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## **Pedagogical design for knowledge creating inquiry in customer projects**

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**Abstract:** Two higher education courses involving students, teachers, and customers in multifaceted experiences of knowledge creation are described. The Trialogical Learning Approach (TLA) provides a theoretical framework to address learning and teaching organized around authentic problems and the development of shared knowledge objects, such as reports, products, and new practices. The approach directs attention to those aspects of social interaction and artifact-mediated activities, which focus on the development of shared objects and the pursuit of novel knowledge and understanding. The roles of

technology-mediation, customer involvement, and guidance in developing effective pedagogical practices for knowledge creation were addressed. It appears necessary to design sufficient open-endedness and complexity for students' teamwork to generate unpredictable, practical, and epistemologically challenging situations. Pedagogical design for such a process has different foci in the four central phases: planning, project initiation, project execution, and presentation and evaluation. Planning and initiation are central to establishing relevance and project awareness for the collaboration of student teams with a customer. Guidance and expert modeling during project initiation and execution is needed to overcome feelings of uncertainty during a challenging and complex assignment. Mediation provided by collaboration tools facilitates reflection on collective practices, iterative development of knowledge objects, and documentation of the learning outcomes of customer projects.

**Keywords:** Higher education; Customer project; Pedagogical design; Knowledge creation; Technology-mediation

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## 1. Introduction

The education of new professionals for knowledge work is a multifaceted endeavor. On one hand there are the knowledge, skills, and practices of established domains, but on the other hand, concepts such as knowledge society competencies, knowledge creation, or 21st century skills (e.g., The OECD Program Definition and Selection of Competencies, 2005; Salas-Pilco, 2013; Tynjälä, 2008) are being highlighted which are difficult to assign clear cut definitions or operationalize into educational assessment.

A means for teaching professional knowledge work practices involves creating spaces for interdisciplinary collaboration within projects or workshops (Latucca, 2002; Manathunga, Lant, & Mellick, 2006; Derry & Fischer, 2005; Nance, 2000). These are meant to simulate work life practices in cross-functional environments (Muukkonen, Lakkala, Kaistinen, & Nyman, 2010). Collaboration in professional contexts, for instance the development of new products, often takes place in the settings in which the collaborators have different professional orientations, perspectives, and skills. The findings from a study of software development teams by Kang, Yang and Mason (2008) suggest that the advantage of this kind of knowledge diversity can be realized more explicitly if team members are aware of each other's differences and uniqueness. Therefore, in contrast to situations confined to studying within one discipline alone, multi-disciplinary course settings can optimally prepare an individual for these kinds of challenging cross-functional environments (Lantos, Brady, & McCaskey, 2009).

It has been argued that cross-fertilization between the practices of diverse knowledge intensive communities and settings is a factor that facilitates advancements in knowledge creation (Paavola & Hakkarainen, 2005). These authors have suggested that engaging students in solving complex problems from outside of educational institutions and organizing the development of shared objects between students and experts can be ways for achieving such cross-fertilization. Potentially, student projects that create artifacts for external stakeholders provide experiences that can be used solving complex problems, and in combination with reflection, they make all parties more aware of their expertise and collective practices (Hakkarainen, 2009; Roth & Barton, 2004; Virkkunen, 2006) as well as knowledge management requirements.

Drawing on the expertise of participants from multiple disciplines and their theoretical backgrounds, tools, and practices gives access to new cultural tools and meditational means. The result of such interdisciplinary, synthetic efforts is giving the participants "the capacity to imagine new ideas, new projects, and new futures" (Latucca, 2002, p. 734). However, it has also been noted that cultural diversity tends to create additional challenges due to language and communication style differences, as well as culture-bound prior educational practices (e.g., Volet & Ang, 1998). Tynjälä, Slotte, Nieminen, Lonka, and Olkinuora (2006) concluded that this is a challenge, which calls for the development of university pedagogy in a way that makes it possible to integrate studying domain-specific knowledge with learning generic skills, such as interpersonal skills, communication, presentation, and collaboration skills.

Prior findings have suggested that collaborative learning based on complex problems can be successful with students who are advanced in their studies and wish to prepare for the challenges of future workplace practices (Carr-Chellman, Dyer, & Breman, 2000; McCune, 2009; Goltz, Hietapelto, Reinsch, & Tyrel, 2008). Two cases from higher education are summarized in our paper. These courses have been designed by the teachers and their collaborators from professional organizations (course customers) to engage undergraduate students in complex knowledge creating inquiry processes in multi-disciplinary teams. Knowledge creating inquiry is defined as higher education

practices that seek to foster collaborative inquiry into authentic, open problems and shared development of knowledge objects (Muukkonen & Lakkala, 2009; Muukkonen, Lakkala, & Paavola, 2011). This entails applying theoretical and research-based knowledge in practice during customer projects. The aim of the present paper is to explore what kinds of knowledge creating processes higher education students are engaged in when they work on real customer projects and how these processes can be supported by means of technology, customer involvement, and instructor guidance.

