2nd PROLEARN Doctoral Consortium in Technology Enhanced Learning

Crete, Greece, September 18, 2007

Preface

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In today's knowledge society, companies are aware of the crucial role that education and training, life-long learning, and knowledge management play in shaping a workforce able to strengthen its competitive position. Knowledge workers and employees are also aware of their responsibility in keeping their professional skills at the highest level. Current and emerging technologies are offering new opportunities for implementing novel pedagogical scenarios, innovative environments and customized learning content. To effectively design, implement, and manage technology to enhance professional learning requires an interdisciplinary understanding of a diversity of scientific fields such as educational sciences, human-computer interaction, information and communication technologies, as well as marketing. This is the challenge of the PROLEARN Network of Excellence funded by the European Commission in the framework of its Information Society Technology programme. PROLEARN's core mission is to bring together the key research groups, professionals, as well as other cutting-edge organizations and industrial partners working in the area of Technology Enhanced Learning (TEL). By fostering joint research, education and training, as well as professional networking, PROLEARN is establishing TEL as a new core and interdisciplinary research domain. It is also incubating a new generation of researchers and experts to be able to design and manage complex technology enhanced learning solutions for tacking the challenges of a sustainable world.

The PROLEARN Academy (www.prolearn-academy.org) is more especially dedicated to develop an institutional culture and to bond distributed researchers across Europe into one community. This goal is achieved at three main levels:

- Researchers or junior faculty members to develop and maintain PEOPLE leadership;
- Full range of research issues in TEL covered by PROLEARN working groups to develop and maintain TOPICS leadership;
- Large set of activities to develop and maintain a leading TEL COMMUNITY of researchers.

Operational since 2004, the PROLEARN Academy has successfully inaugurated an annual summer school for early stage doctoral students. The first summer school took place in Sile, Turkey, September 5 - 9, 2005. The second one took place in Bled, Slovenia, June 5 - 9, 2006. Finally, the third one took place in Fréjus, France, May 27 - June 2, 2007. All editions attracted about 130 doctoral students working in the diverse areas of TEL.

As a result of the experience with the summer schools, PROLEARN Academy wanted to create another forum for doctoral students more advanced in their thesis work and who would get personalized feedback about their research from distinguished researchers in TEL. A major conference like the EC-TEL is an excellent event for such a forum because many of these famous researchers are present. Therefore, a first Doctoral Consortium was organized at EC-TEL 2006 and, thanks to its success; reiterated this year.

For this 2007 edition, the papers were selected according to the possible benefit the doctoral students could get from their participation to the doctoral consortium in terms of refinement or consolidation of their research work.

These proceedings include 8 accepted papers. One should underline that not only these papers are important. The reviews given by the experts after the submissions and after the oral presentations constituted also essential references for the doctoral students. They not only served to improve the initial manuscripts, but also helped the doctoral students to get or keep on the right path towards their doctoral research completion.

To conclude, we would like to thank of all the doctoral students for their implication in advancing the state-of-the-art in the research field of TEL. We would like also to thank all of the reviewers whose precious time has been so instrumental in giving professional guidance to the doctoral students. We would like finally to thank the organizers of the EC-TEL for giving us the opportunity to host our Doctoral Consortium at their event. And of course, we would like to thank the PROLEARN and the PRO-LC cluster in disseminating and promoting this event, thus contributing to the institutionalization of our virtual PROLEARN Academy.

Katherine Maillet, Tomaz Klobucar, Denis Gillet, and Ralf Klamma
Doctoral Consortium Chairs
September 10, 2007

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Model Driven E-learning Platform Integration

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Abstract. The success of the e-learning paradigm observed in recent times created a growing demand for e-learning systems in universities and other educational institutions, that itself led to the development of a number of either commercial or open source learning management systems (LMS). While the usage of these systems gains recognition and acceptance amongst institutions, there are new problems arising that need to be solved. Because of multiplicity of platforms and approaches used for various systems implementation, it becomes increasingly difficult to manage or compare them. Their variety and growing number is also a true barrier for re-use of existing learning materials that is a clear economical concern for the future of these technologies. Applications and their data become isolated. As the result of platform diversity, future vision of interconnecting LMS of different educational institutions is demanding, too.
The present study ambitions to overcome the aforementioned difficulties by using the Model Driven Architecture (MDA) approach of the Object Management Group (OMG). The goal is to provide a generalized architectural framework enabling an integrated specification of platform architectures. This platform-independent framework can then be used to specify and classify existing or future Learning management systems and to simplify migration of data between different kinds of e-learning systems.

