Web-based collaborative learning and knowledge sharing in informal business networks[1]

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Abstract: The work presented in this paper is the development of an integrated web-based solution to support informal learning among businesses through knowledge sharing. The aim was to offer a customized service to SMEs and larger organizations to address the needs of business managers for information and knowledge exchange, enhancement of high order skills and decision support. To this end, a set of services are proposed which support the formation of learning networks, allowing managers to learn from peers. The services are offered through a web-based platform that facilitates structured inter-organizational knowledge management operations, learning processes and enhanced communication. The platform includes tools for creating and operating learning networks, capitalizing and sharing informal knowledge and information, as well as effective and flexible communication, adapted to the needs of SME managers. The solution is highly customizable to the individual needs of various networks and is offered as a service. Trials in collaboration with pilot learning networks in Belgium, Ireland and Cyprus resulted in valuable feedback for service refinement and showed positive prospects for commercial vendoring of the services in the European market.

Keywords: Informal Learning, SMEs, Customized Service, Decision Support

1. Introduction

A widely adopted practice worldwide to support the development of higher- order skills of managers (e.g. project management, team-working, business planning) is the formation of networks, either among clustered SMEs or among divisions inside large organizations (Siemens 2005, Ruiz-Mercader 2005). Recent research work (Mackey 2011) provides an insight on how connections among professionals are used to extend their learning, challenging the way formal online learning is designed and highlight the potential for networked learning. Centers of excellence, such as CELSTEC (http://celstec.org) run several projects that investigate novel ways of learning, in particular through networking and exploitation of new technologies (Koper 2009).

Specialized entities that facilitate learning in networks also exist, operating mainly on the basis of supporting informal communication and information sharing. Such entities, as for example Chambers of Commerce and Industry or organizations for SMEs, may also organize physical or electronic learning sessions for SME managers and provide informational support. As an international large organization in this field, it is worth mentioning the Global Development Learning Network (GDLN) (http://www.gdln.org), which is a partnership of over 120 recognized global institutions in over 80 countries that collaborate in the design of customized learning solutions for individuals and organizations working in development. A combination of learning techniques are used, such as expert panels, case-based learning and action plans, as well as information and communication tools, used in face-to-face, videoconferencing and e-learning events.

The concept which differentiates novel learning approaches such as the ones mentioned above from conventional e-learning is that of the Learning Network (LN). LNs are inter-organizational structures aimed at promoting and supporting learning, knowledge management and networking among their member companies. On the level of people, LNs are connections with people and information, communicating in such a way so as to support one another's learning (Dirckinck 2009). Key elements of any network are activities, actors, resources and systems. These four concepts are regarded as components of a relationship where they are equally important and are dependent on each other. However, it is stressed that the term learning networks does not refer to networks where learning simply happens, but to inter-organizational networks where structures have been formally established to increase the participants' knowledge and innovative capability.

Learning networks currently exist in a variety of themes, several of which are addressed to clusters of SMEs (Keeble 1999), while others are of intra-organizational nature (Wilson 2004). Existing learning networks operate according to a set of defined processes, which are typically supported by software platforms, since a fundamental characteristic of learning networks is that information and communication technology is used to promote connections between one learner and other learners, between learners and tutors and between a learning community and its learning resources (Goodyear 2004). The size of such networks, the strength of collaboration among the members and the adopted learning approach differs significantly. Existing practices include the operation of information exchange platforms, the organization of formal learning activities, such as physical or web-based seminars, as well as the provision of support services by experts. More advanced tools and emerging technologies have also been reported, such as the integration of learning with social networking and the use of training games and simulations (Downes 2008, Siemens 2009). Surveys on the effectiveness of networked learning in schools showed that the benefits are not always clear, despite the prospected potentials (Sammons 2007), which emphasizes the argument that the design of learning networks needs to be supported by a sound methodology and to be tailored to the specific learning community needs.

Unlike the technology-enhanced learning services that focus on "top-down" structured learning support methods, the services proposed in this work focus on the collaborative bottom-up dynamics of learning within networks. Specifically, emphasis is placed on peer-to-peer tacit knowledge sharing and collective decision-making in the definition of new learning topics through a state-of-art voting functionality of the system. The proposed approach considers as a primary factor the ability to motivate network members to learn in a collaborative manner and to

effectively support knowledge sharing within such inter-organizational SME networks.