## 2. Related work

### 2.1. Trialogical learning approach

The two cases in this paper have been explored within the Knowledge Practices Laboratory project (KP-Lab; <http://www.kp-lab.org>). The project has been based on the *Trialogical learning approach* (TLA), which includes three metaphors of learning: the acquisition and the participation metaphors put forward by Sfard in 1998, and the knowledge creation metaphor introduced in Paavola, Lipponen, and Hakkarainen (2004). The acquisition metaphor of learning addresses assimilation of prevailing knowledge and an individual's mental models and strategies of learning. Such practices are quite familiar to anyone taking part in traditional higher education courses, i.e., attending lectures, working on individual tasks, and reading for exams. The participation approach highlights the adaptation to existing cultural and communal practices and the dialogical practices of learning (Lave & Wenger, 1991; Sfard, 1998). Such practices may be exemplified by field-training period, where students become familiar with the practices, tools, and cultural knowledge of a particular working community.

In various models describing knowledge creation, for instance in Engeström's (1987) expansive learning, Nonaka and Takeuchi's (1995) organizational knowledge creation, and Bereiter's (2002) knowledge building, a key characteristic appears to be that collaboration is organized around long-term efforts to develop shared, tangible objects, such as products, articles, models, and practices (Paavola & Hakkarainen, 2009). The trialogical learning approach upholds the cognitive (individualistic) and social (participatory) forms of expertise and learning, but emphasizes the knowledge-creation (object-centered) approach. The presence of these artifacts, practices, and products—objects—is the rationale for the term 'trialogic' in contrast with the 'dialogic' approach. The objects are seen to mediate knowledge advancement by structuring the efforts of the participants in the direction of working on these objects, negotiating meanings, expanding, and versioning them by collaborative efforts. This approach puts emphasis on the interaction between collective and individual efforts in working on shared objects as well as on the iterative and sustained character of this process.

Within the TLA, six *design principles* (Paavola & Hakkarainen, 2009; Paavola, Lakkala, Muukkonen, Kosonen, & Karlgren, 2011) have been explicated to define the characteristics of pedagogical practices suggested to promote students' knowledge work competencies: 1. Organizing activities around shared "objects"; 2. Supporting integration of personal and collective agency and work through developing shared objects; 3. Emphasizing development and creativity in working on shared objects through transformations and reflection; 4. Fostering sustained processes of knowledge advancement with shared objects; 5. Promoting cross-fertilization of knowledge practices and artifacts across communities and institution; and 6. Providing flexible tools for developing artifacts and practices.

In this paper, design principles 1, 5, and 6 are in the main foci because the teachers highlighted these aspects in their pedagogical planning. However, also the other design principles have their roles in the course designs, in the form of soliciting individual efforts within the team framework, promoting reflection on collective practices, and iterative advancement of course assignments.

### *2.2. Educational practices for cross-fertilization of knowledge practices between educational institutions and work organizations*

One of the design principles of TLA (see Paavola et al., 2011) posits *cross-fertilization between the practices of diverse knowledge intensive communities and settings* as a factor that facilitates advancements in joint knowledge creation. The importance of cross-fertilization of knowledge practices between educational and professional practices (e.g., Derry & Fischer, 2005; Hakkarainen, Palonen, Paavola, & Lehtinen, 2004; Tynjälä, 2008) stems from the fact that professional communities typically develop their own methods, means of communication, tools, languages, and practices, which may be difficult to understand or enact for someone coming from a different community. The ability to transfer between contexts may be seen as a specific competence (Walker & Nocon, 2007; Tuomi-Gröhn & Engeström, 2003).

The settings used in the present paper, two higher education courses, cannot be defined as long-term communities. They have been summoned and disengaged in the frame of 3-6 months, and teams hardly have had time to develop any collective practices in a sense of a community of practice (Lave & Wenger, 1991; Wenger, 1998) or a knowledge building community (Scardamalia & Bereiter, 2006). Yet, it is argued that the members of a course do engage in building a learning community, and tutoring efforts should strongly facilitate this. Even though they may be transient, such learning communities in a course should be transparent. On the part of the instructors, there is a pressure to model and structure the activities around the development of shared objects; and on the part of the students, teams are expected to negotiate and establish practices for collaboration at an accelerated rate.

Other research has further highlighted other concomitant challenges for effective teamwork, e.g., managing team diversity, interpersonal skills development, coordinated information search, and integrating individual and group problem solving processes (e.g., Bolton, 1999; Goltz, Hietapelto, Reinsch, & Tyrel, 2008; Mäkitalo, Weinberger, Häkkinen, Järvelä, & Fischer, 2005). Within the dialogical learning approach, these questions are seen to be essential for the design principle on supporting integration of personal and collective agency and work through developing shared objects (2). Research in this field has particularly examined the role of agency (e.g., Damsa, Kirschner, Andriessen, Erkens, & Sins, 2010; Kosonen, Muukkonen, Lakkala, & Paavola, 2012) during collaboration.

