by proposing implications for developing KP-Lab technology, modifying the scenarios and exploiting best practices, based on the empirical results reported here. In addition we will suggest plans for research in the next implementation cycle of KP-Lab theory, tools and methods.

1.1 Design principles

Design in the KP-Lab project involves the creation and the development of pedagogical methods and technological tools, which are for the most part based upon design principles that are grounded mainly in the perspective of trialogical approach on learning following a co-design approach. The design principles serve as generic guide and criteria in the co-design process in the sense that, for instance, the scenarios that are described in D8.1 attempt to situate and contextualize the knowledge practices they prescribe within particular pedagogical contexts. Hence, the pedagogical scenarios can be conceptualized as the operationalization of the design principles and can accordingly be employed as boundary objects for facilitating communication and development within the project.

Nevertheless, the design principles are provisional implying that they reflect the current understanding within KP-Lab and will therefore be subject to continuously review and if necessary revision or extension based on empirical results. The versions of the design principles and their definitions that we have applied in the present deliverable are those that were developed during the first year of the project under the work of WP3 (see http://kplab.evtek.fi:8080/wiki/Wiki.jsp?page=DesignPrinciples).

1. Focus on trialogical activity around shared objects

A central idea of trialogical learning is that work and learning are organized around developing some shared objects of activity. These shared objects can be, for example, conceptual artefacts (emphasized in knowledge building), or collective activity systems or social practices (emphasized in activity theory), or products and product plans developed in

companies (emphasized in Nonaka and Takeuchi's (1995) model of organizational knowledge creation). In trialogical learning the interaction happens through developing these shared objects of activity;

2. Interaction between personal and social level

One central background for trialogical learning is the knowledge creation approach on learning. This approach is aimed at transcending the dichotomy between the acquisition approach on learning (which emphasizes individuals) and the participation approach on learning (which emphasizes social practices). So trialogical approach does not concentrate just on what is happening within individuals' mind or how individuals learn but neither just on collective processes or social practices as such but on those processes where people are developing something new and combining individual initiatives and social processes for developing novel objects of activity;

3. Fostering long-term processes of knowledge advancement

The processes of transforming existing knowledge practices and developing something new take usually a lot of time (from individuals, groups and from social institutions). Trialogical approach should provide tools and practices for supporting knowledge practices and collaboration around shared objects not just here-and-now but also within long-term processes, that is, in various ways to use and develop previous knowledge and practices when developing something new;

4. Development through transformation and reflection

Models and theories belonging to the knowledge creation approach (which is a basis for trialogical learning) emphasize development through interaction between various forms of knowledge and between practices and conceptualizations, etc., that is, an interaction and transformations between tacit knowledge, knowledge practices, and conceptualizations are a driving force in processes of knowledge creation;

5. Eliciting (individual and collective) agency

Trialogical learning has its basis on epistemic agency of the participants; both agency of individual participants on their own efforts but also on collective agency supporting social processes and collaborative efforts. KP-Lab should provide tools and practices for supporting such forms of agency;

6. Cross fertilization of knowledge practices

The KP-Lab system is meant for assisting people to solve complex, "authentic" problems and producing objects also for purposes outside educational institutions. It has its basis on cross fertilization of knowledge practices between various educational institutions (like polytechnics and universities), on the one hand, and between educational institutions and professional organizations, on the other hand.

7. Flexible tool mediation for trialogical activity

The trialogical approach is based on the idea of mediation, that is, activities of human beings are seen to be mediated by tools, signs, artefacts, and social practices which people can develop collaboratively and with cultural means. The trialogical approach has its basis on flexible tools which facilitate those aspects which are highlighted in other design principles, that is, long-term, cross fertilized work around shared objects of activity which help an interaction between personal and social levels, and which help to make transformations between various forms of knowledge.

1.2 Priority areas

The research cases in this deliverable differ in the knowledge practices they emphasize and with respect to the learning activities that students, teachers, professionals and other stakeholders are engaged in. They address equally present and future challenges in higher education practices. This results in a diverse array of research cases that differ with respect to: a) the focus of research, b) the type of data collected, c) the granularity of the data selected, d) the characteristics of the courses selected for study and e) organisational contexts.

In the development of a coordinated research direction and to inform the theoretical analysis of knowledge practices (i.e., the first phase in the co-design framework), efforts went into developing a taxonomy that considers the central areas of interest in knowledge practices from the field. As a result, KP-Lab research has now been clustered around eight priority areas of investigation. The priority areas reflect the different ways knowledge practices are investigated in KP-Lab and set the stage for determining tailored research questions and corresponding research strategies, methodologies and technologies. As design principles, the current set of PAs is subject to constant evaluation and development in the KP-Lab project. The following PAs were defined in the Description of Work 2.1 for months 13–30, Part A.

1. *Managing collaborative design in higher education* involving efforts of co-designing of various artefacts by educational and professional communities;
2. *Retooling boundary crossing between education and work* in terms of providing collaborative and mobile tools for students engaged in field work;
3. *'Knotworking' in complex learning environments* by providing tools for systematic reflection and semantic annotation of authentic work situations;
4. *Creating teacher networks that foster professional transformation*;
5. *Developing capabilities of transformative learning and knowledge management in work places* by reflective tools and practices;
6. *Ontology-based collaborative modeling*;
7. *Developing technology-enhanced practices for scientific writing* by providing tools that scaffold collaborative production of knowledge as prototypical trialogical activity;
8. *Contextual investigation of knowledge practices in personal use of students*.

The Priority Areas were originally developed by pedagogical partners and scientific coordinators during the preparation of Description of Work 2 as an attempt to set the stage for strategizing future research in KP-Lab, and all pedagogical research cases that will be studied in the second period of the project employ these eight PAs. The PA clusters proved to be useful also to organize the research cases of WP8 investigated in the first period, which resulted in the categorization of these cases within six of the above priority areas (i.e., priority areas: 1, 2, 3, 6, 7 and 8).

Our aim of rising above individual cases to describe generic knowledge practices arising from our courses is a rather challenging enterprise and something not often done in educational research. However, to serve co-design in the KP-Lab project, we made an effort to select and to organize those results that show how the trialogical approach is actualized in practice and how this may lead to requirements on different levels of abstraction for pedagogical methods, technological tools, and organizational aspects.

1.3 Research methods

The research approach and methods employed in the research cases reported in the present deliverable are to a certain extent comparable. The methods described in this paragraph,

generally cover the methods used in the cases for PAs 1, 2, 6 and 7. However, the research approach is somewhat deviating in PAs 3 and 8, which currently both involve the description of one research case; research methods employed in these cases are described and explained within their respective sections.

Research approach

As an approach, we tend to combine design-based and ethno-methodological research with qualitative and quantitative analysis methods, resulting in a mixed methods approach (Johnson & Onwuegbuzie, 2004). The general research designs are based on the design-based research paradigm (also referred by design experiment or design research) (e.g., Brown, 1992; Collins, Joseph, & Bielaczyc, 2004). The design-based research paradigm was developed to address several issues central to the study of learning, including: the need to address theoretical questions about the nature of learning in context; the need for approaches that take account of learning phenomena in the real world rather than the laboratory; the need to go beyond narrow individual measures of learning; and the need to derive research findings from formative evaluation (Collins et al., 2004). Design-based research is potentially a powerful tool for addressing these needs, although it is also acknowledged to bring with it serious challenges, which include the difficulties with complexity of real-world situations and managing the extensive amounts of variables and data obtained from trying to capture the activities in iterative implementation cycles.

Data-collection and analysis

At this stage of the project, the studies conducted had a predominantly explorative character and were aimed at gaining a multi-faceted and comprehensive picture in the current knowledge practices and use of existent technological tools. For this purpose, various data sources and analysis methods have been combined. A rich data set has been collected from all cases by means of employing (a selection of) the following methods: (group) interviews, observations (audio and video recordings of seminar sessions and group meetings), curriculum descriptions, students' written self-reflections; theory-based reflective reports; interviews with teachers and clients; diaries of tool usage from students; pre- and post-questionnaires; database contents, and intermediate and final student products. In some studies, pre-and post-questionnaires, both of which were collaboratively developed by WP8 partners, were administered. In general, the data analysis consisted of an overall reconstruction of the actual, patterned progress of the activities (i.e., knowledge practices) based on the explorative analysis of the data collected by each partner.

For this deliverable an integrative overview of the main relevant results of each case, relating to the trialogical design principles, was created. Each partner investigated their own cases employing a particular set of research methods described above. Main results from each case were then described by clustering them according to the PA they belonged to, using the framework of design principles to organize and describe outcomes within their PA. Subsequently, coordinators for each PA were assigned who subsequently reported on the main results of the research cases belonging to that particular PA, based on the information provided by their WP8 partners.

The following section presents an integration of the results across each priority area, based on the most relevant findings reported by each partner. Table 1 provides an overview of the cases investigated in WP8 for this first period and that are reported in the present deliverable. More about the individual research cases, their design, methodology and results can be found in the Appendix in Plone (http://www.kp-lab.org/publications/public-deliverables/documents-of-the-public-deliverables/KP-Lab-D8-2-Appendix.pdf).

Table 1: Overview of the WP8 research cases reported in the present deliverable.

