

KP-Lab System for the Support of Collaborative Learning and Working Practices, Based on Trialogical Learning

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This paper presents an approach in the domain of collaborative systems for working and learning practices called KP-Lab System. This system provides integrated multifunctional application with interesting end-user functionalities as manifold semantic based manipulation possibilities with shared objects of activities in real time, a support for management and analysis of knowledge practices, tools for synchronous and asynchronous communication, tools for personal organization and customization of working spaces, etc. Theoretical background for presented system is provided by trialogical learning, an approach in the domain of collaborative learning or working, with several similar aspects to existing constructivist approaches to learning. These approaches and some other theories, e.g. activity theory and knowledge building had a strong influence on specification of trialogical learning characteristics and their analysis in real settings. Presented research and development results have been achieved in FP6 IST project called KP-Lab (Knowledge Practices Laboratory). KP-Lab is an ambitious project that focuses on developing a theory, methods and tools aimed at facilitating innovative practices of sharing, creating and working with knowledge in education and workplaces. Research and development are integrated into co-evolutionary process that consists of collaboration between various types of project partners and other stakeholders. This paper focuses mainly on the technological results of this project, the KP-Lab System, presenting its architecture, main tools and interesting features provided by this system, e.g. its strong semantics-based character.

Povzetek: Predstavljen je sistem KP-Lab za sodelovanje pri učenju.

1 Introduction

The process of research and development in the domain of technology supported learning brings continuously new methodologies, methods or approaches how to adapt on the new appearing situations posing changing requirements on information and communication technologies. This adaptation process is tightly connected with utilization of existing or newly emerging information technologies, e.g. Semantic web, Web 2.0, as well as the ever changing practices of learning and work. We can identify many existing theories with relevant supporting solutions as Virtual Learning Environments (VLE), Learning Management Systems (LMS) or Computer Supported Collaborative Learning (CSCL) and Computer Supported Collaborative Work (CSCW).

In this paper we describe a new collaborative application called KP-Lab System that can be compared

with existing similar systems to identify advantages of the proposed solution. KP-Lab System provides a complex user virtual environment with integrated end-user tools based on the theoretical approach called Trialogical Learning (TL). This approach was derived from several existing theories in education areas to provide theoretical framework for realization of collaborative processes, focusing on the knowledge creation aspect of learning processes.

This system is one of the main KP-Lab¹ project outcomes. KP-Lab (Knowledge Practices Laboratory) is an IST project examining theoretical background of TL, identifying user requirements for its exploitation based on new technological solutions and accompanying

¹ <http://www.kp-lab.org/>

knowledge practices, implemented and tested on various pilot cases in different learning and working environments across the Europe and in Israel. The described system lays stress on support of collaborative and cooperative activities, work around shared objects of these activities, broader scale of communication possibilities (synchronous or asynchronous), manifold use of semantic information, service-oriented architecture and others.

The rest of the paper is organized as follows. Second section provides a short state of the art about existing approaches in education domain, which mainly influenced the concept of triological learning. This section provides also a short comparison between proposed collaborative system and some of the selected main applications in relevant domain. The third section is devoted to description of triological learning and its main aspects and principles as they have been identified and formulated in EU project KP-Lab, which is briefly described in the section four. The main technological outcome of this project, the KP-Lab System is described in section 5. KP-Lab System consists of two main parts: platform and virtual user environment with integrated end-user tools called KP-Environment (KPE). Section six provides detail comparison of the proposed KP-Lab System with several existing comparable solutions representing various types of VLE, LMS or collaborative working spaces such as Moodle, BSCW, SAKAI and Google Apps. Google Apps was selected as representative of new Web 2.0 technologies. Results of this comparison were used for declaration of innovative elements and advantages of the KP-Lab System. The main contributions of this paper are summed up in last, conclusions section.

2 State of the art

Triological learning (TL) can be defined as a theoretical framework in the domain of collaborative approaches to learning or working practices. TL is not supposed to be a „super-theory” on the basis of different background theories or replace any of these widely adopted approaches but it pinpoints certain kinds of phenomena which are prevalent and central nowadays: how people organize their work for developing some shared, concrete objects. This means situation that individuals (or groups of people) are developing some shared objects of activity within some social or cultural settings. As a representational example of triological activities can be mentioned the way how the wiki pages are collaboratively developed. It is a long-term effort of developing something for communal use on the basis of individual initiative. The interaction happens through shared objects (wiki pages) on the basis of other peoples' efforts. These main characteristics of triological activities represent possible similarity with other existing approaches in examined domain, e.g.:

- Carl Bereiter's knowledge building approach which emerged from cognitive studies in the educational context [16] ;
 - Yrjö Engeström's theory of expansive learning based on Activity Theory [6] ;
 - Nonaka and Takeuchi's model of organizational knowledge creation [12] ;
 - Constructivist approaches representing paradigm that people create new knowledge based on their past experiences and interactions with other people or surrounding environment [3] , [4] .
- Constructivism understands learning process not as passive receiving information and storing into the brain, but an active construction of knowledge and skills. Learning is a self-directed process, and the teacher can only help and support the learner to acquire new knowledge. This paradigm and relevant approaches are described within many works, e.g. [10] , [18] , [14] .
- The triological learning takes some of the ideas from these approaches, adds some new ones and makes different focus of learning activities towards knowledge advancement (for details see next section). In order to validate this learning approach, the KP-Lab System has been designed and implemented.
- KP-Lab System provides interesting features that make it possible to compare it with systems belonging to representatives of e.g. VLE, LMS CSCL or CSCW. We carried out some internal tests to identify advantages and potential disadvantages of our system with existing applications in mentioned domains. Some interesting findings are presented here, but detailed comparison with selected systems is described further in chapter six.
- Awareness of performed activities in user environment is implemented in different formats within most of the collaborative systems, but only BSCW and Moodle provide persistent storage of all performed events and some basic statistics of users' behavior too. KP-Lab System provides separate database for event logs and this historical data are used for several types of analyses, e.g. time-line based analyses or visual analysis of statistical summaries based on user preferences [15] .
 - Basic free term search is implemented in any collaborative system, but BSCW provides in addition also semantic search, supporting different metadata standards and offering faceted browsing and filtering. KP-Lab System extends these functionalities with possibility to save search queries and their results.
 - KP-Lab System provides possibility to create dynamic process models, not only predefined and rigid structure of created courses.
 - KP-Lab System is strongly oriented on semantic information, the main source of data is represented by knowledge repository that stores ontologies as main semantic framework for the whole system; created and modified shared objects with relevant properties represented by metadata; and relations between relevant concepts of the whole system.

Actually it would be possible to compare KP-Lab System with new initiative in this field called Google Wave², but actual version is still available only for invited Google users.

3 Trialogical learning

The theoretical foundation of TL is based on knowledge-creation metaphor of learning, contrasting two most typical previous ones, i.e. knowledge acquisition metaphor and participation metaphor of learning (see Figure 1). These two core approaches (referenced also as monological and dialogical) describe two basic ways of understanding the area of learning by Anna Sfard [17] :

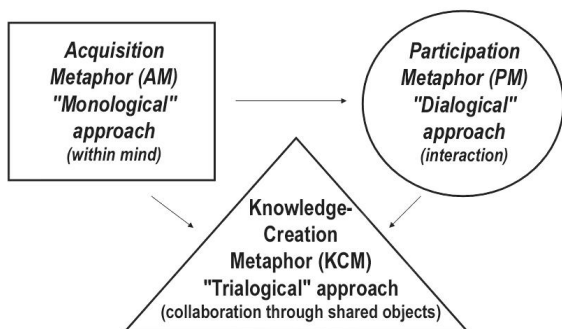


Figure 1: Three metaphors of learning, taken from [7] .

The acquisition (*monological*) metaphor of learning relies on the idea that knowledge is a characteristic of the individual mind, and the individual is the basic unit of knowing and learning.

The participation (*dialogical*) metaphor of learning understands learning as an interactive process of participating in cultural practices and shared learning activities that structure and shape cognitive activity in many ways.

From these two previous approaches third metaphor of learning has emerged that is aimed at overcoming the dichotomy between the acquisition and participation metaphors. It is knowledge-creation metaphor of learning [8] . While the acquisition metaphor represents a monological view on human learning as a mental within-mind process and the participation one represents a dialogical view based on interaction between humans and the cultural environment, the knowledge-creation perspective may be tagged as trialogical.

Definition describes TL as process where learners are collaboratively developing shared objects of activity (such as conceptual artefacts, practices, products) in a systematic fashion [7] . It concentrates on the interaction through these common objects (or artefacts) of activity (see Figure 2), not just among people or within one’s mind.