### *2.3. Mediation based on collaborative technologies*

The concept of mediation explicates the intermediary role of tools in a community's knowledge creation activities (Vygotsky, 1978). Mediation based on collaborative technologies can be said to transform students' intangible ideas into digital entities that can be further articulated, shared, interlinked, and extended (Hakkarainen, 2009). As prolonged episodes of knowledge advancement tend to become messy and layered, instruments and methods that allow making visible, reflecting on, and transforming prevailing practices are needed. As also expressed in the last TLA design principle, a

flexible educational technology should provide varied types of mediation for a team's collaboration, including epistemic, pragmatic, social, and reflective types of activities (Paavola & Hakkarainen, 2009; Rabardel & Bourmaud, 2003; Lakkala et al., 2009). *Epistemic mediation* involves creating, transforming, commenting, organizing, and linking knowledge artifacts. It is needed for the explanation of understanding and advancement of knowledge. *Pragmatic mediation* is needed for practices such as planning, organizing and coordinating tasks and work processes. *Social mediation* aims to foster managing social relations and interacting around shared objects. *Reflective mediation* intends to support making visible and reflecting on the work processes (Lakkala et al., 2009; Paavola et al., 2011). The integration of various types of mediation in one environment is one of the interesting design challenges of learning technologies, because current environments typically mediate only one type of practice, for instance pragmatic mediation is offered in many project work tools; similarly, social media applications create forums for advanced types of social communication.

### 3. Research objectives

The exploration of the two cases in the present paper aimed to shed light on aspects of pedagogical design for knowledge creating inquiry and to contribute to theory development within the Trialogical learning approach. In particular, the following questions were addressed:

1. How were the course activities arranged to promote working on shared objects?
2. How was technology-mediation designed and carried out?
3. How did customer involvement promote cross-fertilization of knowledge practices?
4. How was guidance arranged to support the development of effective inquiry practices?

### 4. Methods

#### 4.1. Research framework

Design-based research (Brown, 1992; Collins, 1992; Design-Based Research Collective, 2003) is a methodological approach, which focuses on examining educational practices by iteratively designing interventions or pilots, examining what works, identifying constraints and limitations, and re-designing the field experiment in the subsequent iterative cycle. Design-based research is, by nature, hypothesis generating and cultivating, rather than testing (Kelly, 2006). The aim is to directly impact practice while advancing theory that will be of use to others (Barab & Squire, 2004). This is envisioned to take place by uncovering causal processes within the complex interactions between the elements of a design and the participants in a particular setting (Sandoval, 2013).

This paper makes a comparison between the pedagogical practices in two courses at a descriptive level. It addresses the details of pedagogical planning, arrangement of course activities and tool use, customer involvement, and guidance. The paper draws on research carried out on previous iterations of Case 2 (Marttiin, Nyman, Takatalo, & Lehto, 2004; Muukkonen, Lakkala, Kaistinen, & Nyman, 2010), and the present courses (Kosonen, Muukkonen, Lakkala, & Paavola, 2012; Nikko, Muukkonen, & Hakkarainen,

2013). Design-based research is therefore applied here to expand on the description of the pedagogical design and guidance practices for knowledge creation in customer projects.

#### 4.2. Procedure

The researchers, the first two authors, took part in planning sessions prior to the start of the courses with the course teachers and customers (audio-recorded), followed some of the teaching sessions, and carried out interview sessions of teacher groups in both cases after the course. These interview sessions concentrated on course idea and objectives (e.g., What are the goals of the course?), course content (e.g., What is the role of the customer in the course?), pedagogical implementation of the course (e.g., What are, in your opinion, the critical phases, issues or elements in implementing this kind of course?), and experiences of the course, (e.g., How would you evaluate the organization and implementation of the course? What succeeded well and what should have been done in another way?). In addition, customers were interviewed in both cases after the course to obtain an understanding of the customer's conceptions about the purpose of the course, and their experiences of course implementation and technology use.

The students were asked to reflect on their learning experiences after the course, their reflections were collected as open-ended questionnaires by email. The students were asked the following questions: 1. How would you characterize your overall experience(s) of the course? 2. How would you characterize your own participation and activity during the course? Please justify your answer. 3. What has been positive or impressive in the course? 4. What has been challenging or disturbing in the course? 5. How satisfied are you with the guidance and support that you have received from the teachers and the clients? Please explain why? 6. Which collaborative technologies have you used for course work? 7. How would you suggest the use of collaborative technologies could be improved for a next iteration of this course? 8. Other comments? We obtained 35 responses for Case 1 and 22 for Case 2. All responses were read through several times and excerpts from the responses are presented in the findings to exemplify students' reflections on their learning experiences.

#### 4.3. Settings

##### 4.3.1. Case 1: Application Development Project

Case 1 is the "Application Development Project" course (short ADP) that was organized at the Metropolia University of Applied Sciences, Finland, and lasted from September to March. Undergraduate students and teachers from 3 training programs, *media engineering*, *industrial management* and *media and communications* participated in the investigated course. In addition, four customer organizations were involved in the course. It was purported to promote learning of various professional practices featuring the development of business ideas and related services and multimedia products in real working life.

A total of 50 students participated from 3 degree programs: media engineering (n = 18), industrial management (n = 30), and communications (n = 2). Of these, 44 % were international students. Four teachers participated in these programs, (2, 1, and 1 respectively). Four customer organizations were intensively involved in the process: a small online recommendation company (5 representatives), a large mobile phone company (2), a small music company (1) and a small photo company (1).