Partner	Site/case	Time period	Participants students/ teachers	Tools used	Data collected
PA 1. Managing collaborative design in higher education					
FH OÖ	Usability-Engineering	Spring -07	13/2	Moodle	*Students*: pre-questions, post-questions *Process:* diaries of tool usage *Products*: results of students
HUJI	Organizational Management and Behaviour, MA	Autumn -06	35/1	Course Web site (HighLearn LMS); Interviewing tool (not digital)	*Students*: pre-questions, post-questions, interviews. *Course instructor:* interview *Process:* observations throughout the course *Products:* team presentations by students
HUJI	Organizational Management and Behaviour, BA	Autumn -06 and Spring -07	60/1, with 5 doctoral instructional assistants	Course Web site (HighLearn LMS); Interviewing tool (not digital)	*Students*: pre-questions, post-questions, interviews. *Course instructor:* interview *Process:* observations throughout the course *Products:* team presentations by students
UH	EVTEK/ Multimedia product	Spring -07	20/2	Shared Space r.1; NetPro; OVIportal; Domain-specific tools	*Students*: pre-questions, team interview, post-questions *Instructors*: post-interview, teaching log (1) *Process*: observations/videos of seminar meetings *Products*: database contents,
UH	EVTEK/ Media project	Spring -07	30/1	NetPro; OVIportal; Domain-specific tools	*Students*: pre-questions, team interview (2), post-questions *Instructor*: post-interview *Clients*: post-interview (2) *Process*: observations/videos of all lectures & some team meetings *Products*: database contents, final multimedia products
UU	Educational and Instructional Design (EID)	Autumn -06 and Spring -07	35/3	Blackboard	*Students*: pre-questions, group interview (2 groups), post-questions *Instructor*: pre- and post-interview *Process*: audio recordings of group meetings (2 groups) *Products*: database contents, email correspondence (2 groups)
UU	UniC secondary school -student learning	Autumn -Spring -06-07	25/3	FLE3	*Students:* pre-questions, group interviews (during & end of the course) *Instructors:* interviews during & end of the course *Process:* observarions, audio recordings of group meetings (2 groups) *Products:* database contents
PA 2. Retooling boundary crossing between education and work					
FH OÖ	Internship course (Berufspraktikumsseminar)	Autumn -06	13/1	Moodle; Blogs; Moodlewiki	*Students*: semi-structured interview in the end of the semester *Process*: Observations/videos of seminar meetings, protocols of seminar meetings

					Products: joint internship report in wiki, forum discussions
UNINE	Research	Spring -07	15-20/1	Moodle	*Process*: Observations throughout the course *Products*: team presentations of posters, individual reports, documents on Moodle
UNINE	Speech therapist	Autumn - Spring - 06-07	25	Claroline	*Process*: Observations throughout the course, pre and post questionnaires, video recordings of role playing *Products*: forum discussions
PA 3. 'Knotworking' in complex learning environments					
KI	CEPS pediatric simulations	Spring -07	48/15	VHS video; Simulation equipment	*Students*: questionnaires before, during, and, after the course. Interviews. *Instructors*: questionnaires during and after. Interviews. *Process*: Observations/videos of courses
PA 6. Ontology-based collaborative modeling					
UH	Qualitative methods seminar	Autumn - 06	6/1	FLE3; CMap Tools	*Students*: Pre- and post-questions *Instructor*: Teaching log *Products*: Database content
FH OÖ	Mediaproduction and ePublishing	Autumn - 06	36/2	Digital Homework for Students (DHS); Moodle; Word Template	*Students*: pre-questions, post-questions *Instructor*: interview in the middle of the semester, post-interview *Products*: results of students, feedbacks on results
FH-OÖ	Social Psychology of e-Communication	Spring -07	36/1	Moodle	*Students*: pre-questions, post-questions *Products*: results of students
PA 7. Developing technology-enhanced practices for scientific writing					
UNINE	Collective writing and portfolios	Spring -07	15/2 2 courses	Claroline and Wiki	*Students*: pre-questions, post-questions *Products:* wiki and forum work, portfolios
UU	Bachelor Thesis	Spring -07	30/2	Blackboard, Virtual Learning Community, On-line Collaboration Platform	*Students*: pre-questions, group interviews, post-questions (5 groups) *Instructors*: pre- and post-interview *Process*: observations, audio and video recordings of group meetings (5 groups) *Products*: Database contents, Email correspondence (5 groups)
PA 8. Contextual investigation of knowledge practices in personal use of students					
UH	CASS follow-up longitudinal research pilots	Spring -07	58	CASS-Query tool	*Students*: Pre- and post-interview; CASS Query 5 times/day in 2 weeks

2 Main results of the case studies

In this chapter we present an overview of the main results obtained from the research cases in WP8, organized according to the priority areas. For each priority area, first a general description of the PA from the viewpoint of WP8 (i.e., knowledge practices in education) is provided together with the research questions which were based on the overview provided by

the investigated cases. Then, the KP-Lab design principles are employed to report on the main results that were obtained from the research cases belonging to that particular PA.

2.1 PA1: Managing collaborative design in higher education

The main characteristic of the research cases in this priority area are students' collaborative design activities, aimed at developing authentic design products (e.g., educational or training material, software, multimedia products, instructional activities, services), for clients or other target audiences. These design products have a central place in the collaborative work as they direct, motivate, and embody the results of participants' shared efforts. Such activities are performed in the context of courses wherein educational and professional communities collaborate with the purpose of creating design products for authentic use. These activities aim at providing students with the opportunity to relate their theoretical knowledge to practical design; to develop practical design skills and to apply them in authentic work situations. These processes not only involve collaboration between students (within the group), but also with teachers, design experts, and clients, as they iteratively create and elaborate shared design products. Such complex tasks require integration of knowledge from various fields, such as knowledge of design methods and theories, as well as project management knowledge and knowledge concerning communication. Web-based technology plays an important role in most cases, with the aim of enhancing communication and supporting collaborative work on shared products.

Results on some cases studied under this priority area were presented in the EARLI 2007 conference (Damsa, Andriessen, Sins, Erkens, & Kirschner, 2007; Lakkala, Paavola, Muukkonen, & Rämö, 2007; Shternlicht, Ben Ami, Schrire, & De Groot, 2007).

Research questions

The research questions to be answered by means of the studies under this PA are:

- How do students organize collaborative work, when engaged in authentic design activities?
- What are participants' experiences of the collaborative educational design?
- How does existing (web-based) technology or new KP-Lab technology support collaborative design practices?
- What recommendations can be made for further developing the course design and the tools?

Main results

1. Focus on trialogical activity around shared objects

In five out of seven investigated courses, the main course assignment consisted of a group design task. In the majority of cases, the task was assigned by an external client who was contacted by the students themselves. In two courses students were given the opportunity to envision their own products and look for potential clients; in case no clients were found, students created a project proposal themselves and created a product for the teacher. The HUJI cases did not necessarily encompass the creation of a design product as specified earlier, but collaborative project work on topics chosen by students. Collaborative design practices were often modelled by providing students with design process information, templates, and examples of designed material. The most frequently reported activities around the common design product were: planning group work, regular discussions on the design topic and design methodology, evaluation of product versions and giving feedback on products. The ways in which the product was completed varied between the different courses. The majority of students indicated that they were highly motivated to deal with practical aspects of design

work and to work on a concrete, authentic product that might become into use in an authentic fashion.

2. Interaction between personal and social level

The activities that took place in the studied courses were characterized by a blending of collaborative and individual work. Various collaborative work strategies were adopted when producing the design product. In some groups, students worked individually on different sections of the product (sub-products), which were, at the end, integrated into the final product. In other cases, the group worked together on intermediate products, moving to the next one after the previous one was finished. In both situations, the division of labour was necessary, which involved negotiation and agreements between the group members. Often the collaboration also included contact with teachers, clients and subject-matter experts. In some cases, problems were reported concerning the integration of group and individual goals, which resulted in further negotiating about how to continue with their work. Although the individual dimension was much valued by the students at the beginning of the course, at the end many students reported that by using the collaborative work strategy they learned from each other and learned how to use each other's strengths.

3. Fostering long-term processes of knowledge advancement

The core nature of professional design activity is that the design solution and the final product are developed through successive, iterative cycles. This was at some form actualized in all investigated courses. Especially in the cases where the design product was intended for authentic use in external client organization, students seriously revised their knowledge products on the basis of the feedback from clients. In some courses, not all groups succeed to deliver a final product or they had difficulties with finalizing the product in time. Many students indicated that the course period was too short for such a complex, iterative assignment; this problem relates also to institutional level decisions for organizing study programs as one semester long courses.

In a number of cases, fulfilling the given design task required some knowledge and skills accumulated in previous studies, and the majority of students reported that the course provided them with the opportunity to apply practices of design work learned in previous courses. In some of the participant institutions, curriculum design complies with this aspect: there is a planned continuum in curriculum to support students in gradually learning the practices of project and design work during a longer period of time. In multimedia design courses in EVTEK (UH), some groups were assigned to improve or finalize products produced by students in previous courses, so building on the knowledge created by others.

4. Development through transformation and reflection

The ill-structured nature of design tasks was found to support this aspect of knowledge creation; in order to manage the assignment, students were challenged to integrate their previous knowledge and practices about the subject domain and design work into practical knowledge that is required to carry out the actual design task. In most cases the students also had a possibility to learn from and work with professionals from the field and experienced experts in design work. Typically such integration happens implicitly through the practice without the actors being able to explicate it directly. Some teachers indicated that they consciously tried to foster deliberate conceptualization of design knowledge and practices by a requirement for writing reflective, individual or collaborative reports (explanatory reports, reflective writing on theory and practices, learning logs). In the Usability-Engineering case (FH OÖ), transformations of design practices as results of reflection were investigated. The transformations of practices in groups appears to have resulted from several factors: demands of the client regarding the product (resulted in more concrete specification of the product),

interaction with experts (resulted in changed ways of working), supervision approach, and self-reflection of groups on their current and previous practices.

5. Eliciting (individual and collective) agency

Some features in the courses under this PA can be considered especially to create conditions for developing agency, such as: the complex, authentic task, the presence of a client with his/her demands, and the fact that the students were responsible for the progress and the quality of their final product. Individual responsibility was seen as important, but for producing the shared product, common responsibility was considered essential. In most cases, a high level of commitment was registered by the groups, explained by the students themselves through the fact that the designed product might become in real use and that managing design practices is important for their profession.

The management of the design project represented a challenge that may have induced agency development. Students were confronted with situations in which decisions needed to be made and responsibilities to be taken. Knowledge regarding design practices and the design topic was not always available and students had to find ways to obtain this knowledge themselves. Experts were contacted and interviewed, based on students' own initiative. In some cases, students reported situations in which the responsibility for doing some task or maintaining contact with the client was monopolized by some group members, which often prevented other members from making contributions. In all courses, there naturally were differences between groups in the level of commitment.

The majority of students reported that they were able to achieve also their personal goals by active collaboration with others. Students indicated that they valued the fact that the teacher gave them space to take initiatives and make their own choices regarding the design work. Some design projects were based on students' personal, long-term interests in some topic or workplace project.

6. Cross-fertilization of knowledge practices

Designing a product based on authentic needs and students' collaboration directly with the representatives of the customer organizations set facilitating conditions for cross-fertilization in the courses although in some cases students had the freedom to choose whether to search for expertise outside the course framework or not. Even though the students did not directly take part in the authentic practices in the field in any of the courses, the design products can be seen as 'boundary objects' between clients and student groups. Also the students themselves indicated that through the joint design task they had the opportunity to become familiar with the working approaches, conditions and knowledge practices of their clients as representatives of working life in general.

