MERJA BAUTERS, MINNA LAKKALA, SAMI PAAVOLA,
KARI KOSONEN AND HANNU MARKKANEN

4. KPE (KNOWLEDGE PRACTICES ENVIRONMENT) SUPPORTING KNOWLEDGE CREATION PRACTICES IN EDUCATION[1]

INTRODUCTION

Many activities have moved to the Web, offering a medium for numerous everyday tasks related to home, community, office, education, etc. A constant flow of new tools, use trends, services and terminologies now forms part of people's daily lives (Candy, 2002). The landscape of tools changes constantly and the tools are complemented by a new generation of open source and access tools, social media tools, services, and enhancements. This includes tools for social bookmarking and note-taking (e.g. Diigo), community-building environments (e.g., LinkedIn and Facebook) and collaborative working tools build on wiki engines as well as photo-, music-, and video-sharing tools (e.g., Flickr, Vimeo and YouTube) (Väljataga, Pata & Tammets, 2010). The challenge of combining an appropriate solution to work, study and various other forms of practices is then constant.

The ability to reflect on how and where to acquire adequate resources and filtering methods, or to interpret received and found information and produce, collaborate, share, or modify knowledge have become central requirements for modern knowledge work and learning (Paavola et al., this volume). As Fiedler and Pata (2009) stated, the learners are faced with the fact that they have to select, combine and use various materials, online tools and services. This means that learners need to be guided and supported in their choice of learning trajectory including tools and resources (i.e., the learning environment) as well as provided with examples of tool ecologies and collaborative work practices with the tools. Furthermore, the set of tools and practices that these new opportunities allow influences the study practices of within the environment (Könings, Brand-Gruwel, van Merriënboer, & Broers, 2006; Entwistle & Tait, 1990).

Although many social media and open source tools may be useful and easy for a special purpose, the products and their manners of use are hard to integrate with other systems. The report on industry-led FP7 consultations "New Collaborative Working Environments (CWE) 2020" suggests in the summary that the integrative and interoperational elements do not belong among the characteristics of current Collaborative Environments. Anderson (2007) and Crosslin (2010) state that the challenge for tools, environments and sites that try to offer services for education is

A. Moen, A. I. Mørch, S. Paavola (Eds.), Collaborative Knowledge Creation: Practices, Tools, Concepts, 53–74.

that they need to incorporate APIs and other resources that can be powerful enough to be useful but at the same time should be easy to learn and use. The tools might not allow good enough metadata on the products to exchange materials between applications or to further revise knowledge artefacts collaboratively. Furthermore, most tools used for collaborative work and practices are based on approaches that do not support reflection, a holistic perspective, or a change in perspective (Conole 2010, for alternative approaches that emphasize the holistic, interconnected relationship between tools and users).

The present article introduces the Knowledge Practices Environment (KPE), a virtual environment aimed at providing some solutions to the needs and challenges mentioned above. KPE has been created to provide an integrated system and tools for supporting collaborative knowledge creation in which emphasis is placed on collaborative, iterative and sustained efforts to create artefacts and/or knowledge practices and processes together, and the role of the tool is to mediate the process smoothly and flexibly. Knowledge creation processes are a broader class of purposive and situated activities of a learning community (underlining such notions as object-orientedness) intending to develop knowledge artefacts and the trialogical approach (explanations and descriptions for more details from Paavola et al., this volume). This means that KPE is designed to support flexible ways of working with shared "objects".

BACKGROUND IDEAS OF KPE

KPE is a web-based application developed in the Knowledge Practices Laboratory project (KP-Lab), designed to provide specific affordances for working with shared objects; that is, joint development of knowledge artefacts[2] as well as for planning, organising and reflecting on related tasks and user networks (Markkanen et al., 2008; Lakkala et al., 2009). The features, design and interaction potential of KPE were derived using the co-design processes with several cycles to integrate theoretical perspectives, research-based pedagogical ideas, and technological development. The trialogical approach is a metatheory of knowledge practices, which provided means for transforming prevailing pedagogical practices in various contexts into direction of more sustained, collaborative knowledge creation mediated by technology. KPE went through several phases of co-design in which various intermediate abstractions and ways of instantiating theoretical ideas were used to guide the co-design process. At the start of the project, pedagogical scenarios and design principles of trialogical learning were produced (Paavola et al., 2011). The *design principles* were aimed at defining the general characteristics of trialogical learning for various courses and knowledge practices. The design principles of the trialogical approach highlight that collaborative activities are organized around developing shared objects (collaborative knowledge creation as well as transformation of knowledge practices) in sustained processes and with flexible tools supporting these processes.

The design principles were, however, not enough to direct and give scope to the technical development in the project. *High level requirements* were collected and defined on the basis of research cases and studies for explicating desirable

functionalities of the KP-Lab technology from the end-users' point of view. The requirements were then grouped into *driving objectives* and *types of mediation* which defined general aims and the role of technology in collaborative knowledge practices (see further description of the process in more detail in KP-Lab, 2008).

In practical terms, the types of mediation were used to categorise the features, functionalities and *perceived* affordances of KPE tools into the basic functionalities that they were supposed to be supporting and enhancing (adopted from Rabardel and Bourmaud, 2003; also Hakkarainen 2008; Paavola et al., this volume). The types of mediation defined and used in the KP-Lab project are:

- *Epistemic mediation*: creating, transforming, organising and linking knowledge artefacts;
- *Pragmatic mediation*: planning, organizing and coordinating working processes;
- *Social mediation*: managing social relations around shared objects and linking people; and
- *Reflective mediation*: visualising of and reflecting on the work processes.

The principal requirement for appropriate tools to support trialogical knowledge practices was to enable *multimediation*, providing integrated and rich support for the various aspects of complex collaborative knowledge creation processes. The types of mediation provided an analytic outlook on the basic functionalities of the tools, but they are often very much combined and mixed in practice. Some appropriated practices intertwine the categories; for example, pragmatic mediation often becomes the source of epistemic mediation, and the organisation and coordination processes themselves are the objects, which are linked to other practices and attempts are made transform them. KPE is designed to support this kind of flexibility. In theoretical terms, the types of mediation can be classified into four main orientations in instrument-mediated activity (cf. Rabardel and Bourmaud, 2003) toward the object of activity, activity itself, other subjects, and oneself. The types of mediation thus aim at

- Getting to know the object, which equate to the epistemic mediations of the object;
- Practices on/above/through the object; namely, transformations, regulation management, etc., which equates to pragmatic mediation of the object;
- Towards others, namely for creating interpersonal connections, habits of communication, etc., which equates to social mediation;
- Lastly at the subject itself, to reflect its actions, practices, outcomes, etc. which equates to reflective mediations.