#### *4.3.2. Case 2: Tax Office Exercise*

Case 2 was a course on advanced themes in project management called the Tax Office Exercise (TAX). It involved students and academic staff at the University of Helsinki and the Aalto University School of Economics and lasted from March to May. In this optional course student teams were asked to analyze the characteristics of different groups of taxpayers and to plan a research project to be later implemented by a customer. The customer organization for the course was the Finnish Tax Administration.

Students were organized into multidisciplinary teams, including business and behavioral sciences expertise. 4th year master education students ( $n = 30$ ) from several different training programs (including educational science, economics, information and service management, cognitive science, and psychology) took the course. Of these, 20 % were international students. Three teachers and 2 facilitators from the university departments were involved. Three customer representatives were involved in planning and reviewing the team productions, and three more were following the course practices and outcomes.

#### *4.3.3. Knowledge practices environment*

The Knowledge Practice Environment (KPE) served as the main shared virtual working environment during both courses. In both courses, the environment was used so that there was a common working space for all participants of the course, “the course space”, and working spaces for each team, “the team space”. They were accessible to all course participants. The instructional materials and working documents as well as needed timetables were uploaded into the course space. The students and teachers were introduced to the basic functionalities of KPE. The teachers and the researchers planned the basic visual layout of the course space. The students themselves managed each team space. The student teams were supposed to make use of these functionalities in structuring their work into sub-tasks, in defining their timeframes and organizing diverse working documents and joint elaboration on them in their own team spaces.

## **5. Findings**

### *5.1. Course activities to promote working on shared objects*

In Case 1, the Application Development Project, the students worked in 11 multidisciplinary teams of 3-6 to develop business plans, user stories, marketing strategies and software architectures to come up with an application and business in operation. The students were introduced to the practices and methods used in business and application development by a series of lectures. Some of the lectures were given by visiting experts from the business settings.

Working documents (templates) pre-structured with domain specific conceptualizations were used to guide students’ work on their solutions and analysis of related problem spaces. In addition, the teams were instructed to advance such documents as user stories, software architectures, mockups, prototypes, sales pitches, and weekly team progress reports. These documents along with other team products were presented and discussed during steering group sessions.

The “steering groups” consisted of 1-2 teachers and 1-2 company representatives. They were held weekly in the fall, and lasted between 15-45 minutes. The goal of the steering groups was to support the teams to address all relevant aspects of business planning, software development and acquiring clients and users (and business revenue) for their application.

The teams encountered various types of problems in their work, including coordination of activities, multidisciplinary teamwork, the complexity of business planning, a lack of the required skill level to carry out programming tasks, a lack of time and presentation skills. However, with the exception of one team, all of the teams fulfilled one of the two main requirements of the course, i.e., either developing a working application or obtaining a real client for their business. Three teams even managed to accomplish both of these requirements, which corresponds to setting up a small business.

During Case 2, the Tax Office Exercise, the students were asked to analyze the characteristics of different groups of taxpayers and to create, on the basis of this analysis, related concepts for future research projects for the Finnish Tax Administration (the customer for the course). The course was aimed to be a practical way of learning virtual project management practices: managing a subcontracting network, team building, coordinating tasks and responsibilities, managing a complete project in a short timeframe, and using collaboration technology.

The students worked in eight virtual teams (3-5 students) of which six had their own customer projects. This time, a coordination team composed of more advanced students was also in charge of coordinating the work of the other teams and with the customers. A students’ group performing the function of a research team was in charge of studying and reflecting on the other groups’ working activities and experiences during the course. The project assignments required students to brainstorm and collaboratively advance ideas that were developed as shared knowledge objects. In the course introduction, students were made familiar with the basic phases of project based working processes, defining, planning, executing, and delivering. The customer made a presentation of its functions and a framing of the global assignment for the course.

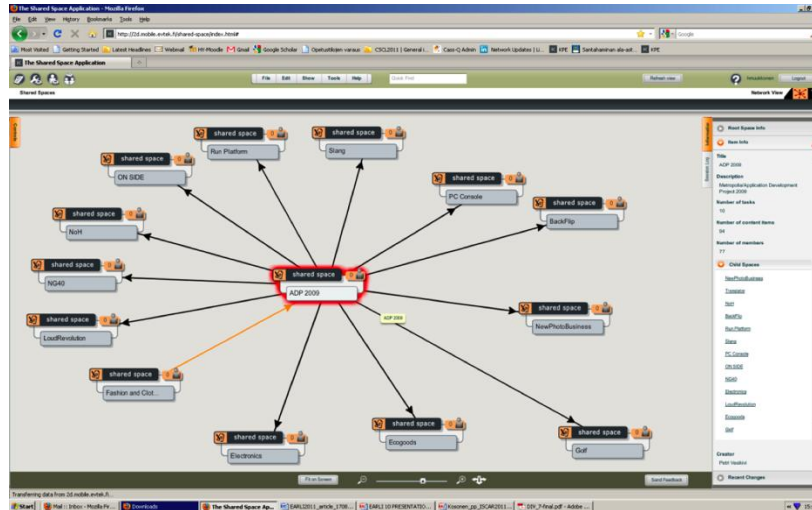
About a week from the initiation, the coordination team together with the teachers and customers held a meeting to agree on the themes for projects suggested by students. Further, the teams were required to create an adequate project plan for their work. During the executing phase, the focus was put on monitoring the progress of the project work. The project manager’s role in each team was rotated so that every student had to be a project manager of their team at least for one week: the project managers were expected to create a weekly project manager’s diary and to conduct a Scrum- survey including reflective questions on each member’s working process. The delivering phase involved the delivery and presentation of the final project report.