The results suggest that often there emerged bilateral cross-fertilization between the involved parties; also the customers learned from the collaboration (they came in contact with new ideas, new approaches and with young, motivated people), in addition to providing their expertise for students' use. The students reported that the authentic collaboration was a central benefit of the course, but also challenging because it brought all real-life problems into the design work (e.g., difficulties to understand each other and to share and explicate domain knowledge; client's varying motivation and participation; or changes in the schedule, plans and resources). Another type of cross-fertilization was mentioned by some students who reported that they applied the domain-based tools, which they were exposed to in the course, in their work places. For the teachers and for the institution, this type of setting appears to involve extra challenges for networking with clients, maintaining long-term contact with potential clients, supervising all projects, and (re-)organizing teaching responsibilities.

7. Flexible tool mediation for trialogical activity

The technological tools that the students (and in some courses also the clients) had at their disposal differed, but the functionalities provided by these tools were comparable. Functionalities such as exchanging files, sharing documentation, posting announcements, up- and downloading course documentation and task guidelines, and possibility to follow the groups' work were provided by tools such as: the OVI-portal and NetPro (EVTEK/UH), Blackboard (UU), FLE3 (UU) and Moodle (FH OÖ). A discussion platform and a chat were available in Blackboard and Moodle. Only in one course conducted in EVTEK (UH), the *Shared Space* prototype (M12 version) was introduced and partially used by students during their collaborative work.

The results indicate that, in general, the tools provided were foremost used as repository for information, such as drafts and final products. In the majority of courses, e-mail was used for asynchronous communication or exchanging drafts. Additional tools, such as Word, Skype, Wiki, Photoshop, Google, Wikipedia, external chat programs, or professional multimedia tools, were used during the design work. Furthermore, it was noticeable that, in many courses, practices of appropriating the available tools for specific needs were registered; for example, in the Media project case (EVTEK/UH), the students developed their own solutions for sharing documents and product prototypes through the Web, and in the UniC case (UU), the students used 3D design programs and editing programs, besides FLE3, which provided more specific support to design their product.

The *Shared Space* prototype was partially used in one course to organize working documents and joint design process at group level. Although not fully functional yet, it appears to have allowed the students to provide them with an overview of the work progress of all groups in the course. The introduction of this tool helped students to better vision affordances of such tools for collaborative design practices, compared to the participants of another similar course without an experience of *Shared Space*.

Regarding students' and clients' self-reported experiences about working with the available tools, the opinions were mixed. In some courses (EVTEK/UH) the clients and the students were mainly content with the given functionalities. In most courses (UU, FH OÖ) students valued the bundling of more functionalities in one tool (such as Blackboard), and the fact that these tools provided support for getting insight in the course guidelines, news within the course, or teacher's requirements. However, many students expressed needs for better or more specific technological support of the collaborative design work and project management, which indicates that more advanced support for collaborative and iterative design work was lacking from the existing tools.

Conclusions

We may conclude that the shared design task functioned as a catalyst and motive for the collaborative activities. Although some groups encountered difficulties in meeting the deadlines or even finalizing the product, working on a concrete product mediated collaboration and supported the integration of theoretical and practical knowledge. The authenticity of the set-up entailed groups to take responsibility for the quality of the design product and, subsequently, for the collaborative activities performed. In most courses, working for an external client represented an extra motivation and challenge, not only for the students, but also for the teacher and for the clients themselves, because they were faced with collaborators from different field than those they were used to. The complexity of the assignment that students were required to perform triggered them to apply collaborative working practices that may seem beneficial in future professional life. These involve not only design practices, but also project management and communication practices. The difficulty of

providing conditions for in-depth iterations of developing the design product could be addressed as a challenge for course and curriculum design.

New challenges must be taken into consideration when engaging in future iterations of pedagogical designs and research projects; such as the complexity of the design task and the circumstances of authentic work situations or obtaining the full engagement and commitment from clients. This is important in order to obtain a balanced and multilevel cross-fertilization of knowledge and practices, and to increase the chances of producing products of high quality, serving each partners' purposes. Good communication and explication of demands, expectations, and task requirements is needed between students, teachers, and clients, in order to make collaboration more efficient.

The technology used in the cases of this PA provides a limited support for the collaborative design activities. During these studies students, teachers and clients provided suggestions for improving the existing technology and proposed ideas for new tools. The most relevant suggestions refer to better support of collaborative document management such as a common space wherein documents can be uploaded, organized in a hierarchical fashion, and shared with the other participants. Other specific needs that were expressed concerned the possibility to edit documents synchronously. Furthermore, the idea of a shared workspace allowing clients to test prototypes of the design products and to deliver their comments and feedback to the students was also introduced. The needs for awareness tools were raised as well as a need for sophisticated searching functionalities. These functionalities would permit participants to be able to monitor activities of their group members. Also, chatting functionalities which may facilitate virtual communication and work should be integrated into this tool. Finally, students suggested that wiki's should offer the possibility of creating tables and of using different authoring rights.

2.2 PA2: Retooling boundary crossing between education and work

On their way to becoming professionals in specific domains of knowledge, students doing internships or field training engage in activities that are aimed at the appropriation of practices characterizing the domain. In the three cases under this PA, a central element of the pedagogical designs was to externalize tacit knowledge, to trigger reflective practices and to engage in and foster cross boundary practices between education and work. Both the Internship case (FH-OÖ) and the Speech Therapist case (UniNE) focus on experiences gained during actual field period in the student's internship. The Research case (UniNE) is an inverse to the usual internship situation where students enrol into working life; in this case professionals come to learn about research in university (understanding research in general as an addition to professional expertise). The use of technology in the courses was aiming at supporting the epistemic mediation of boundary crossing practices through the construction and sharing of knowledge artefacts, such as written self-reflections, case descriptions and reports.

Results on two of the cases studied under this priority area were presented in the EARLI 2007 conference (Richter, Vogel, Zoeserl, & Allert, 2007; Perret-Clermont, Marro, & Bugnon, 2007).

Research questions

- How to help students to elaborate individual and collective reflection on the knowledge practices across education and work, and to manage the challenge of increased knowledge intensity in the working life?
- In what ways does the pedagogical design allow reflection on knowledge practices across education and work?

– To which extent could the reflection processes be supported and mediated by technical tools?

Main results

1. Focus on trialogical activity around shared objects

In all cases, the knowledge practices experienced in the internships or field training provided the shared object of the collective reflection process. The Internship case as well as the Research case aimed at the constitution of a reflexive report summarizing the activities done during the course and in professional field. In the Research case, the course aimed at the development of a concrete research project in professional field that the students summarized in an individual report. In the Internship case, the focus was on the creation of a shared report, integrating the insights gained regarding the knowledge practices in the field; the report had to be created in the form of wiki pages. In the Speech therapist case the goal was to make students aware of the multiple situations that they will encounter in their professional life and, more concretely, to offer a support for students who had faced a difficult internship; the emphasis was more on collaborative reflection on experiences, not so much the production of concrete outcome such as a report.

2. Interaction between personal and social level

In all three cases, both shared and individual reporting of experiences were supported. In the Research case, the outcome of the collective reflection process was used for the individual reflection in the final report. In the Internship and Speech therapist cases, the individual reflection processes were a starting point for the collective reflection.

There appears to be interesting results in all three cases concerning the challenges and needs for new kinds the practices for integrating personal field experiences and group level reflection. The Research case was originally even designed so that the final research report to be produced was individual, although sharing of experiences was meant to support that. In the Internship case, less collective reflection than was intended took place in the collaborative report writing in wiki; the individual perspectives of the students became to the fore. In the Speech therapist case, problems in discussing personal experiences and emotions were found, but the forum, where students discussed asynchronously about their experiences, appears to have helped the students to progressively avoid this shyness; the students got new insights for thinking about the role of a therapist and about their own psychological processes and those of others. Another interesting result of the introduction of the ICT in the Speech therapist case was that it intensified face-to-face interactions.

3. Fostering long-term processes of knowledge advancement

An iterative, long-term development of a concrete knowledge artefact was promoted both in the Internship and Research cases where the students had a task to produce a final report jointly or individually, although in both cases the students did not engage in collaborative reflection and elaboration of the artefacts as extensively as was intended. The cases contributed also to the continuous adjustment and change of the study program, due to the joint internship report of the participants that was fed back to the instructors. The Speech therapist case is part of an integrated program of four years consisting of seminars, personal diaries, group discussions in vivo and/or online forum. The sustainability of the knowledge advancement in that case relates more to students' personal and professional development during these four years rather than iterative development of concrete reports for mediating boundary crossing between education and work.

4. Development through transformation and reflection

All cases were intended to foster interaction between various forms of knowledge and between practices and conceptualizations. In the Speech therapist case, the main aim of the academic course was to foster students' individual and collective reflection on their actual and future professional practices. As said, in order to help the students constitute reflection on their practices, a forum was made available for them. In the Research case, the aim of constituting a research project fostered students to ask "authentic" questions they could apply in their own professional field. They had to try to apply and translate knowledge, taught in the course, in their concrete practices. In the Internship case, blogs, forums and wiki were utilized as tools to trigger the externalization of the experiences made and to foster a joint discussion and analysis. Due to the implementation chosen, it was somewhat difficult for the students to trace contributions across the different media used and therefore to clearly associate a given topic with a specific person or group of persons. Traceability seems to be important in reasoning and arguments.

5. Eliciting (individual and collective) agency

In these research cases, it is somewhat unclear how they contributed to eliciting agency; such issues were not emphasized in the results. The students were able to decide on their own, which issues they want to examine concerning their experiences or studies in the field, and they had to take responsibility for their individual and collective reports. In the Internship case, more specifically, the joint report was meant as a mechanism to provide feedback both to the designers of the study program as well as lecturers and other students. In retrospect it turned out that some of the students had not grasped the purpose of the assignment completely and were not aware of the report's feedback function; the students mainly emphasized issues related to their own role as an intern in the joint report rather than taking responsibility for providing information for common use.