The aim of the presented work is to develop a Learning Management System (LMS) to facilitate innovative e-learning services which cover the need of SME managers to learn from peers. This is achieved by enabling and supporting collaborative learning within inter-organizational learning networks. The proposed LMS offers tools for structured learning (e.g. formation of groups, management of sessions, setting of learning objectives and collective planning), enhanced tools in the form of components (such as training simulation) and communication tools integrated with knowledge capturing, management and sharing techniques.

Our focus is that the developed Learning Management System is particularly effective in creating and running learning networks, as opposed to alternative platforms that are best suited to the provision of e-learning services. The primary needs to be addressed are those related to the support of "face-to- face" learning activities (e.g. workshops, seminars, meetings etc.) with an internet-based communication and collaboration service. The "off-line" forms of co-operation within networks are not replaced but rather complemented and strengthened. Specifically, the services are focused on supporting network members in pre-physical and post-physical learning activities, in addition to accommodating purely "online" network communities. Emphasis is also given in collaborative resource building and effective distribution and reuse of the produced knowledge.

The developed web-based services have been designed on the basis of an innovative and tested learning methodology (Angehrn 2003, Nicolopoulou 2002), thus resulting in an application service platform offering the technology together with a matching business support service. The underlying methodology has been produced within the framework of the research project Knowlaboration (IST-2001-32505) and the proposed services were validated within the market validation project "Knowledge and Learning Among Business (K-LAB)", funded by the EU program e-Ten, by offering them for use in pilot form in three learning networks in Belgium, Ireland and Cyprus. The user feedback and market evidence collected during the latter provided useful input for refining the platform and the supported services. Further advances were also introduced in knowledge representation, towards more effective semantic-oriented resource sharing. An iterative development process has been applied, that was based on rapid prototyping (Whitten 2004) and user feedback, aiming at a solid product with prospects of deployment as a pan-European commercial service.

2. Requirements and Methods

2.1. Overview

The aim of this work was to develop and validate a Learning Management System (LMS) able to adapt to customizable learning models and individual network needs. In particular, it was planned to develop and validate an inter-organizational collaborative environment which offers to the members the means to capture, manage and share the knowledge generated within the LN, thus facilitating methods for setting up multi-disciplinary virtual communities of learning. Although both formal and informal learning are within the scope, the primary emphasis is on the informal aspect of learning, which is closely linked to the dynamic and informal nature of a LN, as opposed to structured e-learning sessions (i.e. courses). The ION (Interorganisational Networking) project funded by the British EPSRC1 (GR/L20504, L23536, L21617) investigated the processes of setting-up and operating a learning

network, producing a Guide for setting and operating a learning network. In parallel, a theoretical framework for establishing and maintaining collaborative learning networks has been presented by Wenger (Wenger 1998). Among the central concepts in this learning theory are the two aspects of interaction and motivation, while learning is viewed as processes taking place in what is called communities of practice (Sorensen 2005). In the current work, the above approach of "communities of practice" has been adopted, implemented on the basis of modern web technologies. The principles on which the proposed LMS is based and which differentiate it from alternative solutions are that:

1. The need for content and support emerges dynamically from the member interaction and the goals are set collectively.
2. The platform not only facilitates the operation of an LN but also stimulates the creation of new networks.
3. The technology is driven by a solid methodology, which supports the platform with best practice guidelines on network creation and effective implementation of collaborative learning processes.
4. Provision is made for integration with external learning tools such as games and simulations.

In the following subsections, the main high-level requirements, stemming from the above principles and set goals, are presented.

2.2. Functional requirements and structure

The integrated e-learning and knowledge management platform under development is required to support the following main functionalities:

Learning processes, as follows:

- ***collaborative learning:*** collaborative learning activity includes both online learning sessions as well as support for offline/physical learning sessions
- ***learning dissemination:*** the system supports the dissemination of knowledge to the other network members as well as non-network members through the network news section, network calendar (where events are published), forums, chats, instant messaging, sms, e-mail and mailing lists.
- ***harvesting learning:*** the system supports the assessment of the learning impact on the network and its members with voting forums and an online evaluation tool, through which the network moderator and group facilitators can post questions and see the aggregated results.
- ***decision-making:*** the system supports decision-making through chats and voting forums. For example, network board members can create a private group area and in order to take decisions through a group forum.