The implementation of these functional requirements called for open, modular and loosely coupled technical design which, it was decided, would be pursued with the semantic web technology and the service-oriented architecture (SOA). The project carried out state-of-the-art studies on existing software, comparing functional and technical requirements with various groups of collaborative learning and working environments, such as knowledge-building environments (FLE, Knowledge Forum, CMap Tools), web collaboration environments (BSCW, Google Apps,

ZoHo), collaboration and learning environments (SAKAI), and on-line classroom and eLearning platforms (Moodle, Claronline). Although the various environments provided similar features and functionalities to those the KP-Lab project targeted, none of them provided a solid software base to build on. Major prohibiting factors were that the software was not open or the architecture did not support extension of the functionality as required by the KP-Lab pedagogical scenarios.

KPE comes close to many existing virtual learning environments but aims at providing affordances for systematic and sustained creation and formation of collaborative practices and knowledge. The Knowledge Forum has inspired the development of KPE because it provides a knowledge space with functionalities like: to create, link and build on shared multimedia objects. Another system, FLE3, was developed for progressive inquiry practices (Muukkonen, Hakkarainen & Lakkala, 1999; Leinonen, Kligyte, Toikkanen, Pietarila & Dean, 2003). It includes tools supporting virtual inquiry discourse as well as the sharing, co-construction and versioning of digital artefacts. KPE aims to provide support for other aspects than epistemic mediation, or discussion and argumentation (such as: Coler and Belvedere; cf. Coler and Belvedere: Suthers & Hundhausen, 2003). It supports collaborative knowledge creation by offering flexible tools instead of pre-set tasks (see for stricter step-like guidelines such sites as WISE and Viten), roles, or order of executing the tasks. It also provides a holistic and more integrated perspective on the work in contrast to environments which separate processes and different aspects of work more clearly (such as LAMS and Sky Lab).

KPE is also meant to provide a different approach to accessibility from environments connected to typical learning management systems (LMSs) do (note that here we refer to LMS and not generally to virtual learning environments). LMSs are used by universities to facilitate the management of courses and information sharing. An LMS often dictates that the access is restricted to a particular course, so that no one else can see the materials, tasks, etc., except the course/group/team members, and it is hard to add participants from other organizations. The students are tied to the tools provided by the institution, and often using material beyond course boundaries is impossible. Most of the virtual learning environments allow change in the defaults, which however are not easily changed, such as Moodle where the differences in the teacher, group and student roles are very marked. Combining the web 2.0 tool provides personal and collaborative tool ecologies (see, e.g., Arenas, 2008; Crosslin, 2010; Huijser & Sankey, 2010). These combinations include such tools as file sharing systems such as DropBox, combined social media tools including Facebook, Google sites and applications, Zoho, ad hoc tools such as Piratepad, Typewith.me, Zotero, and Confluence wiki, which however is commercial, just to mention few well–known ones. For example, files are often just shared through DropBox or the more advanced SugarSync. Being able to share and keep the versions smoothly synchronized is a start for collaborative elaboration of a shared knowledge artefact, but the tools do not provide further affordances for systematic and sustained creation and formation of collaborative practices and knowledge – all, however

emphasize in some respect issues within epistemic mediation (Wallace, 1999; Cigognini, Pettenati & Edirisingha, 2010; Downes, 2005 & Bates, 2010: 24).

KPE is based on a visuo-spatial desktop metaphor that enables working with knowledge items, and the presentation and managing of relations as well as the filtering and organisation of materials and ideas according to meaning, process, or division of work. It also promotes reflection on the spot because of its affordances support object-bound usage facilities. KPE further provides opportunities to integrate different tools so that the information and content flows between tools and services become visible.

FEATURES IN KPE TO PROVIDE AFFORDANCES FOR COLLABORATIVE KNOWLEDGE CREATION

In this section, we describe the Knowledge Practices Environment (KPE) in more detail. KPE users are able to build collaboration environments by creating and configuring the means of the common practice, as opposed to operating with predefined structures. KPE is a virtual environment that includes a set of basic, integrated tools (e.g., working spaces with real-time and history-based awareness, wiki, note editor, commenting, chat, semantic tagging, linking, process organisation, filtering and search) for working with the shared knowledge artefacts. KPE is based on strong visual and spatial ways of organising the work, building on a kind of a desktop metaphor. The spaces do not have folder structures, but KPE supports filtering, spatial organisation, structural and semantic tagging for organizing, restricting or grouping various knowledge items. This approach provides a novel perspective on relations between knowledge and practices as will be described below. KPE enables object-bound and threaded comment on all items (task items, files, web-links, notes) in a shared space as well as viewing of knowledge artefacts and their relations from several perspectives. The three basic perspectives provided are the Content, Process and Community Views. Various tools and functionalities are integrated in the basic views to enable multifunctional and flexible connection, organisation and reflection on all information related to the knowledge artefacts, processes and people concerned. Some screen shots that are presented to exemplify the software have been picked from real course settings (hence some parts of the images may be smudged to protect students privacy).

Work with Knowledge Artefacts (Epistemic Mediation)

Epistemic mediation is supported in KPE by functionalities that enable users to create, modify, build on and organise various knowledge artefacts as well as their relations flexibly. Some important characteristics related to the work with knowledge artefacts are briefly described below.

Sharing and co-construction of knowledge artefacts with free visual arrangement and linking In KPE, user groups can create 'shared spaces' through which various knowledge artefacts can be shared and co-constructed. The basic features include uploading any type of file or web-link into the shared spaces, but instead of providing only a space to store or manage versions and the synchronisation of a vast number of documents, KPE enables the users to organize knowledge artefacts (represented by graphical icons) through visual representations. A central view in KPE for working on knowledge artefacts is the Content View that allows free visual arrangement and linking of its content (see Figure 4.1). The organisation of a shared space reminds the organisation of files on the desktop, except that KPE allows better tools for spatial arrangement and linking of items, filtering based on metadata and tags and the creation of user-defined views ('Tailored Views'). These features and functionalities also allow reflection on the artefacts, their relations and organisation. KPE is not based on folder structures or hierarchical presentation of the content; it does not conceal the content in folders which detach items from their relations. One of the most interesting ideas in KPE is this strong approach to integrating visual and spatial organisation, filtering, categorising, prioritising, semantic meaning creation and process visualisations.