6. Cross-fertilization of knowledge practices

Naturally the entire practice such as internship or field work exemplified by the three cases in this PA are in their core nature aiming at cross-fertilization of knowledge practices between educational institutions and working life. In the Speech therapist case, the academic training aimed to develop student's competencies in understanding the role of relations in their profession. Classroom observations indicate that the main difficulty for students is to bridge the gap between the notions learned during the academic training and the situations met in the professional field where things are more complicated because of the multivoicedness of the situations. In the Research case, the students reported that they were pleased to have learned new knowledge practices as well as new ways of reflecting on their practices and highly satisfied with seeing that the research that they conducted during the course had concrete effects on their professional practices.

In the Internship case, the students were assigned to produce a shared object of their insights: a joint report for the faculty, their fellow students and the hosting companies. Due to the exchange and analysis of other's experiences, the students become aware of alternatives. One noteworthy result was that although students' experiences gave valuable insights for their colleagues, fellow students and the faculty, crossing boundaries between university and work practice was not systematically realized: students feared that companies could read the reflections from wiki and they used quite a lot of additional tools to accomplish their assignments non-publicly.

7. Flexible tool mediation for trialogical activity

There are clear differences in the role and quality of technology in the three cases. In the two UniNe cases (Research and Speech therapist), rather conventional technology was used. In the

Research case, Moodle was mainly used for sharing instructional materials and the interaction between the participants was carried out through e-mails. In the Speech therapist case, discussion forums were the main tool and the practices emphasized dialogical interaction. However, ICT appears to have had concrete effects on students' knowledge practices in that case. It was the first year in which ICT tools were introduced in that course. After some time of adaptation, students valued the opportunity given to reflect on their practices, difficulties, feelings, and feel support through the forum. They also reported that due to ICT, they had learned to distance themselves from their immediate reactions. It seems also that the goals of the course became clearer for the students because of the introduction of the ICT tasks. They used to be scared by other people's opinions but now they declared that the multiplicity of perspectives of the different fellow students enrich the understanding of complex situations.

In the Internship case, both the technological tools (Moodle with blogs, wiki, forums) and students' capacity to appropriate them appears rather advanced. Students particularly appreciated the use of a single and familiar system, which eased cross-referencing of entries and reduced administrative overload, as well as the forum software, which allowed retrieving new entries via email. Weaknesses mentioned by the students included the need for a (private) internet access, the rather inflexible rights-management within the system (access rights to a forum cannot be defined individually) as well as poor usability of the wiki system and aesthetic appearance of the wiki pages and hence the final report. Students used quite a lot of additional tools to accomplish their assignments: only one out of eight students used the blog integrated in Moodle while other students used blogs hosted by themselves or external vendors. Their reasons for this were better usability, the possibility to make the entries available to a public audience and to customize the blog regarding its visual appearance. Interesting result is that the technology was not particularly used for mediating collaborative knowledge construction. Even though the forums provided an important means for communication between all course members, students preferred to use other media for small group work. They met face-to-face or used phone, Skype or email in order to discuss more personal issues; they did not want to discuss with all fellow students or they had an acute problem requiring specific and timely information. Several students reported to have met face-to-face when creating the wiki pages for the joint report, and to have used a word processor to create the entry which was copied to the wiki system afterwards.

Conclusions

All cases in this PA indicate that there seems to be a barrier when students are asked to publish their personal ideas or experiences from actual working life. We do not know how much this relates to specific experiences worked on, particular working cultures or national differences. For the tool development, this might imply that it is important to provide differentiated access for student's entries in the tools. It should be possible to define entries accessible for the owner only (private), for one or more groups, or for all (public). But this might also imply that students require more guidance in the form of alternate course design for accepting and practicing collaborative sharing of experiences.

The lacking collective reflection in the wiki in the Internship case could be a result of the student's lack of clarity regarding the sense and purpose of the common reflection process. It seems to be important that reflection will not become an end in itself but needs to be connected with subsequent actions; concrete benefits can only be found in long term cases and investigations. Therefore, it is important to expand students' investigation period beyond a single course or semester.

Tool usage cannot be predicted in advance. Students use tools for their own purposes. If a tool does not fit into their conception of the knowledge practices, other possibilities are used. Tools that are integrated in a pedagogical design need to be task compliant and the knowledge

practices has to be explicitly supported, otherwise the outcomes will not be as intended. It also means that we have to take under consideration, when designing and evaluating cases, also the additional tools that are used by the students.

2.3 PA3: 'Knotworking' in complex learning environments

General description and focus

Knotworking refers to expert work that takes place in rapidly emerging and transient projects where groups of people assemble for a short period of time to accomplish a particular task (Engeström, Engeström, Vähäaho, 1999). The notion of a 'knot' refers to a distributed and partially improvised orchestration of collaborative performance. The participants do not necessarily know each other beforehand and need to quickly create collaborative partnerships that allow them to productively coordinate their activities. The projects can be carried out in complex constellations of organizations, representing divergent sectors and without clear-cut boundaries.

The case investigated under this priority area is concerned with the coordination, leadership, and communication in critical care contexts, more specifically on simulation training courses for medical teams involved in neonatal resuscitation. The challenges of knotworking are addressed in the simulation courses studied in this priority area. The participants are practitioners in various fields and the medical university Karolinska Institutet arranges the courses. The courses are intensive one-day courses starting with lectures and followed by simulations and debriefing and feedback sessions. In the simulations, the course participants work in inter-professional teams to practice solving complex, authentic cases: the medical teams provide newborns (a small manikin) 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.

This priority area, has been concerned with (a) analyzing the current practice in the simulation courses (b) developing the practices by, e.g., developing and introducing conceptual tools to the course, and, (c) developing a computer based tool for analyzing the performance of the medical teams. The work of this priority area and case has been presented in (Karlgren, Dahlström, Kierkegaard & Berglund, 2007; Karlgren, 2007; Karlgren, Masiello, Dahlström, Kierkegaard, Berglund, Lonka & Ponzer, 2007; Karlgren, Dahlström, Lonka, & Ponzer, 2007).

Research questions

The research questions to be answered by means of the studies under this PA are:

- How can trialogical design principles be introduced and realized (in simulation courses) to support knotworking in the context of critical care?
- How can the teamwork and communication of medical teams involved in critical care be improved? How can we make participants in simulation courses pay more attention to and conceptualize the "tacit knowledge" involved in the medical teamwork?
- As analyses were carried out, a conceptual model (APCER) and computer prototypes have been developed, new questions emerged: What should a conceptual model which is used in simulation courses addressing medical teamwork and communication consist in and how should it be designed?
- How should an annotation tool be designed which is aimed at supporting learning to observe and analyze medical teamwork and communication?

Research methods

Besides the research methods described in the general chapter on research methods above, an iterative design method was used including testing with paper prototypes in actual courses. The use of prototypes has been studied by collecting questionnaire data intensely during courses; before and after courses as well as at least eight times before and after each simulation during the courses. Also, the courses were video recorded for video analysis.

Summary of results

1. Focus on trialogical activity around shared objects.

A goal was that the participants should become more attentive to the quality of the teamwork and communication and they were therefore encouraged to become engaged in doing observations and creating analyses of the performance of the teams in the debriefings following simulations. To support this, a conceptual model (APCER) was constructed in order to support and structure the discussions about the teamwork, team leadership, and communication displayed in the simulations. The model covers key issues concerning efficient medical teamwork and team communication and concerns important, desirable, and easily observable team leader and team member behaviors. Its objective was to make the key issues more explicit and thereby observable and to provide a shared conceptual tool for debriefing analyses. The model was intentionally designed to resemble the format and use of another shared model well-known to the participants, namely the Apgar model which is a scoring system to assess the status of the patient; here the idea was similarly to assess the status of teamwork.

Introducing a model as a starting point for observations, reflection, and analysis reminded participants about the central issues which otherwise risked being overlooked and; it appeared to structure discussions, as shown by interaction analyses of the debriefings. Although participants sometimes had difficulties deciding upon a score for a particular category in the model, such difficulties lead to discussions about the categories. However, introducing a new model always raises the risk of controlling and limiting the discussions too much. We have, however, not seen that this was the case: issues which went beyond the model were still discussed. And sometimes the model itself was discussed; e.g., discussions about potential clashes between desired but conflicting goals. Another possible disadvantage of introducing a new model is that the model needs to be learned and understood by the course participants, which uses up valuable time that could be spent on other things. Therefore efforts have been put into creating a model which is as simple as possible.

2. Interaction between personal and social level

After each simulation, the participants were encouraged to first do individual analyses using the conceptual model (APCER) and later to discuss and analyze the simulation collaboratively with the whole team, agree on a common understanding, and finally to set up new goals for the following simulation. Interesting discussions took place when the participants discovered that they had made different observations or had differing opinions and when they tried to reach a common score. Participants sometimes engaged in negotiations and sometimes the team's decision about a certain category was contested in a way that was not likely to happen previously. The interaction between the personal and social levels was not always smooth: participants would sometimes hesitate to mark individual scores before they had discussed and agreed upon a shared score.

3. Fostering long-term processes of knowledge advancement

The course aims to provide course participants with tools and some practice enabling them to continue and develop practices concerning analyzing teamwork in other contexts. The APCER model was designed with the aim of being one tool to support these practices and which has been iteratively refined and simplified in each new course.

A challenge here was that the knotworking between the participants needs to take place under extreme time pressure. There is not a possibility for extended reflection 'in situ', during the stressful teamwork. Rather, the situated practices need to be well-prepared in advance and the participants must in beforehand have the necessary conceptual tools for analyzing their performance. One important issue here is that making observations (and analyses) is *not* just some automatic or passive process unaffected by training and reflection. On the contrary, such skills can and should be developed so that participants do not remain blind to what takes place and are given the preconditions for improving. Focus is on the more concrete *activities* of *making* observations and analyses about medical teamwork and communication. These skills are thus viewed as a kind of knowledge practice which is trained and which participants are encouraged to foster in the long-term. A challenge here is that many participants lack knowledge about these skills and their importance. Therefore much emphasis is put on turning them into more explicit, salient knowledge practices.

In their responses to questionnaires, the course participants reported that they were better at doing observations/analyses after the course (than before). The results of these self-reports were interesting since not one single course participant mentioned observation skills as something that they expected to learn in the courses when asked in beforehand. This observation is an initial step in the desired direction since it shows that the course participants have identified and (in their own view) improved the skills which are the very long-term processes that the course aims at fostering.