Knowledge resource management: the system provides an online document management system, able to handle conventional documents as well as audio and visual resources. The management system is based on a specialized meta- data model, offering advanced search and sharing capabilities. Moreover the system provides a members' contacts directory that is organized in a tree-like structure of all the companies/organizations involved in the network.

Administration, adapted to the organisational structure of a LN. The platform is organised in different levels/areas, together with the related access control mechanisms, that reflect the typical organisational layers of networks: i.e. a network level area, group areas and a personal area for the individual network members. A "back-end" environment is also required to enable management tasks, such as

session scheduling and content management at all levels, i.e. portal, network, group and member levels.

2.3. Users

The typical structure of a Learning Network includes the "network facilitator" who has the central responsibility for facilitating the network and "members", who are the beneficiaries of the learning that is taking place within the network. These main user types have clearly different requirements regarding functionality and usability, the needs of facilitators being more easily identifiable but the needs of members being more critical for the success of the venture.

More specifically, the system's usage scenario involves 5 types of users, organized as roles. The identified roles are divided into network roles and group roles and are the following:

- **Network Operator:** this is the network manager or person who has been assigned to co-ordinate the daily operations of the network. The Network operator typically represents a leader organization co-ordinating the LN, such as a Chamber of Commerce, Industry Association, consultant etc.
- **Network member:** a network member refers to the individual member or person who represents his organisation in a learning network.
- **Group facilitator:** the group facilitator is a network member whose responsibility is to facilitate the learning activities of a learning group.
- **Group member:** a group member is a network member who belongs to a learning group of the network.
- **Guest/Expert:** a guest is a non-network member who has been invited to participate in the network for a specific reason (such as presentation of a topic) and for a set period of time.
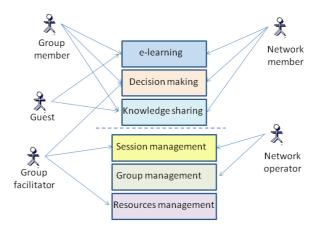

Figure 1. The main services and the user roles to whom they are addressed.

Each role has specific system rights and permissions that can be selected and modified by the network operator. The operator is the Role that administrates a specific network area of the Portal. The Portal can have multiple network operators, corresponding to the multiple numbers of running networks. Although a number of standard member roles are predefined in the system, additional customized roles can be created by each network operator in order to serve special needs. The access of user roles to the offered services is shown in Fig.1. An access control mechanism

based on user role needs is applied to all types of resources, including documents, knowledge content, communication services and tools.

2.4. Technical Requirements

A requirement considered as a starting point in this project was to develop a web-based portal, in order to take advantage of the flexibility, communication/networking capabilities and minimum technical requirements for the user side that web applications offer. End users should not need to acquire specialized hardware or software components in order to access the services. Therefore all communication between end users and the system are performed over a common IP network, based on HTTP and HTTPS protocols and the interface to the end user is actually a web site.

Additionally, a centralized Application Service Provider (ASP) schema is adopted, which allows rapid and efficient creation of platform instances customized to individual LNs. In this way, more efficient deployment of the new platforms is achieved, together with easier, faster and more secure maintenance and upgrade processes. The look and feel of the interface is adaptable to the individual needs of each network so that the platform can be perceived by the users as an extension of their own corporate website, thus offering a familiar environment.

The Portal stores and communicates valuable information/knowledge content, which is property of each network or specific group. Sensitive data may also be contained in user profiles and document library. Therefore, strict requirements apply on data security, access control and integrity. According to the user requirements, various levels of access rights are defined for each functionality and content item. Moreover, these levels need to be defined and implemented in a way that facilitates the integration of more functions and knowledge content in the future. Therefore, a complex access control mechanism is required that would apply not only on data and services but also on meta-data and search mechanisms, in order to avoid indirectly exposing protected data. Security and integrity requirements also apply to prevent unauthorized access, as well as data damaging at place of storage or within communication. Additionally, in order to ensure material authentication, there should be provision for document watermarking or other content authentication services.