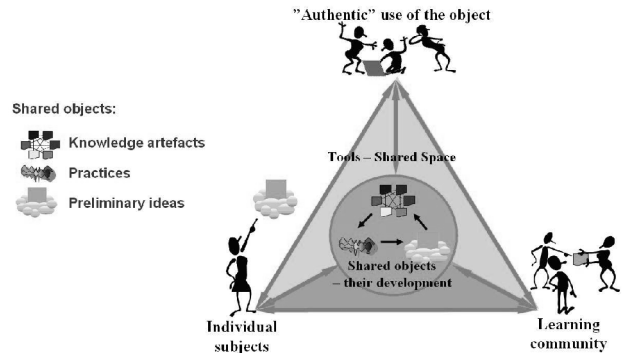


Figure 2: Structure of trialogical process, taken from [13]

The main goal of trialogical approach is to facilitate innovative knowledge practices within educational or professional communities. A central characteristic of these practices is a collaborative pursuit of complex problems, sustained knowledge advancement, and transformation of practices within heterogeneous networks of actors representing both application areas. The following six, interrelated basic features characterize TL [7] :

1. Focus on shared objects of activity whether those are knowledge artefacts, concrete products or practices to be reflected on;
2. Sustained and longstanding pursuit of knowledge advancement;
3. Interaction between personal and collective knowledge advancement efforts;
4. Cross-fertilization of knowledge practices between educational and professional communities;
5. Development through transformation and reflection;
6. Flexible technology mediation designed to scaffold collective creation, building, and sharing of knowledge.

4 Knowledge practices laboratory

Theoretical as well as practical aspects of TL have been created and are continuously researched in Finland, at the University in Helsinki (Centre for Research on Networked Learning and Knowledge Building³) mainly. From this institution the idea has been distributed in the (not only) European educational community, e.g. within the Knowledge Practices Laboratory (KP-Lab) project, UH (University in Helsinki) being the project coordinator. KP-Lab is an ambitious project that focuses on developing a theory, methods and tools aimed at facilitating innovative practices of sharing, creating and working with knowledge in education and workplaces.

This five years long IST project is sponsored by European Commission within the "Sixth Framework Programme" and has been launched 1st of February 2006. The first three years the main focus was on the research and development of methods, practices and supporting

² <http://wave.google.com/help/wave/about.html>

³ <http://www.helsinki.fi/science/networkedlearning/eng/>

tools. New tools were designed, developed and tested against user requirements in real situations within various pilot cases (in e.g. Finland, Holland, Switzerland, Hungary or Israel). The last two years have been devoted mainly to finish longitudinal experiments, improvements of existing tools based on experimental outcomes, dissemination activities and exploitation planning.

KP-Lab technological background consists of emerging technologies, such as Semantic web, Web 2.0, web services and service-oriented architecture in general, real-time multimedia communication, and ubiquitous access using wireless or mobile devices.

The multinational consortium integrates expertise from various domains, including pedagogy, psychology and engineering as well as end-users and key representatives from the corporate/business sector to provide authentic environments for research and piloting. The project involves 22 partners from 14 countries providing a suitable variety of universities, companies, work places and other prospective end-users.

The dialogical approach must be researched, developed and evaluated differently in different contexts. TL gives direction and ideas for developing existing practices and models to have more elements of collaborative knowledge creation, and both needs and problems of existing practices as well as the theoretical ideas have given requirements and guidance for the technology developed. This means that the basis for KP-Lab project is a challenging co-design model which must combine theoretical development, pedagogical research and models, and technology research & development. The main aim of its strategy is to provide a platform for researchers, developers and end users to create a shared understanding of current knowledge practices and to envision, design and evaluate novel applications and methods and thereby contribute to the facilitation of innovative knowledge practices.

4.1 Project objectives

The KP-Lab project aims at developing theories, tools, and practical models that elicit deliberate advancement and creation of knowledge (the dialogical knowledge-creation approach) as well as corresponding transformation of knowledge practices in education and workplaces.

In parallel with changes in society, conceptual frameworks, practices in school and at work, and social organization of learning also have to be transformed to facilitate development of corresponding individual and cultural competencies. The KP-Lab project examines these knowledge practices, i.e., innovative processes, routines, and procedures of working with knowledge. Knowledge practices represent socially constituted, rather than merely individual activities.

The following three objectives are central in framing the co-evolutionary nature of the KP-Lab project.

4.1.1 Theoretical development and modeling

Theoretical development aims at bridging a gap between individualistic and social approaches on learning and

cognition by building on approaches focusing on knowledge creation processes, that is, how people collaboratively develop new artefacts, products, and ways of working in long-term processes. Based on close collaboration with empirical research and technology development the aim is to understand and conceptualize transformation of knowledge practices with the use of novel technology in education and workplaces. The emerging dialogical framework is disseminated at academic and professional arenas and publications.

4.1.2 Educational and professional knowledge practices

The general objective of the pedagogical research is to develop a set of pedagogical methods to foster knowledge creation in educational and workplace settings and to specify possibilities of their implementation. Within the field of higher education, the focus is on the development of methods for symmetric knowledge advancement. Symmetric knowledge advancement is realized when communities of learners cross the boundaries of a classroom or an organization and promote one another's advancements rather than emphasize a one-directional flow of knowledge and competence from old-timers to newcomers.