4. Development through transformation and reflection

Key aspects of the teams' performance were discussed on a theoretical level in the lectures in the beginning of the course. The rest of the course is set up in a way so that certain activities are iterated over and over again during the course; first a simulation, followed by a debriefing session, and finally a session when a video-recording of the simulation is watched and analyzed. The course participants take part in the deeply involving simulations where various kinds of "tacit knowledge" are displayed and then analyzed immediately afterwards using, among others, the APCER model.

Initially, the participants had some times difficulties in applying the categories of the APCER model due to interpretation problems. But by iterating the process they became more familiar with the categories and were better able to connect them to concrete performance in the simulations. In the beginning of the course the participants were not sure about how to behave in the simulations and they become confused with the many issues brought up. But by encouraging the participants to make brief analyses of the teamwork on their own and providing them with a concrete model for this as well as setting up concrete, achievable goals for each new practical exercise, the participants developed a way of handling their confusion and making use of some of the many theoretical ideals in practice.

5. Eliciting (individual and collective) agency

An objective of the course was to make all participants more actively engaged in the medical planning, decision-making, and evaluation of the team's resuscitation work, not just to rely on the team leader's decisions. Efforts were made to carry out the teamwork in a way that created an atmosphere which encourages active team members; they were supposed to feel that they were collectively responsible for decision-making and for resource management. The APCER model includes categories referring to desirable behaviors displayed by team leaders as well as all team members, and scores are given to different categories of the model. However, rather than scoring individual participants, only summative scores pertaining to the performance of the entire teams are given. This was an intentional design decision in order not to single out individuals who risk being blamed for problems and leading to an unconstructive atmosphere. It was in each team member's interest to improve all members'

performance rather than just focusing on themselves. During the course, others than only just the team leaders did in fact become more active in planning, sharing, decision-making, and evaluation activities.

6. Cross-fertilization of knowledge practices

The courses strongly emphasized creating settings which were authentic – similar to the real work environment and with realistic tasks. Beyond this level of authenticity, the courses provided participants with experienced instructors who possessed expertise which can cross-fertilize the everyday work environments of the practitioners. The course instructors are senior specialists or experienced practitioners in their respective field with deep knowledge of (a) the particular medical domain and knowledge of international and national guidelines for how to do resuscitation work through memberships in various boards and committees involved in establishing such guidelines; and (b) knowledge about medical teamwork and communication. The participants often have limited time to reflect during their everyday practices; the courses provide an opportunity to learn from experts and a chance to train and reflect on their own teamwork in a way which went beyond the analyses possible at the workplace.

7. Flexible tool mediation for trialogical activity

So far only old-fashioned video recordings were used together with paper and whiteboard analyses. The paper and whiteboard pilots, however, give valuable input to the design of electronic versions about what works and what should be modified leading to specifications for requirements for KP-Lab technological development.

Conclusions

It has been challenging to introduce innovative knowledge practices into an environment which is as tradition-laden as the one studied here. Nevertheless, the knowledge-creation metaphor and the trialogical design principles contributed something important and support improvement of the medical teams in a sense that would probably not have occurred as naturally using other approaches. Although they do not specify exactly what to do and how, they highlight certain aspects rather than others and give valuable hints about in which direction the design and development of educational practices should proceed.

Emphasis was put on knowledge creation activities: the participants were encouraged to actively engage in making observations and creating analyses about teamwork and communication. The instructors are experts in these knowledge practices, but instead of handing over the responsibility of such analyses to them, the participants were involved in doing them on their own. This was achieved by the design of the course including debriefing sessions, video commenting, and by introducing the APCER model which participants used to analyze team performance.

When creating the model (APCER), particular emphasis was put on a simple design focusing on concrete, observable behaviors. It has iteratively been simplified and improved during prototype testing to make it more usable. The intensive data collection supports that it is a step in the right direction: participants' own ratings of the included categories improved in a rather impressive way during courses. More analyses are needed of all the video data to determine what actually happens.

As for how annotation tools aimed at supporting observing and analyzing medical teamwork and communication, different design propositions have been developed which are promising. A finished tool has not yet been implemented but different prototypes have been launched.

2.4 PA6: Ontology-based collaborative modeling

This priority area is focused on systematic collaborative modeling as a core knowledge practice for the explication, communication, analysis and evaluation of procedural, domain and/or design knowledge. The common denominator of the three courses subsumed under this priority area is students' collaborative engagement in the creation and use of various kinds of models (concept maps, argumentative diagrams, structured descriptions of design problems and solution patterns) in order to create a shared understanding and to mediate their collaborative efforts. For instance, in the Qualitative methods seminar (UH), students explored their conceptions on qualitative research methods by constructing and revising concept maps in pairs about concepts and issues they consider important. In all investigated cases, the creation of models is not meant as an end in itself but related to some overarching activity, such as the evaluation and improvement of a design product or the informed choice of empirical methods to be applied within a research context.

The courses foster the interaction between the individual and social level, as the creation of a shared model requires the students to share their ideas and reflect the joint models against their own understanding. Furthermore, due to the complexity of the phenomena to be depicted, students have to weigh and integrate knowledge from various sources and domains in order to come up with a coherent model. Throughout the courses in this priority area, collaborative modeling is understood as an ongoing process in which students are asked to iteratively refine and update their models. Tool support plays a twofold role in these practices. While on the one hand technical tools such as CMapTools (http://cmap.ihmc.us/) are used for the development of the models themselves, modeling languages as semantic tools are used to scaffold the modeling process and to provide a conceptual framework for the depiction of the phenomenon at hand.

Research questions

The research questions to be answered by means of the studies under this PA are:

- How do students collaboratively create and use external representations to mediate their understanding of a particular domain or problem?
- How do scaffolds (e.g., templates or modeling languages) affect the creation and work with models?
- What recommendations can be made for further developing course designs, tools and scaffolds?

Main results

1. Focus on trialogical activity around shared objects

In all three courses investigated, shared external representations assumed the role of mediating objects of collaborative activity and were used to materialize otherwise intangible phenomena such as concepts of research methodology, theories of social and developmental psychology or design rationale. The work on these objects was motivated either by the students' interest in the subject, an external customer's request for clarification or concrete design assignments provided for the students. In two of the three cases (courses in FH OÖ), textual templates were used as external representations instead of graphical displays. Throughout all three courses, the creation of a shared external representation turned out to be very challenging and sometimes even beyond the reach of the students. The problems encountered by the students might be attributed to (a) limited prior knowledge of the students which does not orient them towards specific concepts and relations and/or (b) difficulties in applying domain-specific schemata and their underlying rationale. For example, when being asked to identify alternative solutions for a given design problem, students often had problems to identify the design problem clearly.

2. Interaction between personal and social level

The collaborative creation of shared external representations can be viewed to mediate the interaction between individual and social levels because their creation required the students to share their ideas and also to mirror the outcomes with their own understanding. Furthermore, in two of the cases (Qualitative research seminar, and Mediaproduction and ePublishing), the collaborative activities took place against the background of individual projects or assignments carried out by the students concurrently. In this sense, the outcomes of the collaborative modeling exercises were also meant to inform the individual work of the participants. While the group work was evaluated rather positive across the courses, the data currently available provides little insight in the actual interaction of individual and collective efforts within the groups.

3. Fostering long-term processes of knowledge advancement

In the Qualitative methods seminar, the idea of using collaborative modeling for iteratively developing the models and making them more sophisticated, was clearly built in the design of the course. The students created concept maps in pairs and revised those two or three times during the course. Also individual continuation over the course context was realised in that case because the seminar was especially meant for those students who were working on their master thesis in parallel, and hence could apply their insights also practically in their ongoing personal project. In the other two cases, systematic development of the produced models was not explicitly emphasised in the results. In the Mediaproduction and ePublishing case, students could use a repository of results across different courses and projects; the repository developed dynamically due to new participants, changing problems and new solution approaches.

4. Development through transformation and reflection

The modeling tasks in this PA required an integration and explication of different kinds of knowledge such as declarative (e.g. descriptive texts of qualitative research methods) and conceptual (e.g. core concepts related to research methods) but also practical (e.g. examples of research cases) and tacit knowledge (e.g. examining authentic problems related to student's own research). In all three cases, the modeling activities were linked to some practical problem, such as the testing of design hypotheses, the analysis of design products or the selection and application of appropriate research methods. Even though the integration of practical and theoretical knowledge was an important ingredient and also turned out to be motivating for the students it also was a main challenge for them. At least in the Media Production and ePublishing case, quite a few students had obvious problems to abstract from the concrete examples given and to develop more abstract conceptualizations of the design space. In the Psychology of eCommuncation case, students used above all just one rationale from the template and were not able to use different forms of knowledge.

5. Eliciting (individual and collective) agency

The courses differed significantly in the way they aimed to elicit agency. Two main mechanisms can be distinguished. In the Qualitative Research case the program of the course was largely based on the problems introduced by the students and the course itself was explicitly designated for students with an intrinsic motivation in the domain. According to students reports this design required more own initiatives than average courses and hence might have affected individual agency positively. In contrast, the other two cases, which were mandatory for the students, aimed to elicit agency mainly implicitly by providing the students with methods and tools that empower them to solve domain-related problems on their own.

6. Cross-fertilization of knowledge practices

The cross-fertilization of knowledge practices played only a secondary role in the cases investigated. Even though direct exchange with external experts was foreseen in two of the cases it could not be arranged for practical reasons.

7. Flexible tool mediation for trialogical activity

Within this priority area flexible tool mediation relates both to the technical tools for the creation and management of the shared representations and models as well as to modeling languages and templates in the sense of semantic tools. With regard to the production of visual representations in the form of concept maps, CmapTools, used in the UH case, turned out to be relatively easy and flexible to use. In the other two cases, text-based templates and a wiki system were used to create shared representations which also created little technical problems, despite the fact that commenting and formatting functionalities of the wiki system were evaluated as insufficient.

A challenge in all of the cases was the use of multiple technical tools in parallel. Besides the tools used to create the shared representation, other technical tools were in use for the exchange and storage of background material as well as for asynchronous and synchronous communication. Special problems encountered relate to the sometimes insufficient interoperability of the tools, which for example makes it difficult to link the shared representation and the respective background material.

With regard to the semantic tools, especially the text-based templates used by FH-OÖ, the following problems were encountered. Even though in one of the cases, students were explicitly asked to depict and contrast alternative solutions for a design problem, the solutions were often discussed in isolation lacking traceable comparisons. This finding might at least partly be attributed to the kind of text-based scaffolds used which afford a primarily linear structure and provides little support for direct comparison of design alternatives. In the other case, students used only a very limited subset of the concepts and relationships foreseen by the template, which might be due to the fact that the template was not present throughout all pages of the wiki-system.