## *5.2. Designed technology-mediation*

Next, we explored the technology-mediation by examining the use of the views of the KPE environment and types of mediation they were considered to provide (for more details see Kosonen, Muukkonen, Lakkala, & Paavola, 2012; Lakkala et al., 2009). Simultaneously, we present how the development of shared objects took place in the two cases.

The Network view of both courses in the KPE environment was designed so that the course space was at the center of the visual arrangement and the team spaces were

linked to it (Fig. 1). By double clicking the space icons one enters the Content view of that space.



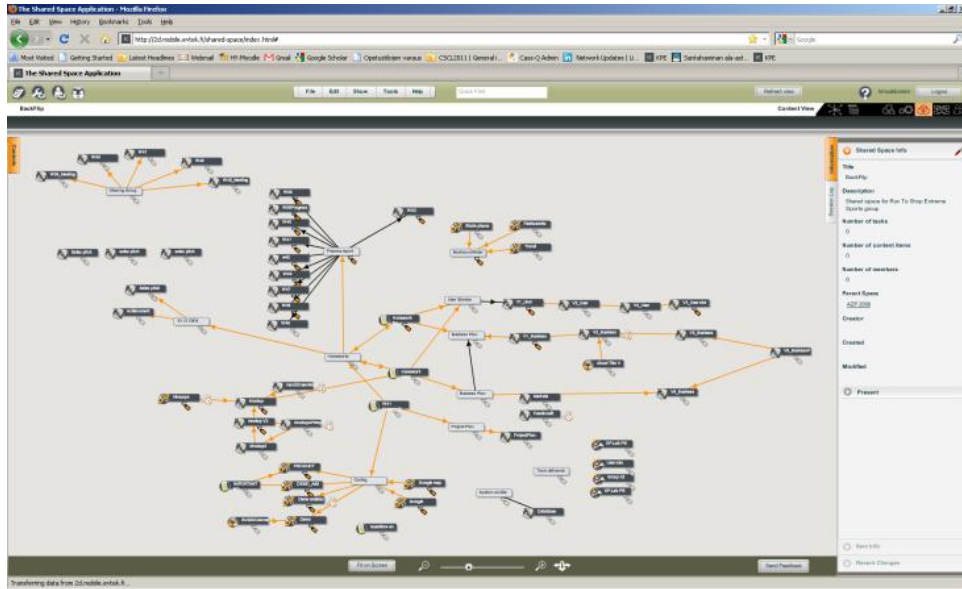
**Fig. 1.** Screenshot of the network view of Case 1

The Content view provided the central working area for the course or the team space. KPE enabled the users to organize knowledge objects (represented by graphical icons) through flexible, visual representations. The Content view (Fig. 2) allowed free visual arrangement and linking of the content items created or uploaded in the space (e.g., presentations, agendas, documents, plans) and provided metadata on the items, their creation and modification history to enable awareness of the learning community's activities. In Fig. 2 grey items represent tasks, black items represent files, web links, notes or chats, that is, all the knowledge artifacts and resources used during the course. Content items could be linked by hierarchical or relational links. In the screenshot in Fig. 2, the team showed the development of their projects work by organizing their subtasks visually as well as linking items to explicate the sequential order of versions and interdependencies between versions of documents.

In Case 2, the Tax Office Exercise, we could observe many of the similar types of activities taking place in KPE. A noteworthy difference was that here several student teams explicitly used the structuring of the course space by also creating defining, planning, executing, and delivering tasks.

The Process view provided a view of the timeframe and tasks of the course or time planning in a modifiable GANT chart format. The creation of tasks, sub tasks, and milestones were found to serve pragmatic and regulative functions in the teams' spaces. The Community view of the KPE environment enabled grouping of the team members and visualizing the affiliations of the course participants, e.g., by the organization or training program.

Some teams decided to use either partly or completely other tools that they were already using, e.g., e-mail, DropBox, and Google-docs, and posted only the outcomes of their process to the KPE course space. This choice was due to several factors as explained in the reflective questionnaires: familiarity with existing tools, technical difficulties with the KPE, not enough guidance with starting to use KPE, and in Case 2, also the time pressure of the course (see Nikko, Muukkonen, & Hakkarainen, 2013 for more detail).



**Fig. 2.** Screenshot of the content view of a team space in Case 1

The teachers of Case 2 stated in the interview that the KPE course space provided a visually compact overview of uploaded and created items while detailed work in teams could be followed in their own working spaces. The course space helped to monitor the progress of the work in teams because the required outcome documents that they created were linked to the corresponding project phase icons in the space. Further, KPE was considered to support the synchronous collaboration between students by providing information about the team members' presence in the environment.