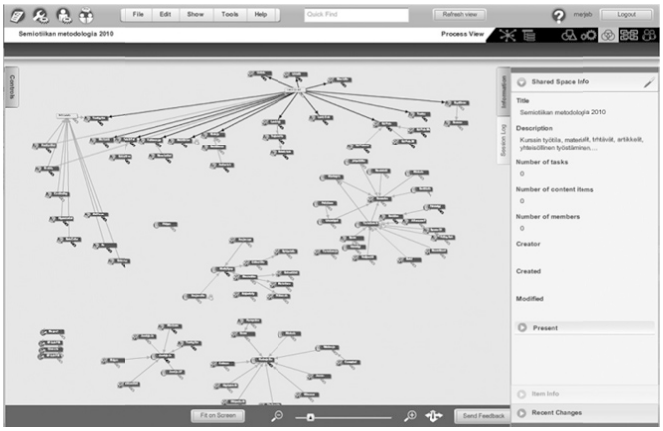

Figure 4.1. Content View: visual arrangement of content items; up-loadable files, Internet links, notes and chats.

In addition to the opportunity to upload files in a Content View, some tools are built in or integrated into KPE to support easy production of texts and sketches as well as co-editing of text versions. With *note editor,* users can directly write their ideas and thoughts as content items in a shared space, without the labour of creating and uploading an external text file (Furnadziev et al., 2009). All members of a space can open and edit the notes and view their previous versions. Furthermore, users can open many notes simultaneously for comparison and integration, and link notes to other content items in the Content View (see Figure 4.2). The implementation of

note editor in KPE is a simple, powerful tool for collaborative knowledge creation, drawing on ideas in Knowledge Forum and knowledge-building (Scardamalia & Bereiter, 1994), where one proceeds through idea generation and elaboration using textual notes. Creating, editing and sketching of texts and images in a shared space is an important function since it enables quick access to previous thoughts and arrangements of ideas and knowledge, which is needed to further develop and ponder on the joint procedures, goals and achievements. The Content View includes a *sketch pad* tool which is based on the same idea as note editor, but enables the creation, co-editing and versioning of simple drawings and visual sketches.

The ability to write collaboratively in a sustained manner, an essential feature of knowledge work, is supported through an integrated wiki. A wiki document can be created as a content item in the Content View, which offers the opportunity to access the same wiki document from a shared space. The progress and changes made to the document are visible to all group members. However, history and changes made in the wiki are visible in the wiki but not in the Content View. This makes the writing process in the wiki more independent of other activities in the shared space. The actual use (observed over four years and in six different courses) showed that the wiki was usually taken to be for more thoughtful writing and for producing more finished texts. The students intuitively used the combination of the tools (meaning here without guidance). The note editor was used for idea generation, sketching and drafting. After the sketching and drafting phase were over and the subject matter was felt to be better understood, the students moved on writing in the wiki, where the goal was to polish and structure previous writings.

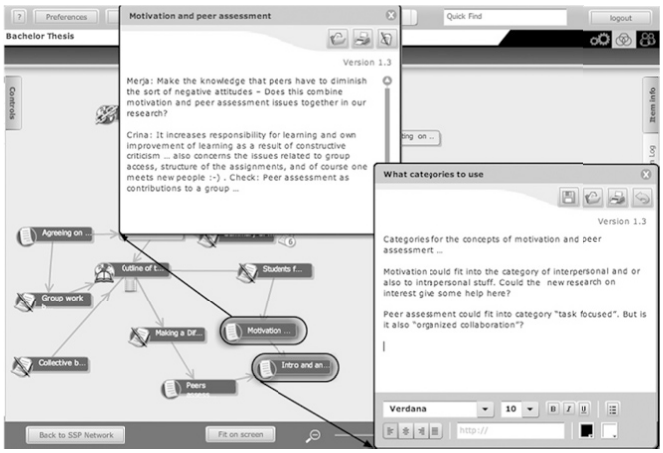

Figure 4.2. Content View: display of the note editor with two notes opened simultaneously.

Object-bound Interaction Around Knowledge Artefacts

In the Content View, "object-oriented" collaboration is emphasized by the object-bound commenting functionality (see Figure 4.3), which means that asynchronous,

threaded discussions are attached directly to knowledge artefacts. One object can have many comment threads, enabling users to discuss various aspects of the objects directly in this context. This object-oriented aspect places KPE beyond isolated discussion forums, threaded notes and argumentative discussion supports, which concentrate only on dialogical aspects of collaboration with threaded discussions and easily lose the context and the object. The KPE answers the need to have individual contributions attached in collaborative work organised around shared knowledge artefacts embedded and embodied in a shared space. Similarly, object-bound chat enables synchronous interchange attached directly on the items at hand. The chat log is saved and linked to the targeted item, thus keeping the log attached to its object for possible re-use and continuation. The object-bound features and functions are further supported by the visual metaphor in keeping everything in sight, allowing different spatial arrangements that can be flexibly changed according to the various phases of the work. The items can also be filtered, thus creating yet another visual view of the content. No other tool so clearly allows contextualised work, which keeps all objects visible and allows their filtering after the phase of work is done. The products and processes do not disappear and get lost in folders, sub-pages, tabs or separate forums.

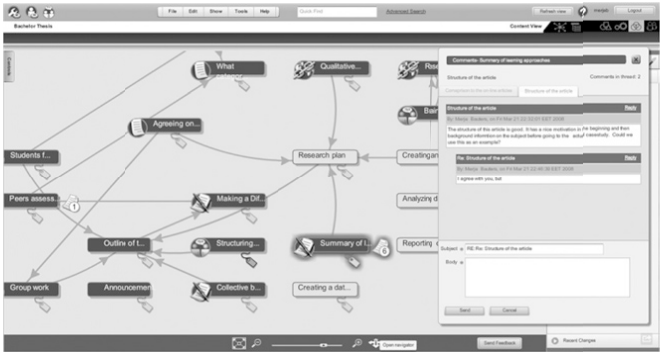

Figure 4.3. Content View: an object-bound comment opened from the selected content item.