Conclusions

It seems noteworthy that all three courses arranged collaborative modeling in the context of a more overarching and practical oriented activity of the students, hence emphasizing the functional nature of modeling. Given the results of the case studies, it appears plausible to assume that the creation of a shared external representation of complicated and multifaceted knowledge objects is a worthwhile but also challenging activity for the students. The problems thereby seem to relate both to limited prior knowledge of the students, which may hamper students' efforts in collaborative mapping of the knowledge object as well as missing familiarity with schemata for the structuring of conceptual knowledge.

Based on the findings so far, several issues seem to be relevant for future pedagogical design and research. Students' level of prior knowledge has to be taken into account more systematically and new methods and scaffolds are needed to support the students in incrementally expanding their knowledge base. When domain-specific schemata or modeling languages are used, special training might be required and scaffolds should be selected carefully, taking into account also the affordances they provide. Potentials for collaborative modeling in heterogeneous and multi-disciplinary teams should be addressed more systematically. Towards this end, the impact of group processes should be studied as well.

As indicated by the results of the research studies, existing technology for collaborative modeling is limited in several ways. While, generally, tools for visual modeling such as CmapTools are preferable for the more intuitive kind of modeling activities described here, they are often hard to integrate into other systems such as content-management systems or

other groupware solutions, making it difficult to share both, models as well as background materials and also results in increased training needs for the students. As encountered in one of the cases, more sustained modeling activities with students working also remotely require dedicated functionality for commenting and communication while engaged in the modeling process. Finally, current tools provide only limited support for creating and using more refined modeling languages beyond mere concept maps.

2.5 PA7: Developing technology-enhanced practices for scientific writing

The cases that were investigated under this priority area focus on collaborative scientific inquiry and writing practices in higher education settings. The scope of this priority area was broadened to include all courses aiming at advancing students' understanding of the practices for creating scientific knowledge in general. The main goal of engaging students in collaborative production of scientific knowledge is to get them more acquainted with the inquiry practices of scientific communities and their members (i.e., students, teachers, researchers, and clients).

In the investigated courses, students conduct literature studies, set up research plans, construct research instruments, share and discuss research problems and results, perform field research, and write scientific explanations and research reports. These courses aim at developing complex and abstract academic thinking through object mediated activities, such as the production of scientific texts. Reflection on individual and collaborative research practices and integration of research knowledge are fostered and encouraged. In this priority area, two cases were investigated and reported. Collective writing and portfolios case (UniNe) focused on the writing and reflecting on general scientific practices in the social sciences, whereas Bachelor Thesis case (UU) concentrated on conducting and reporting on a small scale study within the field of educational sciences.

Research questions

- How do students collaboratively create knowledge while performing research activities?
- How do students create knowledge while writing in collaboration?
- How does existing technology support collaborative scientific writing?

Summary of results

1. Focus on trialogical activity around shared objects

The shared object was defined differently in the two investigated cases. In the UU case the course assignment was to conduct an empirical research in small groups (2-3 students) and to report on this research. Groups of students worked on common research reports, which they wrote in collaboration. Research practices were modelled by providing information of process management and templates and examples of research reports. In the UniNe case, participants were required to develop a personal ePortfolio, in which they wrote about their study path and their professional experiences. This portfolio was to be shared and elaborated with peers using a Wiki tool, in order to foster collective discussion and reflection on the nature and practices of educational sciences. For this purpose, wiki provided a template consisting of categories students could fill in with examples from their practice.

In the UU case, students specified that the research report they had to collaboratively write helped them to gain a focus in their scientific inquiry and in the writing process, especially when they were searching for scientific resources, conducting discussions, or writing sections of the report. Providing and processing feedback on the drafts of the group product was an activity employed by all groups. In the UniNe case, the results revealed that students had

difficulties to raise a common elaboration of texts and that the shared work shifted towards a collage of questions and comments. It was hypothesized that the difficulties could be the result of the insufficiently designed mix between the individual task (i.e., to create an ePortfolio) with a collective one (i.e., to develop a collective reflection on the plurality of social science education).

2. Interaction between personal and social level

Both collaborative and individual practices were embedded in the cases in this priority area. The results highlight that if the goal of the educational setting is especially to familiarize students with certain kind of collaborative writing practices, the requirement for collaboration should explicitly be built in the task assignments.

In the UU case, a framework was created during the course which allowed collaboration between various participants (i.e., students, teachers, researchers, clients). Students were provided with the freedom to create their own ways of working together, which resulted in a wide range of collaboration strategies. For instance, some groups discussed issues in a rather thorough fashion: they discussed every detail, performed research activities (e.g., created a research plan, set-up the research, collected and analyzed data) and wrote the report together; whereas other groups split tasks, performed them separately, reported on the results and met once on a week to discuss and evaluate the written sections. Discussions on literature, but also on own ideas or tutor's feedback took place regularly after groups realized that these helped to develop shared understanding on the research topic, research methodology or reporting strategy. In the UniNe case, students appreciated the idea of creating the ePortfolio, because for most of them it enabled them to reflect on their itinerary and could be beneficial in the preparations for applying for a job. However, students preferred their ePortfolios not to be accessible to everyone, since they were somewhat reluctant in sharing their experiences with other students. This resulted in a low degree of collaboration in discussions and in writing, although collaborative knowledge reflection was the original aim in the design of the course.

3. Fostering long-term processes of knowledge advancement

In the UU course, it was the first time that students were engaged in the whole process of conducting and reporting on an empirical study. These activities required a sustained epistemic endeavor and integration of knowledge and skills acquired during previous learning experiences. Regarding the learning activities during the course period, students mentioned that they appreciated this longer-term work on the shared product, because it gave them more time to gain a better insight in the scientific research approaches and scientific writing. Observations also revealed that the design of and the performance of a collaborative research project and writing a scientific report is an iterative process, which results in a gradually evolving knowledge product, which is based not on a momentary, but on a series of learning experiences. The clients involved in the project also indicated that they value this type of long-term projects and they are willing to get involved in long-term collaboration. In the UniNe case, students reflected on their whole personal study trajectory, which made the course as part of their personal long-term development but the iterative elaboration of written knowledge object during the course was not actualized in the way that was intended.

4. Development through transformation and reflection

The two investigated cases were somewhat different regarding this aspect: the writing assignment in the UniNe case concentrated mainly on conscious reflection and theorizing on one's own experiences and practices, whereas the UU case also required engagement in real research activities and hence implicit application of practice-based knowledge in addition to reflection on the practices.

In the UniNe course, students were active in the re-conceptualization of knowledge, which is illustrated by the creation of a new category in the template in the Wiki. Post-questionnaires indicated that students appreciated the use of reflection in the portfolios. It helped them to realize what they learned during their study, what their competencies are and how prepared they are for their future profession. Also, they made links between knowledge acquired in university and in their professional activities and better understood the complementarities and linkages between theory and practice. These appear to have resulted also in increased confidence in their capacities.

In the UU course students were active in combining and, subsequently, creating various types of knowledge, such as theoretical knowledge from scientific resources, practical knowledge necessary when conducting of the research studies, and writing and editing skills. Further, participants were required to reflect on their individual and their group's experiences three times during the course, and write down these reflections. The reflective reports reveal that students gave a great deal of thought to what research is, how it needs to be conducted properly, what the value of research is, and what their own contribution is to the collaborative research project and the scientific report. Many students indicated that these reflective activities helped them to take a helicopter view and make a thorough analysis of the reflected topics.

5. Eliciting (individual and collective) agency

The scientific inquiry assignment in the UU case represented a challenge for many students, in terms of getting the focus on the investigated topic, choosing the proper research approach, or designing and conducting the research. When writing the research report, many students indicated that the groups had to make deliberate efforts in taking collaborative responsibility for writing that suited all group members and was productive at the same time. Differences were registered in the degree to which students required external expertise when conducting the research and reporting of the research. Some groups relied heavily on teachers input and feedback; others required only feedback on drafts of the product.

In the UniNe case, students worked at a rather individual level, and showed avoidance in sharing any ideas with their peers. However, the initiative in creating new categories in the wiki shows that students were involved and committed to some extent to the commonly discussed topics and to the course activities.

6. Cross fertilization of knowledge practices

Cross fertilization occurred differently in the two cases: in the UU case by collaboration between different parties, in the UniNe case by students themselves reflecting on their experiences from the field through scientific writing. The UniNe case was based on students' individual study path and their reflection on professional experiences that could effectively be employed in the field. Students appreciated this possibility to reflect on their study progression. In the UU case, various participants and groups were involved in the research practices, which resulted in an intensive bidirectional cross-fertilization process between university and professional organisations. Five student groups fulfilled an authentic research task, provided by two external clients. Groups received guidance from expert researchers (i.e., teachers or researchers at the university) and some groups also from an external client. The final group products were presented during a Bachelor Thesis congress day, where students, teachers and clients were present. The groups who were conducting their research for a client also created an advisory reports for the client in addition to their research report.

7. Flexible tool mediation for trialogical activity

In the UU case, students and groups used three different web-based tools (Blackboard, a Virtual Learning Community and On-line Collaboration Platform) for supporting

collaborative research practices. These tools were mainly used for storing students' products and for sharing documents. Other communication tools (e-mail, chat tools, Skype) were frequently used for communication within the group and with external parties. In general, the tools that were provided within the context of the course did not always prove suitable for offering proper support for students' collaborative scientific practices. Students reported that they would require additional support for content-related scientific activities, such as collaborative writing – an online shared text editor was a suggestion made by students. Students also indicated that they lacked a tool that would support the management of collaborative working process. For instance, they suggested using a storage space which allows a complete and organized view of the produced drafts. The need for communication functionalities integrated in the main tool was also expressed by students.

In the UniNe case, a wiki tool and a discussion forum were used to foster students' reflective activities. In practice, the students used Wiki as a discussion forum instead of the forum itself. In addition, the students did not dare to modify someone else's text and all the comments were added afterwards. It also appeared that students preferred to pose questions or to create new categories instead of improving an existing text. Relating this to the other results, it seems that the use of technology was influenced by the way students understood and positioned themselves towards the course task.