To summarize the mediation based on collaborative technologies in the cases, the student teams were set up to intensively engage in the development of their shared objects by iterative versioning of their course products, representing epistemic mediation. In addition, some of the documents and other textual artifacts created by the students supported the organization of the working process and thus served pragmatic mediation. However, not all teams used the KPE as their primary collaboration tool, some groups adopted several tools they were familiar with. The KPE provided them with information about online participants and recent changes. We observed social mediation, which directed activities around the development of the shared objects, e.g., knowing who's involved and awareness of activities. In addition, in both cases, students were seeing each other regularly in face-to-face sessions, where a lot of planning and negotiation took place. The reflective mediation was used by the teachers and student research team as a means of following what took place in the KPE in terms of participation, types of engagement, intermediary project documents, and activities within the teams. Both courses involved face-to-face reflective feedback sessions. Therefore, the pragmatic, reflective, and social types of actions were partly manifested via the mediation of the shared virtual working environment.

### *5.3. Customer involvement to promote cross-fertilization of knowledge practices*

In the third research question we explored the customer involvement. In both cases, the course design involved, prior to course onset, intensive negotiations with the organizing

teachers and the potential customer organizations. The teachers approached several customer organizations based on their existing networks, and negotiation between the interested organizations were carried out to find a suitable scale project idea(s) for each customer. In Case 1, the teachers considered it important that the customers could invest enough time to really be able to support the teams in their project work using steering group guidance. In Case 2, the customer was not in direct contact with all projects teams: the coordination team was the representative of the student teams.

In Case 1, the central cross-fertilization aspect of the course was the steering group sessions during which the teachers and the company representatives reviewed the versions of the documents (business plans, project plans, mock-ups, etc.) that the teams were working on. In the steering group sessions such issues as the analysis of potential market size and user segments as well as the specification of the vision and offerings related to the business ideas were discussed. In addition, several teams worked together with the company representatives at the company premises, e.g., to program parts of the website or software that needed code from the company, to integrate the various widgets in the company portal or to work on details of the services.

Besides the steering groups and separately organized meetings between the student teams and supervising company representatives, one of the companies organized a workshop for the students. The central topic discussed in this workshop was the development of the team's product from the potential end users' perspective. The workshop was not planned before the course but was initiated only after the collaboration between the students and the companies started. It thus was as an outcome of this collaboration.

In their answers to the reflective questions, the vast majority of respondents described their experiences of the course with mainly positive terms pointing out that the course setting provided them with a window into real working life. The involvement of the company representatives was perceived to bring a perspective to the steering sessions that supplemented the teachers' guidance and points of view. As one student explained in the post-reflection, *"the positive aspect has definitely been the collaboration of companies and students in the projects. We got experts' perspectives on our own productions and also got to try out their ways of working."*

The customers' involvement in the course was, as described above, very intense. They were present every week and offered their expertise to guide the developments of applications and business plans. One interviewed customer valued the experiences because it generated a real link between the company and the student team, generating skills valued by the company. Another customer wanted to highlight further the education of multidisciplinary problem solving and systemic understanding of business processes.

In Case 2, cross-fertilization took place in the form of the external customer's assignment and composition of student teams from different backgrounds. One student summarized very acutely the nature of multidisciplinary collaboration on authentic tasks: *"challenges of the course include the large workload required by the course as well as the many additional party's and their personal interests in the course"*. The students became very involved with the customer's assignment, but would have preferred more feedback from the customer (and the teachers) during the process and not only in the final presentation. One student suggested the following improvements based on his course experience: *"Collaboration with the Tax Administration was also a very good thing and I would like more collaboration with professionals also within my own university. Nevertheless, carrying out a virtual project is a very challenging affair, it would require significantly more individual and team specific guidance and facilitation than was*

offered during the course.” Another student from the coordination team responded to the question of what has been positive in the course in the following way: *“Most positive has been the successful division of labor in our group, also the customer’s attitude and the ambition of the teams has made the course meaningful”*.

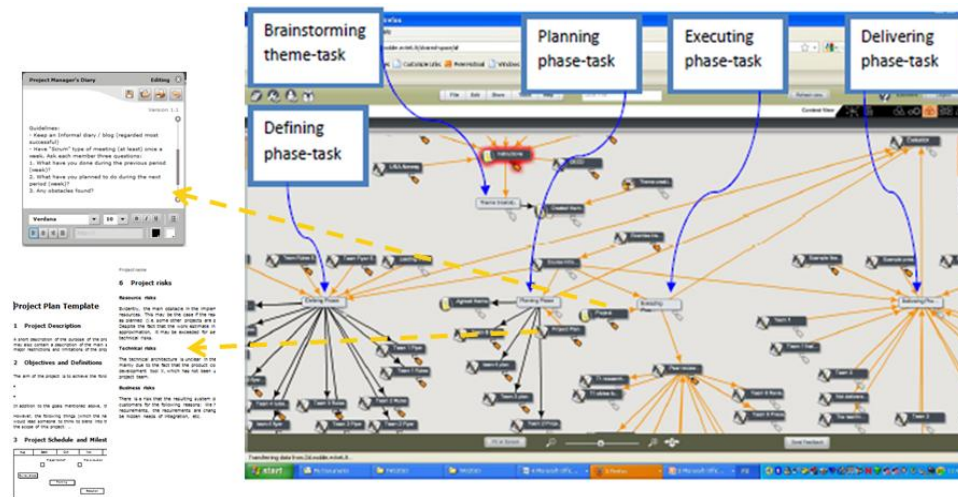
Based on a customer interview, the customer found a prolonged collaboration with universities to be very important, mirroring also a trend in the field of governance and tax administration domain internationally. They found that several of the students’ project ideas offered fresh, out of the box ideas for how taxing is perceived and how services could be developed in the future.