Flexible use of tags

One aspect of KPE related to epistemic mediation that goes beyond current learning environments, especially combinations of social media tools and tool economies, is the use of metadata and semantic features to support the usage and integration of knowledge artefacts in various ways. Tags, tag clouds and tag vocabularies can be created and edited by participants. All items can be tagged in the Content View, which provides additional affordances for various types of knowledge practices in education as compared to existing tools. For example, in typical research seminars, semantic tagging can be used to help students find common areas of interest and related materials, or to analyse the elements and concepts of existing research papers and those that are worked on. The tag cloud generated automatically from the tags assigned by users enables easy filtering of the items according to the subject matter,

categories, and other user defined taxonomies. In addition, the tags users define are implemented in the underlying technology in a way that allows search through the semantics or relations between tags; e.g., semantic information can be reused across various integrated tools. Such functionalities allow the users to create their own cognitive and conceptual tools and instruments based on the potentialities of the semantic web. Filtering using the tag cloud also allows emphasis on different knowledge artefacts and practices depending on what issues or phases the group or individual is working through. This supports the use of the same Content View for longer periods, enabling sustained work, reuse of items and the reflection of previous work and practices without separating the phases or distributing the items across tools and time. The KPE thus integrates different tools but also allows the use of learning objects, i.e., it supports the SCROM packaging. However, supporting the learning object has not been found to be very useful; rather, the need to provide opportunities, to extend the tools used by API's has been requested from the field.

Organising Processes (Pragmatic Mediation)

Pragmatic mediation has been central to the design of the functionalities of KPE for planning, monitoring, and regulating joint activities and working processes. These functionalities enable users to define tasks as well as draft visual, spatial and semantic representations of processes. They also provide users with 'awareness features' (see below) of the activities in the spaces.

Process Planning Through Defining Tasks and Drafting Visuo-spatial and Semantic Process Representations

In addition to content items, KPE users can explicitly define, modify and arrange *task items* and *areas* to represent the process and domain elements of activities. Task items may include, title descriptors, responsible users, start and end dates and status. Areas attached to semantic meanings can be created to represent a phase, an action, or a category, depending on how the users need to organise their knowledge artefacts. These features allow users to explicate their process elements and promote responsibility and ownership over the decisions and actions.

Task items can be created and modified in the *Process View*, which shows them in the form of a GANTT chart (see Figure 4.4). The Process view enables users to plan tasks and processes chronologically as well as to monitor how the required tasks and subtasks have been accomplished. For instance, in courses that teach collaborative design practices, where real design projects are executed, it is very important (for flexible adjustment of the process) that participants be able to monitor the progress of the project and modify the tasks.

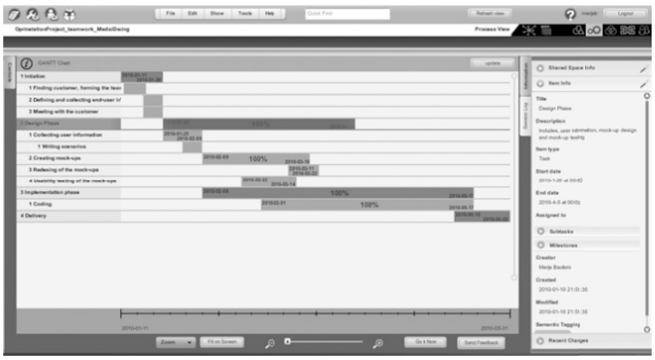

Figure 4.4. Process View: chronological view on the tasks on a time line. Subtasks are the lighter and the main tasks are darker

The same tasks that are displayed in the Process View through a GANTT chart are visible in the Content View, where they can also be created, linked and arranged visuo-spatially manner with the content items. This provides users a holistic and integrated view of their knowledge creation processes, without separating tasks from content (see Figure 4.5). Again, interdependences and mutual connections between the tasks defined in the Process View are automatically converted by the system into graphical constructions representing these connections in the Content View.

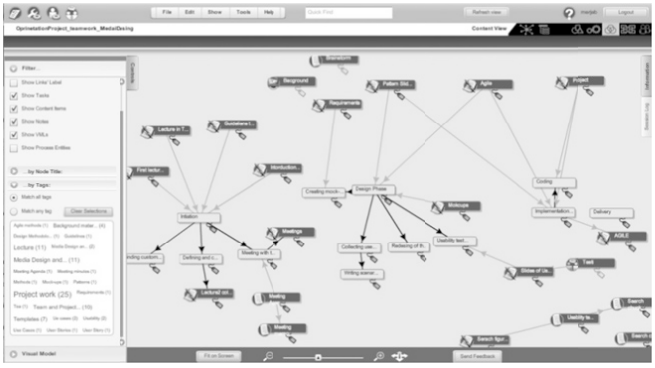

Figure 4.5. Content View of the same tasks displayed in Gantt view in figure 4.4, displayed with all the other items. The left side tab filtering allows displaying, only the tasks, content items, or hiding the links.

In addition, each space in KPE has an *Alternative Process View,* which offers means of structuring the process and its elements visuo-spatially by the users (as an alternative to the linear timeline provided by the GANTT chart). This includes the spatial representation of user-defined areas for organising knowledge artefacts and processes, and enables users to illustrate processes, phases, groups and categories according to shape, colour and place of the areas in question. It emphases

relationships between task and content items and their meaning, since the areas can be tagged, and the tags are inherited by all items placed into the particular area. The tags are also presented in the Content View in the tag cloud, from which users can filter the items according to the meaning of the area specified in the Alternative Process View. The figure (4.6a) present the 'Kanban' table of the tasks, issues to be done and the status the items are in. The left tab's tag cloud has same tags as the Content View, it presents how the tags of the areas can be used for filtering (see Figures 4.6b).

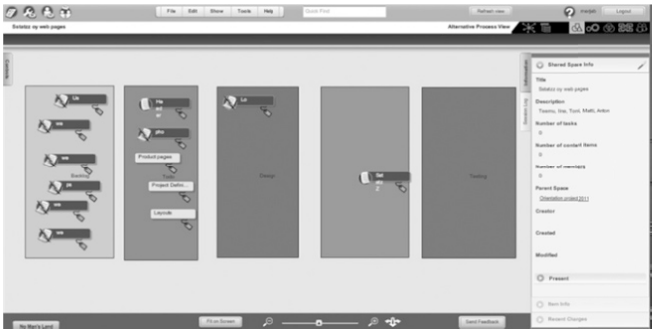

Figure 4.6a. Alternative Process View (APV): a student team shared space from a project course where lean programming methods were used.

This feature makes the tagging process easier than it is with most other tools using tags (e.g., Google mail, Diigo, Delicious). It lowers the threshold for using tags and thinking of the meanings knowledge artefacts and their relations have. This is important since experience has shown that it is often a challenge for students to see the benefits of laboriously explicating the semantic meaning and relations of knowledge artefacts. The features of the Alternative Process View are especially useful in those educational settings where the chronology of the work is not essential, but there is a requirement to see connections, associations and causal relations between the various elements of the process (especially if a specific pedagogical model with particular elements is used to structure the process).