2.5. Interoperability and standardization requirements

An important goal set by the current project is to make the platform as interoperable, expandable and customizable as possible, to support both localized and international LNs, in order to enable a full deployment in a European context. The related requirements are:

- ***Internationalization/Localization.*** The ability of centralized development, maintenance and operation of a platform that is able to support numerous networks with various characteristics, independently from location. At the same time, it is required to support customized applications for localized needs.
- ***Multilinguality/Crosslinguality.*** The system should be able to support different languages according to the needs of each network and possibly more than one language per network. Language support refers both to the interface and content management tools (e.g. search) but not to the content itself, at least at the moment.

- ***Interoperability.*** The portal should be able to incorporate content (i.e. to import, store, export and utilize) in as many available formats as possible and to be compatible to other common applications, such as audio and video players, office packages, statistical software etc.
- ***Standardization of e-learning items and knowledge content.*** The e-learning items (e.g. courses, presentations, simulations) and knowledge items (e.g. document collections, forum content, etc.), either in the form of repositories or in the form of dynamically created collaborative knowledge, need to be organized and standardized, to allow effective management, search and reusability. Specifically, it is required to adopt or define a resource description system based on meta-data and a set of specifications for all content items.

3. Developments

3.1. Architecture

The proposed LMS is playing the role of an intermediate access server residing between end users that enables the collaboration and development of knowledge inside the learning network. The product is an integrated software system consisting of several subsystems, which serves as a learning platform for an inter-organizational mechanism, the Learning Network. The core function of this modern system is to handle the collaborative content (e.g. courses, discussions, documents, sessions, etc.) that is created and exchanged among the users, and in particular to capture the knowledge content, organize it using meta- data and offer it to learners through advanced search and access services. From a technical perspective, the system is a modular web-based tool, which consists of several subsystems providing different functionalities to different types of users.
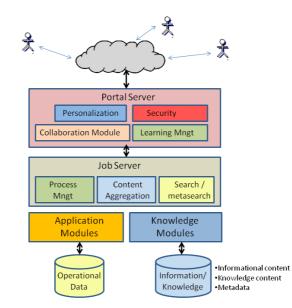

Figure 2. The system architecture. The Portal server is the front end of the system, responsible for service provision, while the Job server is the system core which supports processes, logic and knowledge management.

The system has been designed to fulfill the high-level requirements mentioned in the previous section. More detailed technical and functional requirements have also

been defined, following a user requirements analysis phase carried out in collaboration with managers of three existing learning networks in Belgium, Ireland and Cyprus. Design and development has been performed following the Rapid Application Development (RAD) methodology (Whitten 2004). An iterative process has been applied, involving the users and taking advantage of their valuable feedback to refine the services. The system architecture is shown in Fig. 2. The core of the system is the Job Server, which manages information and business logic, while the front-end is the Portal server, which is responsible for integrating all subsystems into a uniform service provision environment. The components and their functions are listed in Table 1.

Table 1. The system components and their functions

Component	Functions
Portal Server It is the front-end of the system that handles the main functions and provides to the user an integrated environment containing all services.	• Content Management • Organizational chart • Group Workspace • Document Management (group, public, etc) • Personal File manager • Search / Metasearch • Open API • Administration Interface • Reporting and auditing
Job server Manages all the system's content by accessing different data sources. It also performs standard jobs on information/knowledge content, such as update, indexing and tagging, facilitating advanced search capabilities.	• Content Aggregation Engine • Search / Metasearch Engine • Multi Server/ Application environment • Distributed File Systems Indexing Engine • Administration processes
Security Engine Prevents unauthorized access to system functionality and content.	• Users authentication • Modules security engine • Administration of access control • Watermarking
Collaboration tools Supports a wide set of tools which allow synchronous and asynchronous collaboration among users	• Forums • Voting Forums • Chat engine • Instant messaging • Notes • Mailing list management
Learning tools Supports the tools related to the provision of learning services	• E-learning session provision • Learning session management • Authoring and configuration
Personalization Engine Allows the configuration of the interface and the functionality according to user's preferences. Also enables personalized content filtering and message lists.	• Layout • Messages • Language • Content • Tools

3.2. Functionality

The functionality offered by the system is role-specific and configurable to the needs of individual networks. Moreover, user-specific configuration is supported in order to allow personalized preferences and setup for individual users. Certain sets of

functionalities are addressed to end-user roles i.e. learners, such as network members, while other ones are addressed to supporting roles, such as network operator and system administrator. In total, the system covers all the needs for establishing, operating, monitoring, sustaining, evaluating and enhancing a learning network, not only in technical means but also by enhancing the related organizational structure and activities.