Conclusions

The collaborative research activities represented a proper incentive for students for engaging in collaborative inquiry and writing. Students learned new research approaches and created their own collaborative practices. In addition, students gained and developed more knowledge related to scientific writing techniques and ways to write texts in collaboration. The results indicate that technology fell short in providing appropriate support for collaborative writing; an aspect that informs technological design in KP-Lab. Furthermore, especially in the UniNe case, the design of educational settings in future iterations should consider the reasons why students did not engage in collaborative activities and find ways to promote collaborative writing practices in the future. Perhaps course design affected; perhaps investigators methodological lens did not capture evolving collective agency. It is important to make sure that students understand the task and the purpose of using a particular type of technology to support the task. In the use of technology, it is important to stimulate students to develop appropriating practices, in order to use these tools optimally. Moreover, findings from cases in this priority area indicate that it is important deliberately provide support for developing knowledge practices typical for professional scientists.

2.6 PA8: Contextual investigation of knowledge practices in personal use of students

This PA concerns a contribution to methodological development for investigating knowledge practices. The focus is on developing process-sensitive tools, which enable the integration of participant's individually reported plans, thoughts, emotional states, descriptions and assessments with their everyday activities. Also, this PA describes the attempt towards collecting multimedia recordings about these activities into analyzable data for longitudinal research of students' knowledge practices.

KP-Lab has been developing the CASS (Context Sensitive Activity Sampling System) methods which is motivated by *Ecological Momentary Assessment* (EMA) and *Experience sampling methods* (ESM) that have emerged over the last decades as new research paradigms for collecting data about respondent's experiences while they are engaged in activities taking place in natural environments (Reis & Gable, 2000; Stone & Shiffman, 2002). A crucial aspect of such method is to collect longitudinally contextually occurring data of the

participants' knowledge practices rather than ask the participant themselves to make global respective generalizations of their activities. In this regard the CASS diverges drastically from conventional survey methods. The CASS-method capitalizes on mobile technology for making research practices more process-sensitive, longitudinal, and developmentally-oriented in nature. By following a multi-methods approach, the quantitative and qualitative data of CASS investigations will be analyzed in conjunction with qualitative data obtained by interviews, observations, and curriculum descriptions.

Up to now, only the first year students have been investigated; the baseline data in question is needed for analyzing subsequent transformations of knowledge practices. Some results of the studies have already been published (Muukkonen, Hakkarainen, Jalonen, Kosonen, Heikkilä, Lonka, Inkinen, Salmela-Aro, Linnanen, & Salo, 2007). While continuing the study, the very same students will participate both in CASS-investigations and take part in various courses (interventions) supporting trialogical learning practices, investigated within frames of the other PAs.

In collaboration with researchers from Helsinki University of Technology, CASS is being further developed to provide instruments needed for contextual research on work activity. CASS is being applied to examine contextually professional experiences of distributed virtual work. The methods developed are focused on tracking contextually and longitudinally experts' experiences across physical, virtual, social, and mental spaces of professional activity.

Research questions

- How can evolving knowledge practices be captured context-sensitively?
- How do personal and collective knowledge practices relate to one another? Analytic focus on personal appropriation of expert-like knowledge practices or modeling development across time do not make the practices subjective in nature. Knowledge practice could be personally appropriated but still collective in nature.
- What is the role of different contexts, practices and mediating artefacts in learning and creating knowledge?
- What kind of agency does university education elicit?
- What kinds of learning processes and practices hinder or promote the development of agency?

Research methods

The study is planned to include intensive 3-4-year follow-ups with the same student. To repeat the data-collection during four consecutive years, the students are asked yearly to take part in a two-week intensive data collection, questions prompted by mobile telephone five times a day (Nokia sponsored us 20 E70 mobiles).

During the spring 2007, four two-week CASS-mobile phone research periods took place. Participating students were in their first year of studies. At the University of Helsinki, there were two groups participating, educational psychology and teacher training. At the University of Jyväskylä they were participants majoring in psychology (the data was collected in collaboration with the Finnish Centre of Excellence in Learning and Motivation Research). In Espoo, the students were engineering students from the EVTEK University of Applied Sciences, media engineering in the Finnish degree program and in the English degree program. The students were also interviewed individually before and after the two-week period and information was collected about their curriculum, which courses they were taking part in and how those courses were organized.

The data-analysis was carried out with multi-methods approach: quantitative analysis of query data, including comparison of group means and time series analysis of participant's data, and qualitative analysis of projects and other interview data.

Summary of results

The focus of this PA is on the context sensitive investigation of students' knowledge practices and on gaining an insight into how motivational, epistemological and emotional factors are related to students' ongoing activities. As a consequence of methodological focus, the following discussion is not organized according to the design principles.

Preliminary results suggest that the study-related objects, on which students worked together with someone, were mostly determined by the course instructors, e.g., a task or project to carry out as a course assignment. The leisure-related objects were more often defined by long-term personal interest of a student. It could be explained that CASS is designed to address long-standing object oriented work. The projects were personal in this case but could have been collective as well.

Results revealed that there were significant differences between the four groups of students investigated regarding study practices in the first year. Two groups of students had particularly high percentage (about 70 %) of interaction with others while working, the small group of educational psychology students at UH and the Finnish degree engineering students at EVTEK. The psychology student in University of Jyväskylä reported working nearly 70 % of times on their own. The students in the international degree program at EVTEK worked more alone than the other group at EVTEK.

Overall, we found that working in interaction was related to more positive emotions and a higher feeling of competence. Among all locations (café, library, home, lecture, travelling, small group, seminar, elsewhere), feelings of flow were raised in library and small group work. The situational challenge was perceived higher in small group interaction, working with teacher, and in library. Contradictorily, during lectures the student reported low competence, commitment, importance, challenge, and flow.

For these first year students, most of their study related projects had curriculum-based goals and timeframes. Here we have to be careful because some of the results reflect what the students were asked to address (two study related and one other personal project). As study-related projects, they mostly raised courses or learning of skills they were engaged in their studies. On the other hand, their more leisure-related projects such as hobbies and interests portrayed generally a longer-term engagement in activities, which were often partially related to their study-field.

For all students, small scale projects in teams appeared to be most stressful, but also elevated interest during studying. A more qualitative analysis has yielded preliminary findings comparing the two degree program in UH and in EVTEK suggesting that the arrangements where students were working more in small groups, were fruitful in building a learning community. Naturally, our limitation is that by means of CASS-Query data-collection, we can only address the issue from personal viewpoint, as this method is focused on individual knowledge practices. However, the design of the curriculum was seen to have a major impact on whether students are directed to working solo (more lectures and exams) or with peers (more projects and collaborative assignments).

Conclusions

From the view of the knowledge practices we examined, the five groups of students were observed to have degree-program-related differences in how often they worked in interaction with other or alone. The locations that elevated interest and flow feelings were more often

small group and library work. Being in lectures, for instance, was related to the lowest levels in the feelings of competence, commitment, importance, challenge, and flow. Cafés were also found to be important places, raising feelings of competence.

Results from the interviews of these first year students suggested that students appear to rely very much on the requirements set by the curriculum in defining their study-related activities. Typical for their leisure activities was more long-term engagement and personal interest. As a hypothesis for the follow-ups, we expect to see a change as students advance in their studies, so that their personal interests become more intertwined with the courses they select and that the study-related projects become more long-term as well.

The CASS-research carried out with the CASS-Query tool provided an abundance of different types of data, which are currently under investigation. The tool itself was found to work very well for the research purpose. Additional high-level user-requirements were drawn on usability and research practices issues, e.g., interface design for answering Likert-scale questions and the tailoring of different sampling procedures. These requirements are further elaborated in the WK Mobile tools.

3 General conclusions and discussion

The aim of the present deliverable was to report the main findings of the case studies conducted within WP8 during the first period of the KP-Lab project. Based on these results, this section provides an overview of the central conclusions which will inform and feed into the co-design process in KP-Lab. This involves that those conclusions are reported which serve as input for the development of knowledge practices and pedagogical design in higher education, of KP-Lab tools, and of the theoretical definitions of the trialogical approach on learning through revisiting the design principle and priority areas.

3.1 Limitations of design, data sources, and methods of the present investigations

It is essential to put the present conclusions in context by addressing the methodological limitations of the case studies reported in this deliverable. The trialogical framework is evolving and some of the aspects of trialogical approach on learning addressed remain fuzzy and in need of clarification. We have not yet developed adequate instruments for analyzing all aspect of trialogical learning. For instance, the concept “epistemic agency” turned out to be difficult to operationalize. While the notion of “epistemic agency” is essential, we do not have well-developed measures at our disposal to investigate its emergence and conditions fostering its development.

Because of lack or immaturity of methods, we may have been relying too much on the participants’ self-assessments and personal opinions (i.e., discursive entities) while evaluating various aspects of collaborative learning and knowledge practices. Self-reports are a valuable source of information but only among other data sources. KP-Lab is concerned with the creation and fostering of knowledge practices; using self-reports for measuring these practices does not reveal their enacted and tacit nature. In order to capture knowledge practices we need to combine multiple research and data collection methods as, e.g., in ethnographic studies. The reverse side of this methodological solution is that such methods are very resource-intensive. Therefore, the research done in the future iterations of the case studies should carefully be focused on the knowledge practices and conditions for fostering them.

3.2 Research on knowledge practices and pedagogical design

In this deliverable, the knowledge practices studied in the first 18 months within the WP8 have been categorized under six priority areas: 1. Managing collaborative design in higher

education; 2. Retooling boundary crossing between education and work; 3. 'Knotworking' in complex learning environments; 6. Ontology-based collaborative modeling; 7. Developing technology-enhanced practices for scientific writing; and 8. Contextual investigation of knowledge practices in personal use of students. Since the cases were already chosen before the PA framework in the project was developed, there exist a range in the perspectives of the investigated courses which differ in the extent to which they comply with definitions of the respective PA they belong to. For instance, knowledge practices are a special kind of practices which involve epistemic mediation in terms of generating knowledge artifacts. These artifacts were not similarly explicated in our cases or were differently emphasized as a core element of the activities in the course design.

Across the research cases in the priority areas, certain aspects of knowledge practices have particularly been emphasized which appear to be well in line with features that are emphasized in the trialogical design principles:

- Authenticity, involving "real" problems, tasks and clients;
- Assignments in which the creation of collaborative knowledge is emphasized and working on the development and advancement of concrete knowledge objects;
- Focus on flexible knowledge practices such as: teamwork, management and collaboration skills;
- Application and development of templates, models and conceptual tools to support knowledge practices;
- Integrating and translating between theoretical and practical knowledge, as well as conscious and implicit application of knowledge related to various practices.
- Deliberate reflection on individual and collaborative knowledge practices;
- Cross-fertilization of knowledge practices between students, teachers, and external actors such as professionals and clients in organizations and companies.