4.1.3 Technological development and research

The general objective of the technological research and development is to design and implement a modular, flexible, and extensible ICT system that supports the dialogical pedagogical methods to foster knowledge creation in educational and workplace settings. The system provides tools for collaborative work around shared objects of activity, and for knowledge practices in the various settings addressed by the project. The technological framework provides an operational technical architecture for KP-Lab tools and services, software modules allowing for interfacing KP-Lab tools with third-party software. A set of guidelines and reference documents to support the implementation will also be provided in the last part of the project.

5 KP-Lab system

KP-Lab project provides a modular, flexible, and extensible system with a set of integrated and cooperative applications to support TL in educational and workplace settings. The project has developed and maintained a framework of shared technological solutions enabling the development and integration of inter-operable and extendable set of tools and services. KP-Lab System (see Figure 3) consists of two parts, namely platform and user environment (KPE) with integrated end-user tools.

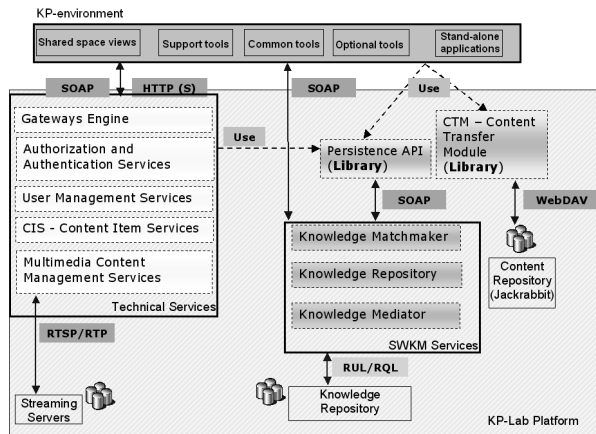


Figure 3: Architecture of the KP-Lab System [9].

5.1 KP-Lab platform

The KP-Lab platform (see Figure 4) is based on a flexible service-oriented architecture that aims at facilitating the integration and interoperability of different end users tools as well as interactions with middleware functionalities.

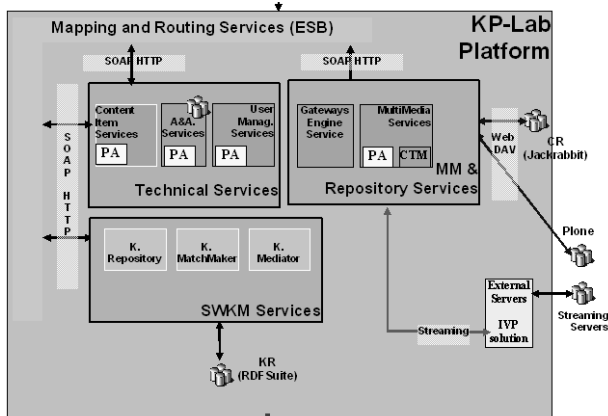


Figure 4: Architecture of the KP-Lab platform [9].

KP-Lab platform architecture is composed from several groups of services or libraries:

- Semantic Knowledge Middleware Services (*SWKM Services* in Figure 4) provide storage and management of the metadata created by the KP-Lab tools. This metadata are stored into RDFSuite that is used as the knowledge repository [1]. RDFSuite is being developed at FORTH -ICS in Greece and comprises the Validating RDF Parser (VRP), the Schema-Specific Data Base (RSSDB) and interpreters for the RDF Query Language (RQL) and RDF Update Language (RUL).
- Content Management Services (*Repository Services* in Figure 4) are dedicated to creation and management of regular content (documents in various formats) used in shared objects (content described by metadata), either towards KP-Lab’s own content repositories or external content repositories. KP-Lab content

repositories are implemented through Jackrabbit for the compatibility with the JSR-170 standard.

- The Multimedia Services (*MM Services* in Figure 4) provide functionalities for manipulation and management of dynamic content such as streamed material for audio and video function to be supplied to the KP-Lab tools (e.g. Semantic Multimedia Annotation Tool).
- *Technical services* cover those middleware support services, dedicated to the authorization and identity management, the user management, routing etc.

The services and applications interfaces build on common semantic data models that describe the semantics of shared objects, with the Trialogical Learning Ontology (TLO, see next chapter) as the core ontology.