Features for focused work on particular knowledge artefacts and tasks The management of knowledge creation processes is further supported in KPE by the use of Tailored Views, into which the users can transfer selected parts of the process (tasks and content items, links, etc.) from the Content View to work within a particular theme or phase of the process in a focused. Tailored View provides another visual means of organising knowledge creation processes by enabling users to arrange shared knowledge artefacts according to a background image or visual structure that presents the various parts of the process (e.g., particular phases in a pedagogical approach). Tailored View supports processes in which a particular topic requires more detailed focus without the abundance of all the material (e.g., inquiry-type practices –

see Figure 4.7) or where particular phases need to be conducted separately in order to be able to move to the next phase (e.g., project-based practices).

Figure 4.6b. Content View related to Alternative Process View in figure 4.6a. Right image: filtered items using one tag ('Backlog').

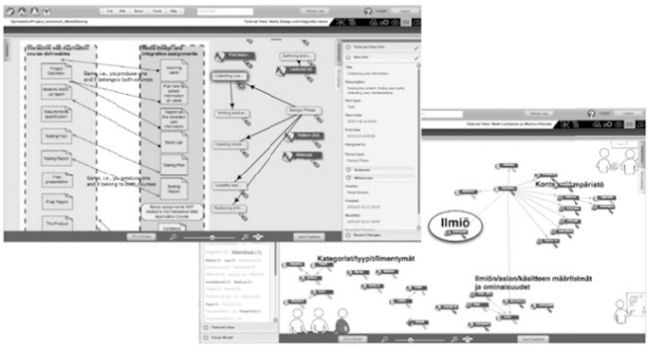

Figure 4.7. Tailored View (layer on top of the Content View): the right displays relations between courses that are held in the same shared space, and the left side is organized by semantic themes and inquiry questions in the semiotic methodology course.

Awareness features to aid process planning and coordination The planning and coordination of a collaborative working process, be it asynchronous or synchronous, will greatly benefit from awareness features that help in explicating tacit knowledge related to one's own or others working practices. Awareness features are not often consciously noticed or paid attention to; however, they may play an essential role in tool-mediated collaboration, keeping track of on-going and past actions. Without such information, the work may be severely hindered. Awareness features in KPE that are meant to support synchronous work include visual clues and on-line notifications about who is online, who is working with whom, or who is working on what object (a lock or a glove is displayed on the

item with the names of the users) and doing what. The right hand tab displays all the recent changes in the Content View because no item has been selected. When selecting an item, the recent changes shows what has been executed on that item (see Figure 4.8). Historical perspective is provided by a list about modifications of knowledge artefacts and tasks or by e-mail or mobile device notifications about the events being shared. As mentioned above in relation to epistemic mediation, KPE offers the means to keep in contact with each other, such as asynchronous commenting possibilities, or general chat and object-bound chat to enable synchronous discussions. Awareness features include clues and notifications of participants' status. All these tools are meant to support the planning and organization of on-going activities in an integrated way, not merely from each participant's private perspective, the latter being the main way we have observed in current virtual learning environments.

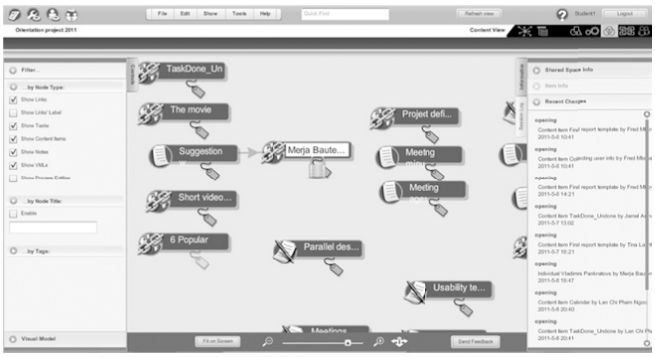

Figure 4.8. Content View: in the middle is a notice that a person ('Merja') is working on the item with a lock on it. No one else can modify this item at the same time.

Social Relations Around Shared Objects and Processes (Social Mediation)

In the KPE, social mediation is implemented by functionalities that support users in presenting group structures and keeping up with changing information about other participants as well as their relations to the shared processes and content items. Social mediation provided by the tools allows users to align their actions with those of others.

Organising social structures, responsibilities and roles

For smooth coordination of collaborative work, it is crucial to explicitly define social structures among the participants, such as groupings, responsibilities and roles. To begin with, it is possible to define people responsible for each content or task item visible in the Content or Process Views. In addition, a third basic view of KPE, called the *Community View* (see Figure 4.9 & 4.10), is especially meant to

support the formation of groups (e.g., by displaying the groups/teams formed with the visual information on the users, and their roles, the same members can have more than one role) as well as coordination of tasks and responsibilities between participants. The users are presented as items in the Community View but they are also presented as a list in the Network View on the right hand tab. Both forms of display also show the information on the users' online status. Detailed user information includes a list of all tasks and knowledge artefacts that have been created and modified by or assigned to a particular member. The awareness features mentioned above include clues and notifications of each user's status as well as past and present activities.

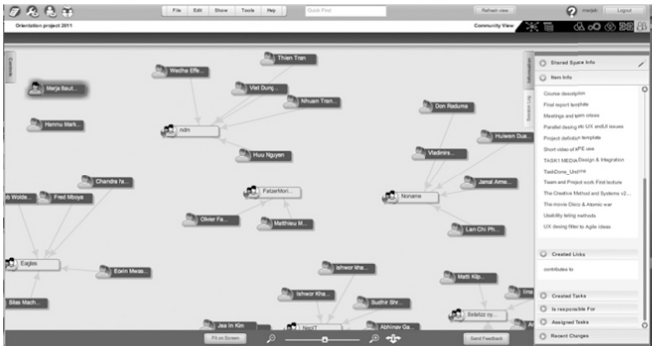

Figure 4.9. Community View: the groups of a project course, the right tab showing items created by a selected user in this shared space.

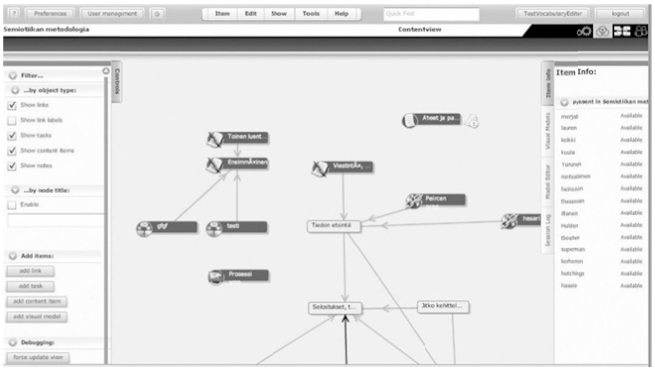

Figure 4.10. Content View: information about online users shown in the panel to the right.