Figure 3. The "Group Area" user screen.

In Fig 3, a screen-shot of the "group area" is depicted, which is the main access point for all the functionality and information available to a group member. In the following, a selection of the system functions and related features are presented.

The Group area. This is the user environment available to group members (as learners) and group moderators, with privileges adjusted to their role. Through this environment, users are able to collaborate and share tacit knowledge with other members within the same group, to access related information (documents, presentations, news articles, etc.) and to participate in events. Additionally, they are able to make use of a dynamic knowledge pool, where informal knowledge captured during group activity has been stored and is available through an advanced search mechanism (Fig. 4).

The network area. Through the network member screen, members have access to those resources of the full network for which the network moderator has activated the corresponding privileges, such as documents, calendar, sessions, news and communication tools. The user can also select a specific group in order to register and enter.
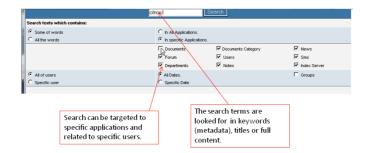

Figure 4. The search tool allows advanced search options

Network operator environment. The network operator has access to a large set of administration, resource management and communication tools, in order to configure, run and monitor network activities. The network operator is responsible for creating/managing groups.
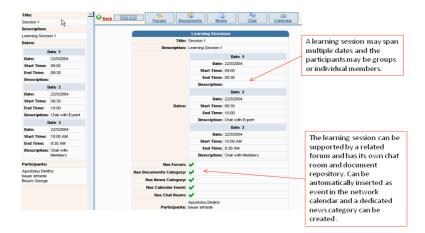

Figure 5. The learning session management screen

Communication. In addition to e-mail, and instant messaging, Skype communication is available between the platform users. Skype is fully integrated in the system's environment, so that discussions can be captured and saved in the system database, together with appropriate tagging and are available for reuse and sharing. Users have two mass mailing tools available, mass mailing to personalised lists of selected member groups and mass mailing to all group members.

Report Designer Tool. Network operators and group facilitators are able to use a rich set of predefined analytic reports as well as to define customised reports on network/group activity, that are not limited to web server's traffic log files. The available statistical tool can generate analytical reports based on a combination of criteria (date, specific page, groups, members) given by the user.
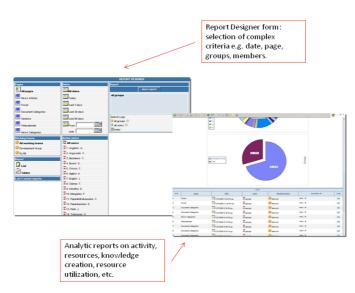

Figure 6. Moderators can use predefined analytic reports or configure customized ones using the Report Designer.

3.3. Technologies

The system has been developed on MS-Windows platform using object-oriented languages (ASP, VB and Java), Microsoft SQL database and Internet Information Server (IIS). The communication between the user interface and the central system is through standard TCP-IP connection (HTTP, HTTPS and SOAP protocols), while the user interface is guaranteed to run on MS-Windows, Mac, Solaris or Linux environments. Standards on coding, documentation, versioning and testing are defined in a quality manual.