5.2 KP-Lab ontology architecture

The common knowledge model for the integration and semantic enabled manipulation with various shared objects of activity in the KP-Lab System is provided by ontologies that are implemented in the following three layers (see Figure 5)

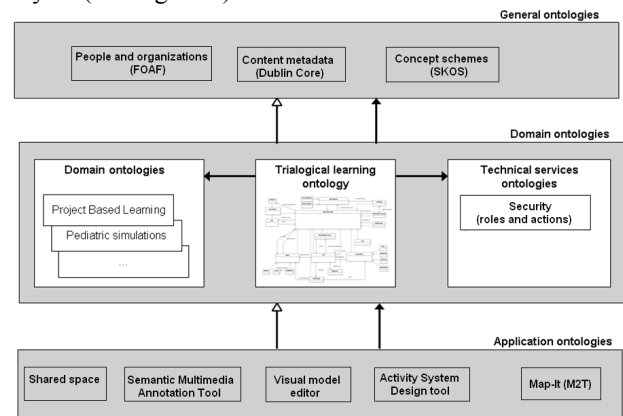


Figure 5: Architecture of KP-Lab ontologies [11].

General ontologies describe in common sense (i.e. reusable across application domains) objects, actors and activities, e.g.: persons and organizations for general description of people and their affiliations, etc.

Domain ontologies provide semantic framework for relevant courses or interesting application domains of KP-Lab System and trialogical learning approach, e.g. Project Based Learning ontology (PBLO). This ontology was created based on evaluation of performed courses by project pedagogical partners in Netherlands and Finland. It defines the basic concepts and relations needed for construction of whole courses and their implementation and further evaluation.

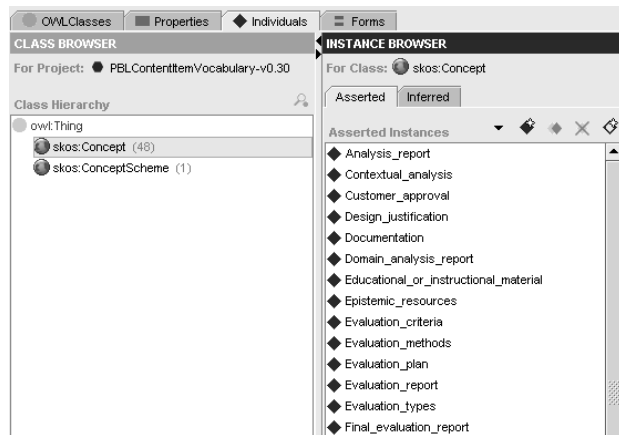


Figure 6: Example of PBLO in Protégé.

Technical ontologies that model technical concepts related to the services provided by the KP-Lab platform, integration of tools, e.g. security ontology to define different user roles in the whole system with personal information as login, password, etc.

Application ontologies represent set of ontologies relevant to end-user applications in KP-Environment as Shared space, Semantic Multimedia Annotation Tool, Visual Model Editor, etc., in order to model relevant self concepts of these applications.

Triological learning ontology (TLO) defines core concepts and principles of the TL and is shared by all applications and tools in KP-Lab System in order to provide the common semantics needed for the data interoperability. It defines basic classes for construction of user virtual environment with relevant parts as shared objects, users and integrated tools. Properties defined in this ontology provide common semantic framework for description of all types of objects in the system, as title, description, date, status, etc. The whole TLO (see Figure 7) can be divided into several subparts based on relevancies to particular end-user tools or functionalities that are represented with.

PersonalSpace	subclass of SharedSpace
RTCollaborativeContentItem	subclass of ContentItem
Relationship	subclass of Annotation
ScormImsContentItem	subclass of ContentItem
SemanticConcept	subclass of ObjectOfActivity
SharedSpace	subclass of ObjectOfActivity
System	subclass of Agent
Task	subclass of ObjectOfActivity
Template	subclass of ObjectOfActivity
ToDoItem	subclass of ObjectOfActivity
Tool	subclass of ObjectOfActivity
UploadableContentItem	subclass of ContentItem
VML Concept	subclass of ContentItem
VML Relation	subclass of Relationship
VisualModel	subclass of ContentItem
VisualModellingLanguage	subclass of ContentItem

Figure 7: Triological learning ontology, extract through SWKM browser⁴

5.3 KP-Environment

The Knowledge Practices Environment (KP-Environment - KPE) represents virtual user environment to support creation, management and evaluation of different user activities as whole courses, simple collaborative processes or individual actions with selected goals. Actual implemented version (see Figure 8) is a result of co-design process based on initial analyses, case studies, generic scenarios and requirements identification, to enable simple and intuitive environment with relevant features for experienced users with collaborative systems and novices too. KPE is built on conceptual ideas underlying the proposed learning approach (TL), such as collaboration, shared objects, boundary crossing, etc.