Keywords: Model Driven Architecture, Learning Management Systems, Integration.

1 Introduction

As a result of Technology Enhanced Learning (TEL) boom during the last few years, many educational institutions all over the world started to use Learning Management Systems (LMS) to manage e-education of their students. TEL became very popular because of many advantages it offers comparing to the classical way of education – it is possible to study whenever and wherever the student wants to, with the individual speed and use a lot of multimedia interactive material for the studies.

As the answer of sudden popularity of e-learning, number of Learning Management Systems were developed. LMS should make it easy to publish documents, lectures and exercises for professors, assistants and secretaries at the educational institute and faculty. Besides, it should be the main portal for all the students to get the recent information for their courses and exercises. Many institutions created their own LMS, some of them bought a commercial system or adopted an open-source solution.

Architecture of a system consists of elements and relationships between them. Although at the end of the day functionalities of the systems resemble, their internal structure is often completely different. As a result of that applications and their data become isolated. It is also demanding to compare the systems because they use different kind of terminology for describing the same functionality.

The fact that LMS systems have different architectures causes multiple practical problems. It is difficult to share information among systems. This is crucial for example in learning material re-use or students' records sharing among universities. Currently it is difficult to use learning object from an LMS in another one and it can cause great economical problems in the future of these technologies. We should think hard how to enable re-use of already existing material so that we don't need to re-create the same materials again. The students' records sharing among universities can be used for example in a centralised data system among universities where student can choose courses from various institutions. Furthermore to shuffle from one system to another is difficult, because information from one system cannot be easily transferred to another one. Moreover, it is complicated to compare LMS systems because they use different kind of terminology for describing the same functionality.

This project suggests a solution of this situation by using the Model Driven Architecture (MDA) [MDA] approach of the Object Management Group (OMG). We would like to create a common architectural framework enabling an integrated specification of platform architectures. This platform-independent framework can then be used to specify and classify existing or future Learning management systems and to simplify the courseware material re-use from different kinds of e-learning systems.

In the following section we introduce MDA, its fundamental model concepts and relationships between these concepts and afterwards a possible solution of the proposed problem: a staged approach to the Platform Independent Model of MDA. In the third section there is an overview of principles of two open source e-learning systems, Moodle and OLAT. They serve as examples of learning management systems with different architectures and technologies but similar functionalities. The fourth section shows the integration strategy in the example of Moodle and OLAT. Finally, the last section describes concluding remarks and future work.

2 Model Driven Architecture and Its Use For LMS Integration

MDA is a way to organize and manage system architectures; it is supported by automated tools and services for both defining the models and facilitating model types [1].

The MDA approach was proposed by OMG, the open standard organization supporting the well-known CORBA [5] and Unified Modeling Language (UML) [2]. The models in MDA [3] may be developed as a precursor to implement the physical system, or they may be derived from an existing system or a system in development as an aid to understand its behaviour. The building of the system can be organized around a set of models by imposing a series of transformations between them. The whole system creates an architectural framework of layers and transformations.

OMG defines three types of models [4] :

- Computation Independent Model (CIM) – this model is focused on the domain, hiding structure details,
- Platform Independent Model (PIM) – this model provides adequate functionalities, structure and behavior of the system,
- Platform Specific Model (PSM) – combines PIM with specific detail concerning the way in which the system uses a certain platform – it can be automatically transformed into the implementation code.

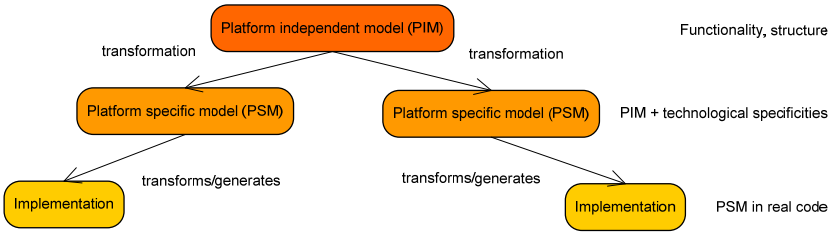

Fig. 1. MDA Concept

Usage of MDA to build up system architectures has several advantages. It consists of models at varying levels of abstraction, which means that refinements of the models are possible at any level. This approach helps users to get a very clear idea of the system. Models help people understand and communicate complex ideas. This way, we can see the commonalities and differences of systems at all levels.