Among the web technologies employed by the system are Microsoft Active Server Pages (ASP) that have been used as a server-side scripting environment to create the dynamic and interactive elements of the applications. The execution of all processes, all data handling and thus the full control of the applications remain on the server, while the users receive Hypertext Markup Language (HTML) pages, accessible through common browsers. A Service Oriented Architecture (SOA) has been adopted, allowing sophisticated information exchange through Web services. The Web Service Description Language (WSDL) and the Simple Object Access Protocol (SOAP) have been used, while information is formatted using Extensible Markup Language (XML). Background communication between user and server is performed via Asynchronous JavaScript and XML (AJAX) (Garrett, 2005).
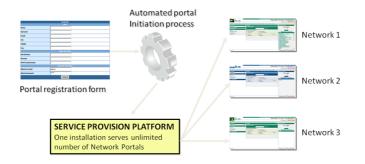

Figure 7. Schematic illustration of the automated portal creation process

3.4. Application Service Provision

The service is provided from a central location rather than on each network site under the Application Service Provider (ASP) model. However each network as well as each group within this network are active in their own protected area, ensuring the confidentiality of the exchanged information, while they are offered an e-learning environment that is tailored to their specific needs. At the same time, customization is achieved efficiently, since an automatic tailoring mechanism has been developed which produces any number of individual LN platforms based on a generic system and a set of templates.

In order to simplify the creation of customized LN platforms, an automated process has been developed (Fig. 7). Preferences and individual needs are collected via a web form, which can be filled in by the operator of the new network. A new platform is then created as a new instance of the generic system, tailored according to the defined preferences (e.g. language, style, logo, set of active services, size). The process includes the automatic definition of web server's setting, the creation of a dedicated database based on a predefined schema, the allocation of physical storage

space and the activation of a set of user accounts. It is noted that all platforms use the same source code and may be served by a common web-server.

3.5. Knowledge Management

An important element in the developed platform is the ability to manage learning resources and more specifically to:

- organize learning content such as presentations, documents, best practice guides and all sorts of learning material in various formats and scope
- capture tacit knowledge exchanged among learners or between learners and peers and make it available for further sharing and reuse
- provide advanced search tools able to handle non-uniform and distributed content
- integrate with external knowledge sources in order to allow import/export of knowledge as well as links to external resources.

Resources of all types that can be used for learning or supporting material, either created within the LN or available from other sources and shared within the LN, are named as Learning Content Objects (LCOs). LCOs can be of several different types, such as presentations, e-learning courses, best practice guides, discussions, as well as external links to internet resources.

In order to achieve the abilities listed above, a model of the knowledge/information handled by the system needed to be elaborated, together with a suitable description system. To this end, a special data model has been produced that includes meta-data descriptions for LCOs. It is noted that the produced model is considered as a data model supported by a meta-data schema and not a knowledge model, in the sense that it does not address the issue of expressing knowledge (e.g. in the form of rules, relations, etc.) but deals with the description and organizing of learning objects or simple information resources (LCOs) that are already formalized.

The description of LCOs has been based on meta-data whose definition is "data about data" (Berners 1998). Meta-data are used to provide information about documents and content items which are meaningful for human users but do not necessarily need to be displayed to the end user. This information is kept by the system and can be used by search engines or management subsystems. Examples of information commonly stored as metadata include authorship, publication date, modification date, copyright information, and subject keywords. Meta-data is therefore used to describe information resources in order to facilitate their categorization, storage, search and retrieval (Miller 1996). A metadata model is a structured description about the characteristics and properties of a type of information resources and allows the creation of catalogues and indexes. It also facilitates searching and comparing descriptions of different information resources and, as a consequence, the automation of search mechanisms.

A large number of metadata models have been proposed by standardisation organisations in order to facilitate common content descriptions in specific domains. However, it is usually necessary to adapt an existing meta-data model to the specific needs of an application with a particular scope (Kraan 2003). It is also possible to combine existing schemas into a package that is tailored to the functional requirements of a particular application, while retaining interoperability with the original base schemas (Duval 2002). Available meta- data standards that are relevant to the current LMS are the IEEE Learning Object Metadata (IEEE LOM 2002), particularly suited to e-learning applications and the Dublin Core (DC 2007),

which is a generic metadata initiative with several specific communities, such as the Knowledge Management Community. In related work on meta-data for e-learning (Nilsson 2002) it is argued that, since a resource can be related to several domains, many of them impossible to foresee by the author or the network moderator, any meta- data description can be considered incomplete. This means that the meta-data description of all resources needs to remain open to new possible uses of the same content and therefore considered as an ongoing process.