Class	Relations
Agent	subclass of http://www.kp-lab.org/ontologies/foaf#Agent ObjectOfActivity
Annotation	subclass of ObjectOfActivity
CollectiveSpace	subclass of SharedSpace
Comment	subclass of Annotation
ContentItem	subclass of ObjectOfActivity
ContentItemOrganizer	subclass of ObjectOfActivity
ExternalContentItem	subclass of ContentItem
GoogleDoesContentItem	subclass of RTCollaborativeContentItem
Group	subclass of http://www.kp-lab.org/ontologies/foaf#Group Agent
Individual	subclass of http://www.kp-lab.org/ontologies/foaf#Person Agent
Milestone	subclass of ObjectOfActivity
Modification	subclass of ObjectOfActivity
ObjectOfActivity	
Ontology	subclass of ObjectOfActivity
Organization	subclass of http://www.kp-lab.org/ontologies/foaf#Organization Agent

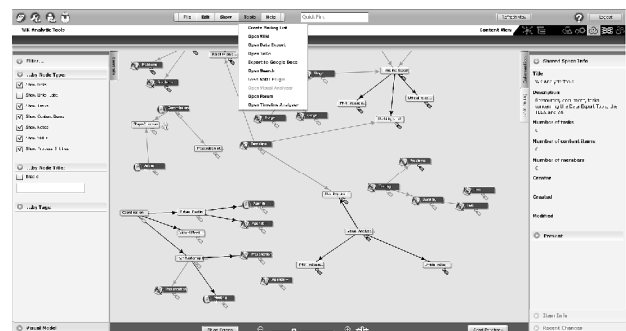


Figure 8: KP-Environment

The user is provided with four basic perspectives (views) when working with KPE: Network view (visualization of shared spaces network), Content view (organisation and management of different shared objects), Process view (management of shared objects relevant to the processes, as task, subtask, milestones, etc.), and Community view (management and

⁴ <http://kplab.fe.i.tuke.sk:8080/swkm-explorer/>

visualization of relations between relevant users). Moreover, Tailored view is a customized individual virtual space which can be created by any user. Various tools and functionalities are highly integrated in these basic views to enable versatile and flexible creation, connection, organization and reflection of the material in shared spaces (personal or individual):

- working with the shared objects, e.g. creating, editing, storing, sharing, commenting, discussing, semantically annotating using existing vocabularies and/or using users' own tags;
- managing different types of processes; e.g. creating, changing and executing process models supporting dynamic structure and adaptation;
- displaying a status information about each logged user, status information about actual working environment, present and performed users' actions, etc;
- context-based chat as one type of synchronous communication;
- Note editor for creation of small notes by users;
- proactive to-do list in combination with Google Calendar to support personal management of time and work;
- possibility to collaborative creation of shared documents through tight integration with Google Docs;
- export and import features for SCORM and IML packages;
- Semantic search [2] with possibility to save search queries and their results, advanced faceted window based on the metadata and content of shared objects and support user-defined, flexible visualization as well as semantics based classification and clustering of search results.

KPE has strong support for semantic features by providing integrated use of semantic functionalities, like tagging, filtering, grouping and searching. Users have the opportunity to flexibly create their own conceptual models and conceptualizations.

5.3.1 Examples of other KP-Lab tools

Semantic Multimedia Annotation Tool (SMAT) is a rich internet application that offers the possibility of annotating any multimedia content item. It is adaptive to the user's domain based on the use of ontologies to define the type of annotated item (i.e. video, audio), the granularity of the item fragments (i.e. page, image, timestamp) and the domain ontology (i.e. actors' activity in a scene, actors' decisions, actors' behaviour, objects in a scene).

Activity System Design Tool (ASDT) was designed and implemented in order to help the participants in making their practices and activity dynamics visible. The idea of ASDT is to enable users to analyse the history, present and future of their work activity in a way that helps address issues critical for deliberate

transformation of prevailing practices based on an intervention method called DWR (Developmental Work Research [5]).

Map-It is a tool that provides features for preparation, execution and evaluation of meetings (face-to-face and remote). Synchronous and asynchronous interactions are possible through the collaborative elaboration of "discussion maps" that capture user interactions through performed meetings. Map-It allows the use of meeting templates, in-advance individual preparations, sharing of materials, planning and follow-up of actions, automatic generation of meeting minutes in various formats.

The *Visual Model Editor (VME)* allows users to create, share, use, and update visual models as well as the underlying visual modelling languages. It provides easy and customizable environment for collaborative semantic modelling in diverse domains of interest.

The *CASS-Query tool* is a Java-application for collecting process and context-sensitive data that supports mobile users for the purposes of further analyses in KPE.

Wiki based on MediaWiki⁵ engine with semantic extension that is integrated in KP-Environment.