We would like to use MDA principle as the background for solution of the proposed problem with LMS integration. We can compare platform independent models of different systems and create a platform independent model that covers common functionalities of all learning management systems.

Our goal is to define a generalized model of LMS system consisting of features of all other LMS systems that can be mapped into it. For this purpose we introduced a new strategy [10] that we call the *reversed MDA paradigm*. In classical MDA approach we create first an abstract PIM model and with automatic steps we can get a PSM and finally the implementation code. In our case we would like to go the other way round – to use real LMS systems to define and abstract model of a generalised LMS.

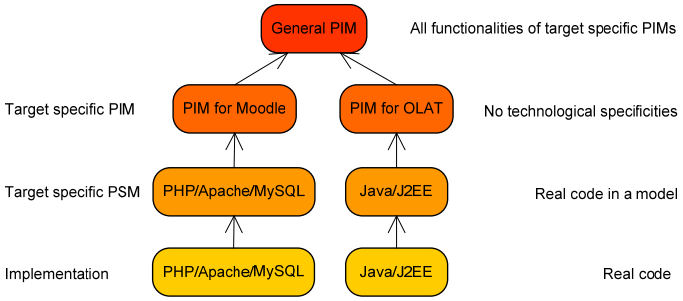

Fig. 2. Reverse MDA Concept for creation of General PIM

The creation of the General PIM needs to be done in several steps. We come out from the premise that functionality is similar for most of the LMS systems thought their implementation and internal architecture is different. We continually add functionalities of different LMS systems until the General model is saturated.

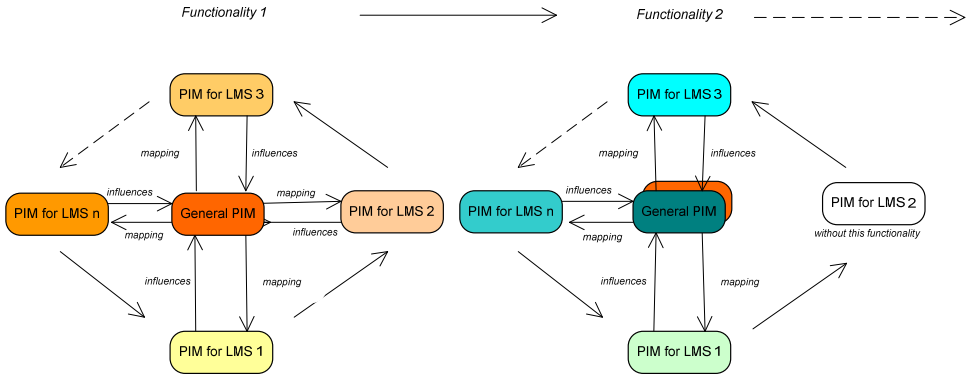

Fig. 3. Integration strategy

The concrete example of the integration strategy will be presented it the chapter four. It will be a real-life example and for this purposes we have chosen two different open source LMS systems described in the following paragraphs.

3 Overview of Two Opensource LMS

To compare the differences between two approaches of LMS systems, two open source systems have been chosen: Moodle based on PHP and OLAT that represents a Java solution.

OLAT [6] is a web-based open source LMS that was founded in 1999 at the University of Zurich, Switzerland. OLAT is implemented in Java and uses a three-tier architecture with Tomcat container technology. Regarding programming concepts, OLAT is a component based tool. Component visually represents for instance a form or a table. OLAT was designed to separate the logic of the application and the layout of the web site. It proposes a refined Model-View-Controller scheme where usage logic is encapsulated in controllers and the manager classes they use, while layout is controlled by modifying Cascading Style Sheets (CSS).

Moodle [8] is an open source software package that was founded in the same year as OLAT, in 1999, in East Perth, Australia. Moodle is implemented in PHP, uses a traditional Apache server and a relational database management system. Therefore the layout of the web site is not separated from the logic of the system. PHP is not an object oriented language in comparison to Java, therefore Moodle is implemented without objects.

The two LMSs represent very different architectural breeds that make them good candidates for our purposes.

4 Integration Strategy in Practise

In this section we would like to present an example of the integration strategy that is used in our project. LMS1 in our example is OLAT, as LMS2 we use Moodle.

In the previously published articles we have had a closer look at a certain set of functionalities - access rights [11] to the LMS systems and learning object management [12]. This time we will focus on explaining the integration strategy at those two sets of functionalities with OLAT and Moodle.