Research findings reported for each of the priority areas led to the following conclusions:

- Students' tasks that concentrated on the creation and advancement of a concrete, shared object promoted various kinds of collaborative practices and fostered the development of commitment to sustained elaboration of knowledge products. In addition, the creation of shared external representations of complicated and multifaceted knowledge was a worthwhile but also challenging activity for the students. Being compelled to negotiate and create a knowledge object together, provided students with the incentive to actively search for and adjust suitable collaborative knowledge practices for teamwork objectives, as well as to engage in explication and reflection;
- It appears that authentic tasks enhanced practices that indicate students' taking shared responsibility of their activity; students persevered in producing a high quality product when it was going to be used in real practice. In most courses, working with an external client and creating an authentic product presented an extra motivation and challenge, not only for the students, but equally for the teacher and for the clients, because they were faced with new types of collaboration and professional standards;
- Findings from boundary crossing between education and workplaces suggest that the main difficulty was to bridge the gap between the study-oriented knowledge practices learned during the academic training and the knowledge practices encountered in the professional field where situations are more complicated. Nevertheless, the cross

boundary experiences were highly valued among the students. Due to the exchanges and analysis of their peers' experiences, the students become aware of alternatives;

- The results from the comparison of university-level study programs through the investigation of personal knowledge practices indicated that there are systematic differences in how much there are collaborative or "trialogical" knowledge practices in separate study programs. In the tradition-laden field of medical training, the knowledge-creation metaphor and the trialogical design principles contributed importantly into the educational design in an innovative sense;
- The collaborative research activities represented a proper incentive for students for engaging in authentic collaborative scientific inquiry and writing. Not only research approaches and collaborative knowledge and strategies were learned, but also scientific writing techniques and ways to write texts in collaboration were advanced. The results from separate cases revealed that collaborative practices should explicitly be modeled and promoted in educational settings; productive collaboration does not necessarily emerge spontaneously.

Our general observations as well as remarks from university teachers involved suggested that the courses and knowledge practices studied represented relatively sophisticated pedagogical designs, compared to standard courses in each educational institution. Thus, they were representatives of rather innovative pedagogical practices, although not all cases involved an intervention towards more trialogical emphasis. However, the practices incorporated new types of challenges to be met by the educators and students alike. The following points refer to new challenges to be taken into consideration when engaging in future iterations of pedagogical designs and research.

- The complexity of design task and the circumstances of authentic work situations render the situations less foreseeable or manageable by the teachers or students, introducing new types of knowledge practices. However, such situations may highlight students' proactive role in the regulation of activities, and, correspondingly, making an appeal on teachers' pedagogical practices to support the development of students as agents of their own learning activities. More research is needed to investigate how to best support students to transform their knowledge practices that correspond with those required in the field;
- Obtaining the full engagement and commitment from clients and external agents or experts is necessary for cross-fertilization to take place;
- For teachers and institutions, external collaborators require substantial efforts for networking with clients, keeping databases with available clients, supervising projects, and re-organizing teaching responsibilities;
- Facing the need to deal with abstract and conceptual knowledge may be highly challenging for bachelor-level students. Students' prior knowledge and experiences with technological enhanced collaborative learning should be taking into consideration when new pedagogical methods that are aimed at supporting knowledge creation practices are being developed;
- Potentials for collaborative modeling and using conceptual frameworks in heterogeneous and multi-disciplinary teams should be addressed more systematically. When domain-specific schemata or modeling languages are used as part of students' knowledge practices, special training might be required and scaffolds should be carefully selected to achieve the goals that were the original reason for choosing those practices as part of the educational setting;

- The research on design of educational settings should consider the reasons for which students do not always engage in collective activities as expected, and find a way to promote the emergence of these activities;
- In view of the personal knowledge practices examined, the first year follow-ups produced evidence that working in collaboration (in contrast to attending lectures) was seen to lead to increases in motivation and in positive feelings towards students' own competence. However, more research is needed to investigate how students' practices transform based on cumulative collaboration experiences.

3.3 Tool development

As indicated by the results of the case studies, existing technologies variably provided support for the collaborative design, modeling, and writing activities. Available tools (e.g., content-management systems, groupware solutions, blogs, wikis, or visual modeling CmapTools) were considered as preferred in educational practice, but the tools themselves or the objects produced by them were often hard to integrate with other systems, making it difficult to exchange background materials or further revise knowledge objects, models, and designs. Students who were proficient in technological tools, started on their own initiative, to use also tools outside the ones offered in the course. Students less competent and confident with technology, however, had problems with incorporating more than one tool at a time. The use of multiple tools resulted in increased training needs for the students, usually beyond the time resources in a course. Thus, in the the use of technology, it is important to support students to develop an understanding of the tools and their functionalities, in order to use these tools optimally.

A noteworthy observation was that the trial of the *Shared Space* prototype, even if it was not ready or reliable at the time, did prompt student to envision more advanced functionalities for the targeted knowledge practices (i.e., collaborative design), which was not at all encountered to the same degree or specificity in the courses organized with existing tools. Hence, hands-on experiences with prototype tools appear an important means for obtaining end-users needs.

Students, teachers and clients participating in the case studies provided various suggestions for improving the existing technology and/or ideas for new tools. The most relevant suggestions were:

- Support of collaborative document management such as a common space wherein documents can be uploaded, organized in a hierarchical fashion, and shared with the other participants;
- A holistic and organized view of the produced drafts;
- The possibility to edit documents synchronously, an online shared text editor;
- Access to a shared workspace allowing clients to test prototypes of the design products, and to deliver their comments and feedback for the students;
- The need for awareness tools, permitting the participants to keep track of each others' working progress;
- Appropriate searching functionalities, allowing various criteria to be used in searching;
- Chatting (or audio) functionalities facilitating virtual communication and awareness to be integrated in the overarching tool;
- Wiki's should offer the possibility of creating tables and of using different authoring rights;

- Annotation tools aimed at supporting observation of and analyses of (medical) teamwork and communication;
- Sustained modeling activities with students working remotely also require dedicated functionality for commenting and communication while being engaged in the modeling process;
- Support for creating and using more refined modeling languages beyond the mere employment of concept maps.

Following the co-design framework of the project, these suggestions have already been communicated to and processed in the different working knots suggesting user-requirements for the KP-Lab tools.

3.4 Applicability and development of design principles and priority areas

The KP-Lab design principles were selected as the shared framework for reporting the research carried out across the priority areas. Comparison of similar cases in each PA helped to concretize how DPs are actualized in practice. As each case and the findings from it was first described by the research partner, partners were subsequently engaged in comparing the interpretations and the findings across cases, first within the priority areas and then across them. This constituted a rather fruitful collaborative process to advance our understanding of knowledge creation practices in higher education. In addition, we consider that our approach to use the DPs as a common framework to structure and organize the description of our results was beneficial for understanding and communicating the current knowledge practices involved in each PA and within our work package as a whole.

In terms of (re)designing educational practices, the DPs were found to be valuable; although they do not specify exactly how affordances of pedagogical methods or tools should be designed, they emphasise certain aspects rather than others and give valuable hints about which directions the design and development of practices should take. In parallel, major efforts have been placed in the co-design activities (also framed by the DPs) that are central in developing new tools for the knowledge practices in the targeted priority areas and the investigations in the next iterations of our research. However, the definitions of DPs should constantly be developed as more unambiguous.

During the analysis and reporting phases, vivid discussions were raised on the meaning of some of the concepts employed in the DPs; for example:

- The connotations of a design product versus a design object were discussed both from theoretical and practical points of view. Discussions resolved around: different interpretations of how a shared object can be conceptualized, objects as the abstract motive for students' activity versus products as the concrete end results of this activity. This last point of discussion corresponds to a high degree with the recent scientific literature on object of activity (e.g., Engeström & Blackler, 2005; Kaptelinin & Miettinen, 2005).
- The actual practices of boundary-crossing and cross-fertilization raised questions of whether there are some particular criteria for using these terms; for instance if cross-fertilization requires a contact with actual practices of another institution or organization, or whether it can be conceptualized as involvement of agents representing knowledge of different instances and practices;
- The issue of "long-term knowledge advancement" turned out to be ambiguous and in need for refined and common definition. It is not a matter of the length of the process

which many analyses appear to assume but the iterative pursuit of advancing epistemic artifacts. One semester can be sufficiently long period of time for various knowledge creation processes but true advancement is only possible through a systematic process of creating novel knowledge products throughout the course, even in the small scale. Here lies the weakness of many projects completed; the design of the courses did not sufficiently elicit such iterative processes for developing the created products;

- DP2 (Interaction between personal and social level) and DP5 (eliciting individual and collective agency) appear somewhat overlapping and agency is not operationalized very well; various things are used to refer to agency.

Overall, most of these questions can be translated to research problems in the next iteration of research and be fed into the work of WP3. A challenge for developing the trialogical framework can be seen to consider these issues and to contribute to the further explication of pedagogical models for knowledge practices in higher education.

As a general comment on the definition of the priority areas, it can be noted that it was complicated to define what was the core focus in the research of some cases belonging to that particular PA. Thus, for some cases it proved to be difficult to put them into a certain PA and compare it with other cases in this PA. Similarly, at least the PA on Collaborative scientific writing' would, from our perspective, be more appropriate if widened in scope, and become *Developing technology-enhanced practices for collaborative scientific inquiry and writing*. That way, it would encompass both courses that are more directed towards inquiry practices, but also others that focus on writing.

Currently, the role of PA8 on contextual investigation of knowledge practices is focused on methodological development, which sets it apart from the other PAs. However, the intention in a longer perspective is that the investigation of the transformation of knowledge practices converges more with the research carried out in other PAs, as the student progress in their studies and take part in boundary-crossing and project work practices, investigated simultaneously.

This discussion on the design principles and priority areas relates to the questions about how to further define the focus of research in KP-Lab in the consortium level so that it becomes clearer into which direction the cases and interventions should be transformed. These aspects should be considered in the development of a joint research strategy (Deliverable 3.2), both in the level of the linkage between empirical research and theory, but also between the empirical research and technological development.

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