6 Comparison

KP-Lab System represents modular and extensible collaborative system based on dialogical learning principles with many integrated end user features so it is possible to compare it with other existing frequently used systems such as Sakai⁶, BSCW⁷ and Moodle⁸. We extend proposed list for comparison with Google Apps⁹ as representative of innovative information and communication technologies based on Web 2.0 paradigm. Results of our comparison (May 2008) are presented in Table 1.

Organization of user virtual space (feature)	
1 (KP-Lab)	Network view, basic list, different filters, favorites lists
2 (SAKAI)	individual lists of user's pages based on their roles
3 (BSCW)	spaces are organized as folders
4 (Moodle)	courses divided into categories
5 (Google Apps)	the sites are presented as list formats
Relations between spaces	
1	links between different spaces with descriptions of these relations

⁵ <http://www.mediawiki.org/wiki/MediaWiki>

⁶ <http://sakaiproject.org/>

⁷ <http://www.bscw.de/copyright.html>

⁸ <http://moodle.org/>

⁹ http://www.google.com/a/help/intl/en/var_1c.html

2	not supported
3	not supported
4	courses organized only hierarchically
5	not supported
Awareness	
1	online status, history of performed actions or changes, notifications
2	supported
3	supported
4	supported
5	supported
Search	
1	free term and full text search, faceted browsing and filtering, saving of queries or search results
2	basic free term search
3	basic and semantic search
4	basic free term search
5	basic free term search, possibility to save performed queries or their results
Process modeling	
1	Gantt chart, dynamic process structure, process templates
2	supported
3	supported
4	supported
5	unverified
Personal management	
1	To-do list and Google Calendar integrated directly into whole system
2	simple to-do list
3	supported
4	supported
5	supported
Analyses	
1	statistical summaries, social network analysis, time-line based analyses (evolution of process creation)
2	not supported
3	not supported
4	basic user statistics
5	basic statistics
Monitoring and logging	
1	persistent storage of performed events in virtual environment – historical data for analyses
2	supported
3	supported
4	Only log files in insufficient format
5	not supported
Commenting	
1	visualization of comments in threaded manner, awareness of ongoing discussion
2	not supported
3	supported
4	supported
5	not supported
Tagging	
1	free tags or tags from vocabularies, consistency check, recommendation service
2	not supported
3	supported
4	not supported
5	simple tags in Google Docs
Semantic wiki	
1	extension of wiki engine with semantic features (tags, search, ontologies)
2	not supported
3	not supported
4	supported
5	not supported
Real-time Collaborative Document Editing	
1	Integration of Google Docs
2	not supported
3	not supported
4	not supported
5	supported
User Community view	
1	Grouping, social relations with visualization within networks, multiple roles
2	not supported
3	not supported
4	not supported
5	simple group formation
Data export	
1	Export information from knowledge and awareness repository for further analyses as Excel sheets
2	not supported
3	unverified
4	supported
5	not supported
Import/Export of IMS packages	
1	Reuse of courses made in some other compatible systems
2	not supported
3	unverified
4	supported
5	not supported
Meeting support	
1	Creation of discussion map, preparation of meeting materials, generation of meeting outputs
2	not supported
3	export relevant data for conferencing application
4	not supported
5	not supported
Visual models and languages	
1	Creation and operations with semantics by means of self-defined visual modeling languages and models
2	not supported
3	not supported
4	not supported

5	not supported
Semantic multimedia annotation	
1	Possibility to annotate uploaded video clips based on created ontologies
2	Project Pad
3	not supported
4	not supported
5	not supported
Specialized tools supporting reflection activities	
1	Analysis of performed activities represented by records in text, sound, video or other formats based on DWR theory.
2	not supported
3	not supported
4	not supported
5	not supported

Table 1: The comparison table.

Based on the comparison summarized in Table 1 we can observe several main and important advantages of the KP-Lab System, mainly:

- Multifunctionality
- Extensive use of semantic features
- Extendable and interoperable solution with existing approaches

6.1 Multifunctionality

No one open-source system provides so many features as KP-Lab System. To sum up the functionality comparison (also with some other systems):

- Dokeos¹⁰ supports videoconferencing, RSS, calendar with agenda, session information, and integration with Google search but lacks much other functionality provided by KP-Lab System, e.g. the semantic aspects and visual organization possibilities.
- FLE3¹¹ consists of three main parts that provide features for knowledge building, sharing objects and collaborative construction of digital objects but does not provide possibility to create and manage processes in an easy way (e.g. Gantt chart), it does not provide possibilities for virtual meetings in context of the selected objects, does not provide tagging possibilities, etc.
- Moodle is strongly oriented on the area of integrated modules while the semantic aspects and possibilities to analyze user’s practices /activities are weakly developed.
- Claroline¹² is a simple tool and has only basic functionalities offering complex and complicated information about courses (users list, accesses to course, utilization of the tools, documents usage, forum contributions), but

hardly addresses the management and flexible modification of processes.