#### 5.4. Arrangement of guidance

The fourth and final research question addressed how the guidance was arranged to support the development of effective knowledge creating practices? In the initial stages of the process in Case 1, a high number of the revisions required by the steering groups concerned work on business plans and applications, while in the later sessions they mostly were comments on presentation to potential clients. Already at the initial stages of the course, the students were encouraged to initiate contacts with potential customers and also implement these contacts as knowledge resources. For instance, as one student team created the first draft of the presentation for potential clients about their business ideas and product, it evoked multiple guiding comments. Teachers and customers aimed to draw the students’ attention to the domain and background of the target audience, something the students had not considered before. The company representatives also shared their experiences related to the development of various technical applications and their presentation to potential clients. One student expressed the role of the steering groups as central. *“My first and pessimistic opinion turned into a very optimistic one as the application developed. The ideas shared during the steering groups were a source of inspiration while the potential shown by the marketing was a source of motivation.”*

Some student teams faced problems in the steering group sessions due to apparent problems in coordination and division of tasks within the teams. For example, one student reflected on it in the following way: *“our team coordination and communication were not always good due to the lack of interest of some team members. (No reply to the email or absence at teamwork...) I think our project needed more real teamwork and more plan-do-check-act in group.”* In order to resolve coordinative problems one of the teams needed concrete and focused assistance. To resolve this issue the teachers met the teams’ programmers and figured out with them how the tasks related to coding could be divided.

In Case 2, the teachers had over several years been developing the design of their course (see e.g., Marttiin, Nyman, Takatalo, & Lehto, 2004; Muukkonen, Lakkala, Kaistinen, & Nyman, 2010). They had each year negotiated a new customer for their course and also developed elements of the task, guidance, and timeframe based on the feedback. They structured the KPE course space according to the central phases of the course (Fig. 3), and provided resources and templates for the teams’ work. They considered it important to create a clear communication structure and specific tasks for each phase, but that the assignment itself should be broad to leave room for creativity and agency.



**Fig. 3.** Structuring of phases and tasks of the course space in Case 2

During the course, the teachers were virtually following the work of the teams, and held meetings with the coordination and research teams. This was a chosen approach, their guidance was primarily provided in the form of templates, structures, and discussions after the weekly lectures.

Many student reflected on the high complexity and the assignment’s initial lack of clarity by describing as challenging the “*lack of instructions during the beginning and limited time for the project*”. There were, however, several students who reported that they valued the feedback they received during the course, shown for example in such post-course reflection: “*In my opinion it was good that the two events, where we needed to present our work, were organized and we got comments*”. These refer to the halfway and final presentation of the team projects, which were compulsory.

## 6. Discussion

The present paper explored how two courses in university education were set up to teach and support knowledge creation practices. The two cases represent educational designs, which intend to engage student teams in the processes of new application and concept development that simulate workplace practices in knowledge intensive companies and organizations. In both cases, customers gave the multidisciplinary teams assignments to work on open-ended and complex tasks.

To address the mediation based on collaborative technologies, we described how the student teams were set up to intensively engage in the development of their shared objects. Student teams versioned various course products and other artifacts supporting the organization of their working process. This represented epistemic and pragmatic mediation. The teachers in the two cases adopted different roles for organizing the space. Particularly in Case 2, the teachers very carefully planned the structure of the environment to reflect their overall design of the course. They also more alertly followed if the teams produced their expected outcomes. In Case 1, the steering group sessions were the hot spots of the activities, and the artifacts stored by students in the KPE served to document the process. However, due to several issues including technical usability and not enough guidance on the use of the new tool, not all the teams used the common

environment as their primary tool for virtual collaboration. The pragmatic, reflective, and social types of mediation were partly manifested in the shared virtual working environment.

The customer involvement promoted cross-fertilization of knowledge practices by means of providing the students teams with authentic, challenging assignments and feedback. In Case 1, the customer engagement was very substantive throughout the course, while in Case 2 it was more central in the course framing and theme selection and later in the feedback sessions. Overall, the students found the involvement of customers very motivating. Similarly, customers perceived the course as a learning experience themselves and were ready to take part in similar courses in the future.

As our exploration demonstrated, the courses had selected quite different design in term of the guidance provided for the student teams. Naturally, the intended outcomes were also different, the first asking to develop a business plan for an application or service and to make it actually happen. The second asked for the generation of a research plan on tax compliance based on a review of existing materials and the ideas of the team. In Case 1, teachers and customers very intensively, “on demand” guided the team projects; the guidance was focused on practices and expertise from business planning and software development. They also highlighted the importance of interpersonal and presentation skills as well as project coordination and management. In Case 2, the work was structured into more detailed tasks but hands-on guidance was not provided. The guidance was focused of generating the conditions for the collaboration, which involved students in intensive multidisciplinary collaboration. This reflects the multitude of choices one can make in pedagogical design. Further analysis is necessary to investigate the processes of the cases in more detail and to examine the outcomes of the courses in relation to the team activities, advancement of shared objects, project management, and tool use.