In the current work, an application-specific meta-data schema has been developed for describing LCOs, based on the IEEE LOM. The basic steps were the following:

1. Define the categories of LCOs on the basis of their object type i.e. learning course, information document, discussion, etc.
2. Define the meta-data terms, selecting the relevant ones from LOM and inserting additional ones where necessary.
3. Define the vocabulary or data type for each term.

The initially developed model has been refined after pilot trials of the LMS, thus introducing the experience gained on the kinds of resources used, on the needs related to the structure of the learning processes and mostly on the arising requirements related to advanced and contextualized search.

The meta-data schema has been implemented as an XML schema, which is a powerful and widely adopted data modeling language, inherently suited to web-based applications. The meta-data on learning content are expressed as XML documents, which mean that they are structured, directly exchangeable through the web and machine readable.

4. Results

The presented learning platform has been developed in three main cycles, each one corresponding to a different level of maturity. The initial implementation has been performed within the R&D project "Knowlaboration" with main focus the usability and technological efficiency of the system. The next phase was the platform refinement for deployment as a service to informal learning networks, where emphasis was given to the integration of the technology with a sound learning methodology and to the optimization towards commercialization of the service at pan-European level. The third development cycle corresponds to technological and methodological updates which were performed after the results of market validation trials in order to incorporate (a) the experience gained from extensive trials with real users and (b) the latest realities in the area of knowledge management and networked learning.

The platform presented in this paper refers to the latest results of the above developments, which can be formalized as a web-based, service-oriented Learning Management System, tailored to the needs of informal inter- organizational learning networks, offering:

- Knowledge management features (supported by a special data model including an elaborate meta-data schema), that enables advanced search and knowledge sharing, capitalization and re-use.
- Structure and functionality that encourages the formation and maintenance of learning networks, refined and validated through extensive trials.
- Support by a matching learning methodology and best practice guide, which were developed in parallel to the platform.

The LMS prototype has passed through several cycles of evaluation and refinement regarding correctness, usability, debugging and performance and is currently at pre-commercial status available for deployment.

5. Discussion

The field of technology-enabled learning evolves rapidly during the last years, following the booming expansion of web usage and e-networking at a professional, personal and academic level. Networked learning, where knowledge is shared and learning processes are informal and dynamic, is already established as a powerful alternative to traditional forms of course-based e- learning and is particularly suited to the learning needs of business managers. Within the trends and technological advances that inevitably affect the expected evolution of networked learning is the extensive acceptance of web2.0, where user participation and interaction are core concepts. Moreover, networked learning is clearly bound with the advances towards web3, since it perfectly fits with the notions of semantics and the abilities to discover and seamlessly share useful information in a distributed information world with unlimited resources.

In line with the above realities, the authors of this paper present an LMS platform that not only supports networking and knowledge sharing through the web but also enables new forms of collaborative learning and informal knowledge building. The plans for future work evolve around two challenges. The first one is to elaborate on tacit knowledge engineering in order to improve the ability of the platform to capture and represent the knowledge shared within the learning networks. In addition to the present abilities to manage learning objects (LCOs) and to describe them with meta-data – already offering advanced search and sharing - the next step will be to transform human-readable LCOs to machine-readable knowledge that will be formalized on the basis of a novel knowledge model. Such advancement would allow the packaging of the knowledge shared within a network in a Knowledge Base so that it is usable by an inference engine for decision support. The second challenge for future work is to come up with a generic model for virtual LNs on the web together with a suitable protocol for collaboration between LNs. The ultimate goal would be to establish within the framework of semantic web a virtual "network of networks", where learning and knowledge objects will be dynamically formulated and shared.

6. Conclusions

The aim of the current work was to present a solution for technology-enabled networked learning which gives emphasis to informal learning. To this end, a web-based service provision platform has been developed, tailored to inter- organizational learning networks and in particular to the needs of managers of clustered SMEs with common learning interests. Among the technologies used are a large set of communication tools integrated with the learning environment, as well as knowledge capturing and sharing facilities featuring knowledge management capabilities based on meta-data. The design is adapted to solid methodologies for creating and maintaining learning networks, based on the aspects of interaction and motivation. As a result of multiple phases of user feedback and redevelopment, it can be stated as a conclusion that the proposed platform is a successful blend of modern learning methodologies and the technological infrastructure to enable the implementation of these methodologies in a service provision scheme.

Acknowledgments

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