- SAKAI places emphasis on the development phase and like Moodle can be extended by relevant modules with new features. SAKAI provides several similar functionalities as KP-Environment, such as: shared workspace, job scheduler with calendar, portfolio, but lack focus on semantics of the used objects, e.g. semantic search, commenting or tagging, semantic wiki and different visualization possibilities.
- BSCW seems to be a strong commercial system that provides advanced functionalities as tagging, communities, templates, search on different indexing services, while editing tags or the indexes is poorly developed or does not exist, also collaborative idea generation tools are not available.

6.2 Usage of semantic features

Another strong point of KP-Lab System is management and utilization of metadata and semantic features. For example, comparable systems provide features to share and save objects (documents in different formats, multimedia, etc.) in different types of repositories as transaction databases or content management systems. KP-Lab System provides possibility to work with different objects that are stored within content repository (content of relevant object: text file, video, audio, package, etc.) and semantically described by self defined or predefined properties stored in knowledge repository. It means that objects’ description consists of two parts:

1. Metadata (semantic information) that is saved into knowledge repository, implemented within RDFSuite based on predefined ontologies. Basic object properties are defined within Dublin Core standard, e.g. Title, Description, etc.
2. The content is saved in content repository based on Java technologies and access services are provided by designed and implemented specialized gateways (G2CR) with supporting of versioning and possibility to select relevant repository based on content type or actual availability.

This is an important point since the metadata is a crucial mean to achieve real semantic integration, i.e. the different tools are not only „co-located“ in a single environment but also share the same semantics, e.g. all tools know what an object is, hence this information can be reused across tools. It enables to work with one shared object in different contexts and different processes. Moreover, one shared object can have different semantic interpretations in different processes.

Semantic features are implemented within end user tools as the tag-vocabulary editor (user has possibility to use existing tags from different vocabularies (e.g. PBLO) or create the new ones based on the actual

¹⁰ <http://www.dokeos.com/>

¹¹ <http://fle3.uiah.fi/>

¹² <http://www.claroline.net/>

needs), semantic search (integrated part of faceted GUI is filtering the results through semantic properties to divide search space based on user requirements and improve performance measures of search algorithms), visual model editor (possibility to create own visual model – ontology, e.g. conceptualization of examined domain or used approach based on identification of main concepts of this domain with relevant relations – the goal is not to replicate existing application as Protégé¹³ or OntoEdit¹⁴), but provide a simple mean for definition of any visual concept model. Semantic wiki (tagging the whole wiki pages or selected internal sections of the pages) and analytical tools as data export (export required data from knowledge repository, e.g. overview summary about created and uploaded shared objects during examined activity with their description) or time-line based analyses (visualization of the whole evolution process of selected share objects based on relevant user actions stored in awareness repository).

6.3 Extendable and interoperable with existing solutions

KP-Lab System is easily extendable and highly interoperable with existing solutions by the following means.

- SWKM and G2CR provide not only simple access to the saved data, e.g. G2CR provides access to different types of content repositories, thus providing potential integration with existing databases from e.g. Moodle.
- The end-users that currently use some different (IMS compatible) systems for their work or learning, will not have problems in migrating to KP-Lab System, and can execute the migration without necessity to redesign their shared objects, because of the possibility to import IMS packages.
- Tight integration with Google Docs and Calendar to provide features for real-time collaborative creation and modification of shared documents and for personal time and work management.
- Proposed logging mechanism can be used for other collaborative system to store performed events in virtual user environment and collect historical data for analyses in KP-Lab analytic tools.
- Data export provides also the possibility to extract data from knowledge and awareness repository for further analyses in third party analytic tools like e.g. SPSS.

7 Conclusion

KP-Lab System represents an interesting collaborative system which is based on the triological learning principles. The architecture and interesting aspects of this

system (mainly its semantic character) have been presented in this paper. Our comparison with other collaborative tools available nowadays showed that collaborative systems usually provide several common functionalities for this type of tools and a few specific ones dependent on application domain or theoretical background behind. KP-Lab System provides all of these common functionalities and many specific ones in one environment as multifunctional application. Furthermore, KP-environment outperforms other collaborative systems with respect to their semantics nature, interoperability with other tools and analytical possibilities provided for knowledge creation processes. Actual version is available on <http://2d.mobile.evtek.fi/shared-space/>.

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¹³ <http://protege.stanford.edu/>

¹⁴ <http://www.ontoknowledge.org/tools/ontoedit.shtml>

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