## **7. Conclusions**

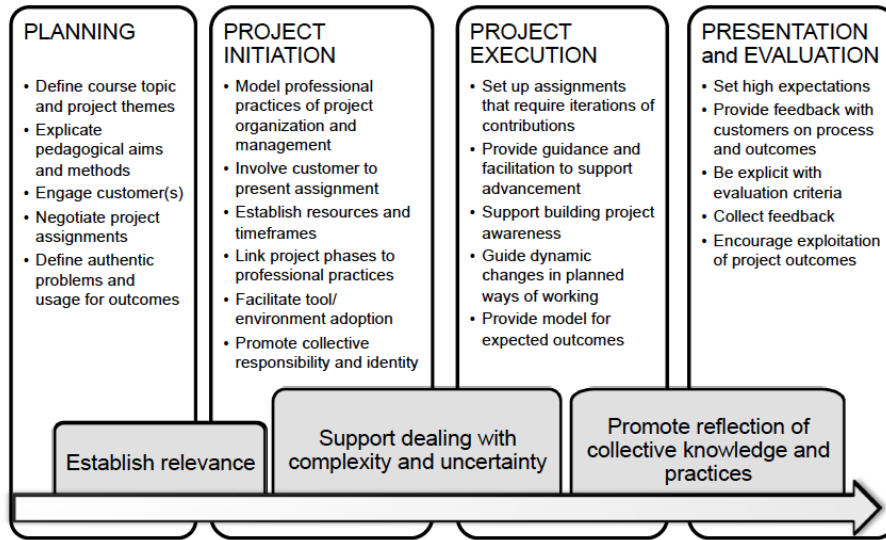
The types of competencies targeted here can be partially labeled generic capabilities (Kember & Leung, 2009), including critical and creative thinking, self-managed learning, adaptability, problem solving, communication skills, interpersonal and group work skills, and computer literacy. Further, the aim has been to create an authentic simulation of professional work practices. For that purpose, it appears necessary to design sufficient open-endedness and complexity for students’ teamwork to generate unpredictable and both practically and epistemologically challenging situations.

The expertise in building relationships between teachers, customers, and students from various domains is an important aspect in such courses. In our experience, the teachers need to establish consensus and plausibility for their educational objectives. In addition, the customers require sufficient knowledge of the educational context to be able to facilitate students’ activities. Furthermore, the customer’s trust and interest has to be anticipated and upheld during and after the process.

Based on the extensive experience of the teachers in the cases, present findings, and prior research following the dialogical learning approach on facilitation of customer projects in higher education (Jalonen, Lakkala, & Paavola, 2011; Lakkala, Ilomäki, Kosonen, Paavola, & Muukkonen, 2012; Muukkonen & Lakkala, 2009; Muukkonen, Lakkala, Kaistinen, & Nyman, 2010), the following recommendations on course design and guidance are proposed. Such recommendations may serve as hypothesis for a next iteration of courses. As detailed in Fig. 4, the pedagogical design for such a process has



different foci in its four central phases: planning, project initiation, project execution, and presentation and evaluation.



**Fig. 4.** Recommendations for pedagogical design and guidance of inquiry in customer projects

First, in order to *establish relevance and motivation for students*, it is important to define the course topic, assignments, learning objectives and outcomes, and the appropriate ambition level together with the customer. Regarding the TLA, this involves the design principles on organizing activities around shared objects (1), supporting integration of personal and collective agency and work through developing shared objects (2), and promoting cross-fertilization of knowledge practices and artifacts across communities and institution (5).

Second, the initiation of the project needs to be explicit on building project awareness, including what are the aims, who are we, who is doing what, how and when, how to proceed, and what will be done.

Thirdly, a *challenging and complex assignment will generate feelings of uncertainty* and even anxiety amongst students (e.g., Denton & McDonagh, 2005; Muukkonen, Lakkala, Kaistinen, & Nyman, 2010; Nance, 2000). Although it appears that weekly guidance was partly able to ameliorate the concerns the students had, in both cases the students were concretely exposed to feelings of uncertainty as the assignment asked them to engage in generating novel applications and concepts. These emotions need to be acknowledged as being focal and intrinsic in knowledge creation (see also Litmanen, Lonka, Inkinen, Lipponen, & Hakkarainen, 2012) and addressed in project initiation and early execution.

Finally, teachers are likely to face implicit or explicit resistance to the adoption of the suggested shared collaboration tools because today's students are accustomed to their particular individual tool ecology of social media applications. Social media applications are not necessarily tailored for knowledge creation or co-design, but rather represent the knowledge sharing or dialogic approach to learning. The educational aim *to reflect on collective practices and knowledge* is difficult to realize if teams use unique technological set-ups. This question stands at the intersection of design principles on emphasizing

development and creativity in working on shared objects through transformations and reflection (3) and providing flexible tools for developing artifacts and practices (6). We propose that by collaborating within a shared environment, the participants are better able to compare and benchmark efficient teamwork practices, because the process of developing the shared object can be traced within the environment. Consequently, the learning community as an entity is better equipped to make dynamic changes in projects and to evaluate and reflect on the best practices and learning outcomes of customer projects.

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