Reflecting on Processes for Deliberate Transformation of Knowledge Practices (Reflective Mediation)

The last of the four types of mediation enables actors to reflect on and evaluate their joint activities as well as the shared objects being created and modified collaboratively. The aim is to provide user groups with information that allows them to take the community's knowledge creation processes as an explicit object of shared reflective activity and consequently elicit deliberate transformation and improvement of their joint knowledge practices. The reflection is afforded in KPE in many ways by the above-mentioned and additional functionalities, e.g., visual representations, awareness tools or analytical services.

Reflecting on the on-going Processes Through Visual Representations and Awareness Tools

One virtue of the visual representations of content items (and related processes) is that they provide users with an overall, graphically supported overview of the current state of the shared space for critical evaluation of the process. In addition, the various awareness functionalities, mentioned above enable users to keep track of the progress of the process and perceive what is going on with the shared objects and tasks, see what the others are up to, as well as acquire off-line information about events and on-going activities.

Reflection and Analysis of Processes Through Analytical Services

Various analytical services in KPE will provide users with an opportunity to reflect on the process from a historical perspective. One means to monitor what is going on within the working environment and to reflect on the community's practices is the *analytic tools* (for more detail see Richter et al., this volume). Especially for researchers and teachers, KPE provides functionalities for exporting available data from a knowledge repository, covering all changes made in the selected part of the knowledge practices environment for a specified period of time (*data export tool*) and use external data analysis tools to evaluate the data. Analytic tools facilitate teachers, students and researchers in analysing information and identifying patterns from collaborative activities conducted around shared knowledge artefacts. Analytic tools also include such applications as *visual analyzer* and *timeline based analyzer*, which process data from user action logs according to the query parameters selected by a user and convert processed data into concise texts, tables and visualizations. These representations allow users to monitor and reflect on their collaborative work, including the contributions of individual members on separate content items and other forms of participation, and the intensiveness of the work on various content items during the time period selected.

EXPERIENCES OF KPE USE IN EDUCATIONAL SETTINGS

As part of the research in the KP-Lab project, successive releases of KPE were used and investigated in several higher education courses applying project work, an inquiry approach or similar knowledge creation practices. This section reviews and discusses some experiences from the field tests conducted in Finland (Jalonen et al., 2011; Vassileva et al., 2011). KPE was tested at the Helsinki Metropolia University of Applied Sciences, in various application design courses for engineering students and in one cross-curricular course between media engineering, industrial management and communications. In those courses, students designed all kinds of multimedia, web and mobile products in teams for real customers, and shared their design documents and tasks through KPE. At the University of Helsinki, KPE was used in several iterations of two methodological courses, one in semiotics and the other in behavioural sciences, as well as in a virtual project work course built up as a multidisciplinary setup involving technical, business and psychology students from three universities: the Helsinki University of Technology, the Helsinki School of Economics and the University of Helsinki, Department of Psychology. In these courses, mainly inquiry-type working methods were applied. In the multidisciplinary course, there was an external client organization for which the students produced their inquiry results.

Benefits Experienced and Strengths of KPE

Many students in the courses reported that the main benefit of KPE was the user interface with space-like views, affording flexible management of knowledge resources in comparison to the typical folder-based environments. This visuo-spatial desktop metaphor appears to be one of the most important and successful elements of KPE. A powerful and unique extension of this metaphor is the easy manner of tagging knowledge resources in the Alternative Process View: areas can be assigned by keywords and all items dragged onto a certain area will inherit the tags of that area.

KPE was found to afford integrated epistemic and pragmatic mediation in particular by, enabling the organisation of various documents and other items into functional clusters, commenting on individual documents and tasks, and the easy creation and flexible modification of textual artefacts for brainstorming or for coordinating joint activities. For instance, the spatial Content View allowed student teams to visually organise their subtasks as well as explicate the sequential order and interdependences between different versions of diverse intermediate documents. Link items were frequently used in explicating multiple connections between various types of resources. This visual representation of relationships between multiple items was considered better than the folder structuring in Google Docs or DropBox, for example. One student from the project work course stated that KPE appears to support an open-ended working process, allowing users to initiate new unforeseen branches to work on.

The integrated note editor was widely used in various epistemic and pragmatic activities of student teams as a flexible and easy to use tool, for such tasks as quick

brainstorming or writing coordination plans. In some courses, students created artefacts for work coordination with the note editor to divide tasks and responsibilities within the teams during various phases of their joint work. For instance, a team that had used KPE during the virtual project work course explained in the final interview that the collaborative drafting of notes in preparing the final presentation helped them to integrate all ideas together and then split the whole task into subtasks for each member to work on. In other courses, many student groups also mentioned that an iterative writing procedure of this kind and a clear indication of the state of the text was helpful. Students felt that the drafting phase of the writing process was easier this way, and the actual writing of an essay, report or deliverable was more comfortable.

The actual emphasis in the design of KPE was not so much on social interaction and networking, features supporting social mediation becoming useful when integrated with epistemic and pragmatic support. For instance, in the multidisciplinary application design course, an active team used the object-bound chat in discussing and commenting on their document tasks; they considered it as an advantage that commenting and discussions could be attached to particular items. This allows users to focus their discussions on the objects of their work, unlike other systems where usually only one isolated discussion board is available. Chat was also considered helpful because it enabled discussions to take place synchronously.

The analytic tools, designed as specific tools for supporting reflective mediation, were implemented in KPE quite late, which is why there have been few opportunities so for to test their usefulness in pedagogical practices (Richter et al., this volume). In one course, instructors used both the visual analyzer and the timeline based analyzer to assess the KPE activities of student team as well as the engagement of individual students in their teams' activities. The instructors emphasized the potential of analytic tools to enable the following of activities related to specific documents.

Weaknesses Experienced and Suggestions for Improving KPE

The negative aspect of KPE most often mentioned was its overwhelming number of features and functionalities, which made the tool complex. This is important feedback since it may restrict and even entirely prohibit the use of KPE. Therefore, reducing the least used functions, or the functions and tools that have already been designed and are in use by other open source communities and are available on the Internet, has been planned. The reduction of functionalities is intended to keep the threshold of beginning to use the tool as low as possible. The Tailored View was one of the features which was originally meant for filtering items for more detailed and concentrated work on some selected objects. The field experiences showed that it was too complex a solution for the users. The most useful new feature that Tailored View provided was the opportunity to include a background image on the virtual desktop. The same opportunity was later implemented in the Alternative Process View, which also otherwise provides better means than the Tailored View

for process planning as well as for organizing and filtering shared knowledge artefacts. In the future, integrating the Alternative Process View with the Content View and reducing overlapping features and functionalities is a relevant option for developing KPE.

Student teams in the courses investigated appropriated the use of KPE to varying degrees, and only some teams sense the unique potential for effective knowledge creation activities and its added value. This outcome relates to the feedback on the complexity of the tool. There are so many good and simple tools on the Internet to be used for collaborative activities that if we want KPE to be adopted and appropriated, the whole user interface and user interaction logic has to be simplified. For instance, many open source editing tools (e.g., editors built on the Etherbad engine such as piratepad.net or typewith.me) offer chats and timelines that are tied to the writing itself. These chats are also object-bound similarly to the object-bound chat in KPE. These tools are extremely easy to use, respond fast, and often do not require signing in. One of the future improvements of KPE will thus be to open it up for user-generated 'add-ons' and linking of other open source tools into it better based on the users' ad hoc needs.

The facilitation of contextualized, object-bound user interaction seems to promote quick brainstorming and collaborative production of ideas when both synchronous and asynchronous communication modes are supported. The original aim in implementing both possibilities was to provide flexible tools that allow users to lean on each other's competence, expertise and experience and help them align their actions with those of others. KPE both makes explicit and visualises the participants' activities in the virtual spaces (see Figures 4.8–4.10), which seems to help students become more conscious of the challenges and more systematic with the strategies of collaborative knowledge work. However, the ability to connect the work within KPE with existing users' networks, or to post notifications from KPE to other social media platforms and the other way round are highly desirable extensions to KPE design.

CONCLUSION

In the end, summarising the experiences and results of the scientific research of five years, it can be concluded that KPE captures the essence of the trialogical perspective, that is, offers means for working with shared objects and processes from multiple perspectives and in an integrated way.

- It allows commenting, collaboration and organising and sharing of work in a holistic and visuo-spatial manner, stressing the process besides the outcomes. The KPE desktop metaphor provides multiple perspectives on the knowledge artefacts and practices.
- It supports the reflection of practices in context, not separating activities into fragmented reflection parts. The KPE's object-bound interaction enhances opportunities for reflecting on individual and collaborative products and practices.
- It enables flexible group formation.

– It supports information display of online statuses, social relations, roles information, etc., and use as well as multiple perspectives on the work by various filtering methods (e.g., with tags, visuo-spatial organisation, linking, etc.).

KPE was found to support virtual project management and the practical organisation of collaborative processes, but also open, joint development of ideas. The management of collaborative and/or sustained knowledge creation processes in a flexible, multimediational way is one obvious strength. KPE also served the mediation of epistemic, object-oriented activities by providing a space for collecting resources and organising successive iterations of materials and items, as well as by the commenting facility. KPE appears especially to support the early phases of the knowledge creation process and the integration of different activities (separate, specialized tools are usually needed for actually working with different types of content). In addition, in the courses examined, KPE provided awareness of synchronous and asynchronous knowledge creation processes by showing the contributions of participants, hence supporting the elaboration of items. The ability to get visual overviews of things, to organise processes flexibly and visuo-spatially and to tag items through placing them in particular areas are especially appreciated features of KPE (related to a "virtual desktop" metaphor).
However, there are challenges that need to be taken into account and met in developing KPE further. Such challenges include the following:

– KPE is too complex and needs serious reduction of features and functionalities. Such integration forms as SCORM – packages in particular were found to be useless. Furthermore, it seems that both the learning objects and semantic metadata (which is based on ontologies) are losing ground to microdata, also called microformats. These formats try to provide an alternative solution to the RDF construction that was based on ontologies and has clearly failed in this attempt.[3]
– KPE is competing with other tools, which users already know and which are continuously emerging on the Internet. These tools are easy to use and do not require registration. KPE needs to be opened up so that these tools can be added and used in collaboration with it.
– The previous point relates to the requirement of integrating individual self-reflections with group activities and offering awareness information about the social system in which individual activities are embedded. New distributed social tools and services (e.g., pushing feeds for the group, mashing and filtering group feeds that enable people to interact in the group environment from within personal learning environments, would help to provide scaffolding both for an individual learning process and for collaborative activities.

NOTES

[1] This paper is an elaborated and updated version of a paper presented at the CSCL'09 conference (Lakkala et al.: 'Main functionalities of the Knowledge Practices Environment (KPE) affording knowledge creation practices in education')

[2] Knowledge artefacts are products which are created, developed or used by individuals, groups of people or the learning community, where both their conceptual or epistemic aspects (they embed knowledge) and material qualities (they are some sort of entity with certain material characteristics) are emphasized. Typical examples of knowledge artefacts are documents, models, graphs, visualizations, notes, etc.

[3] schema.org

REFERENCES

Anderson, P. (2007). What is Web 2.0? Ideas, technologies and implications for education. Bristol, UK: Joint Information Systems Committee. Retrieved June 19, 2011, from http://www.jisc.ac.uk/media/documents/techwatch/tsw0701b.pdf.

Arenas, E. (2008). Personal learning environments: Implications and challenges. In D. Orr, P. A. Danaher, G. Danaher, & R. E. Harreveld (Eds.), Lifelong learning: Reflecting on successes and framing futures. Keynote and refereed papers from the Fifth International Lifelong Learning Conference (pp. 54–59). Rockhampton, Australia: Central Queensland University Press.

Bates, T (2010). Understanding Web 2.0 and its Implications for E-Learning. In M. J.W. Lee, C., & McLoughlin (Eds.) *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching* (pp. 21–42). Hershey, PA: IGI Global.

Candy, P. (2002). *Information literacy and lifelong learning* [White paper]. Prague, The Czech Republic: UNESCO.

In M. J.W. Lee, C., & McLoughlin (Eds.) *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching* (pp. 109–127). Hershey, PA: IGI Global.

Conole, G. (2010). Stepping over the Edge: The Implications of New Technologies for Education The Open University. In M. J.W. Lee, C., & McLoughlin.(Eds.) *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching* (pp. 380–393). Hershey, PA: IGI Global.

Crosslin, M. (2010). When the Future Finally Arrives: Web 2.0 Becomes Web 3.0. In M. J.W. Lee, C., & McLoughlin (Eds.) *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching* (pp. 394–415). Hershey, PA: IGI Global.

Downes, S. (2005, October). E-learning 2.0. *eLearn Magazine*. Retrieved June 22, 2011, from http://www.elearnmag.org/subpage.cfm?section=articles&article=29-1

Entwistle, N., and Tait, H. (1990). Approaches to learning, evaluations of teaching, and preferences for contrasting academic environments. *Higher Education 19*(2), 169–194.

Fiedler, S., & Pata, K. (2009). Distributed learning environments and social software: In search for a framework of design. In Hatzipanagos, S., & Warburton, S. (Eds.), *Handbook of research on social software and developing community ontologies* (pp. 151–164). Hershey, PA: Information Science Reference.

Furnadziev, I. H., Tchoumatchenko V. P., Vasileva, T. K., Lakkala, M., and Bauters, M. (2009). Tools For Synchronous Communications in Collaborative Knowledge Practices Environment (KPE), *V International Conference on Multimedia and Information & Communication Technologies in Education m-ICTE2009*, Lisbon, Portugal, 22–24 April, 2009, 588–592.

Hakkarainen, K. (2008). Features of trialogical learning: An introduction of research and development of Knowledge-Practices Laboratory (KP-Lab). Internal working paper for the KP-Lab project.

Huijser, H. and Sankey. M. (2010). You Can Lead the Horse to Water, but … : Aligning Learning and Teaching in a Web 2.0 Context and Beyond. In M. J.W. Lee, C., & McLoughlin (Eds.) *Web 2.0-*

Based E-Learning: Applying Social Informatics for Tertiary Teaching (pp. 267–283). Hershey, PA: IGI Global.

Jalonen, S., Lakkala, M., & Paavola, S. (2011). Investigating knowledge creation technology in an engineering course. *Computers & Education 57*(3), 1930–1942.

KP-Lab (2008). D3.3 A report on educational technologies and emerging web technologies in relation to trialogical approach to learning. A report of the KP-Lab project.

Könings, K. D., Brand-Gruwel, S., van Merriënboer, J. J. G., and Broers, N. (2006). Does a new learning environment come up to students' expectations? A longitudinal study. *Journal of Educational Psychology 100*(3), 535–548.

Lakkala, M., Paavola, S., Kosonen, K., Muukkonen, H., Bauters, M., and Markkanen, H. (2009). Main functionalities of the Knowledge Practices Environment (KPE) affording knowledge creation practices in education. In C. O'Malley, D. Suthers, P. Reimann, & A. Dimitracopoulou (Eds.), *Computer supported collaborative learning practices: CSCL2009 conference proceedings* (pp. 297–306). Rhodes, Creek: International Society of the Learning Sciences (ISLS). Retrieved July 22 2011 from: http://www.helsinki.fi/science/networkedlearning/texts/Lakkala_et_al_2009_KPE_cscl09.pdf

Leinonen, T., Kligyte, G., Toikkanen, T., Pietarila, J., and Dean, P. (2003). Learning with collaborative software – A guide to FLE3. Helsinki: University of Art and Design. Retrieved July 22 2011 from http://fle3.uiah.fi/papers/fle3_guide.pdf (March 8, 2009).

Markkanen, H., Holi, M., Benmergui, L., Bauters, M., and Richter, C. (2008). The Knowledge Practices Environment: a Virtual Environment for Collaborative Knowledge Creation and Work around Shared Artefacts. In *Proceedings of World Conference on Educational Multimedia, Hypermedia and Telecommunications* 2008 (5035–5040). Chesapeake, VA: AACE.

Muukkonen, H., Hakkarainen, K., and Lakkala, M. (1999). Collaborative technology for facilitating progressive inquiry: Future Learning Environment Tools. In C. Hoadley, and J. Roschelle (Eds.), *Designing new media for a new millennium: Collaborative technology for learning, education, and training* (pp. 406–415). Mahwah, NJ: Erlbaum.

New Collaborative Working Environments 2020 (2008). *Report on industry-led FP7 consultations and 3rd Report of the Experts Group on Collaboration@Work*. Retrieved July 22 2011 from http://ec.europa.eu/information_society/activities/atwork/hot_news/publications/documents/new_collab_environments_2020.pdf (March 8, 2009).

Paavola, S., Lakkala, M., Muukkonen, H., Kosonen, K., and Karlgren, K. (2011). The roles and uses of design principles for developing the trialogical approach on learning. *Research in Learning Technology 19*(3), 233–246.

Rabardel, P., & Bourmaud, G. (2003). From computer to instrument system: A developmental perspective. *Interacting with Computers 15*(5), 665–691.

Scardamalia, M., & Bereiter, C. (1994). Computer support for knowledge-building communities. *Journal of the. Learning Sciences 3*(3), 265–283.

Suthers, D.D., & Hundhausen, C.D. (2003). An experimental study of the effects of representational guidance on collaborative learning processes. *The Journal of the Learning Sciences*, *12*, 183–218.

Vasileva, T., Tchoumatchenko, V., Lakkala, M., and Kosonen, K. (2011). Infrastructure supporting collaborative project based learning in engineering education. *International Journal of Engineering Education 27*(3), 656–669.

Väljataga, T., Pata K., and Tammets K. (2010). Considering Students' Perspectives on Personal and Distributed Learning Environments in Course Design. In M. J.W. Lee, C., & McLoughlin.(Eds.) *Web 2.0-Based E-Learning: Applying Social Informatics for Tertiary Teaching*. Hershey, PA: IGI Global.

Wallace, R. (1999). Learners as users, users as learners: What's the difference? Retrieved June 19, 2011, from https://www.msu. edu/~mccrory/pubs/HCIC_LCDboaster.htm

AFFILIATIONS

Merja Bauters
Helsinki Metropolia University of Applied Sciences
Finland
email: merja.bauters@metropolia.fi

Minna Lakkala
Institute of Behavioural Sciences
University of Helsinki,
Finland
email: minna.lakkala@helsinki.fi

Sami Paavola
Institute of Behavioural Sciences
University of Helsinki,
Finland
email: sami.paavola@helsinki.fi

Kari Kosonen
Institute of Behavioural Sciences
University of Helsinki,
Finland
email: kari.kosonen@helsinki.fi

Hannu Markkanen
Helsinki Metropolia University of Applied Sciences
Finland
email: hannu.markkanen@metropolia.fi