Functionality 1: Access rights

In OLAT [7] we can recognize five kinds of users while there are four different ones in Moodle. It is possible to recognize the rights of the users on the Figure 4:

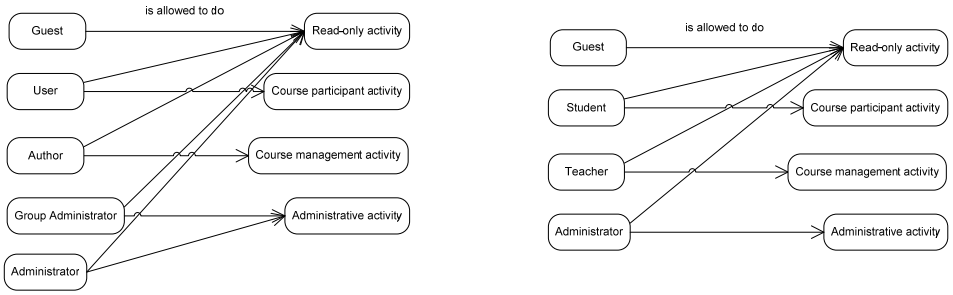

Fig. 4. Access rights for different kinds of users in OLAT and Moodle.

However, the roles are not the only attribute that determines access rights in Moodle. To enable greater flexibility, for example to allow a student with role A to post to forums, while student with role B is prevented from posting, three more attributes are defined: capability, permission and context. The role consists of a list of capabilities for different possible actions within Moodle. For example a teacher is allowed to add learning resources to a course A but is prevented from adding resources to another course where he is considered to be a student.

We can show the integration into a General model in the proposed analysis. The General model integrates approaches from both systems. All users in both systems are allowed to do read-only activities, as can be seen on Figures 4 and 5. Therefore the parent class G_Role contains read-only procedures that are inherited by all children classes: G_Guest, G_Student, G_Teacher and G_Admin. The children classes contain procedures that are allowed for a guest, a student, a teacher or an admin (Figure 5).

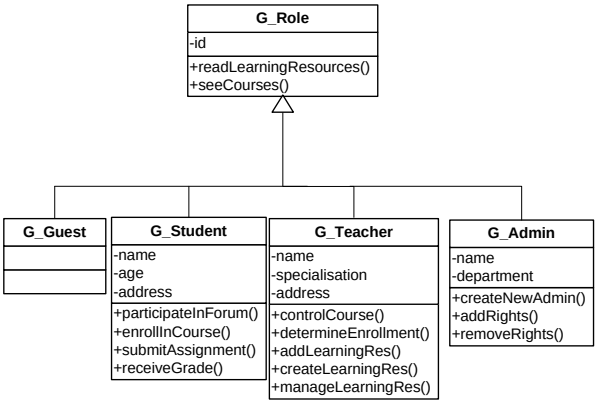

Fig. 5. Classes of General Platform Independent Model. This model shows allowed activities for each class.

The classes of Moodle and OLAT can be mapped into the classes of General PIM. Please see the details in the table 1. The previously mentioned roles A and B of student in Moodle can be modeled as child classes of Student class, Student::StudentA and Student::StudentB

Table 1. Mapping the classes from Moodle and OLAT to the General PIM.

General PIM	Moodle	OLAT
G_Guest	Guest	Guest
G_Student	Student	User
G_Teacher	Teacher	Author
G_Admin	Administrator	Group Administrator, Administrator

Functionality 2: Learning object management

After the General PIM model is saturated – all observed LMSs are mapped into it and it is mapped to all the observed LMSs – it is possible to continue with another set of functions.

As another example, relevant for learning object re-use, we consider part of the learning management systems that incorporates learning objects. In a regular system, users with different access rights to learning objects can view them, add them, edit them, catalogue them and in some cases, import them from other systems, export them and search for them. The searching possibility is not a regular part of an LMS system and only a few of them have this possibility by default, for example OLAT repository.

Slightly simplified PIM models of both LMS systems are modeled on the Figures 6 and 7, OLAT and Moodle respectively. Here we can see the objects of both systems and relationships between them.

Each resource of the repository in OLAT is an instance of the class *RepositoryEntry* that contains attributes like the name of the resource, its location, the author or activities that are allowed for the resource. The list of attributes can be broaden in the *MetadataElement* class in which we can define any other metadata, with their name and value (for example name = version, value = 1.2). Repository entries can be ordered in a catalogue, with the help of *CatalogEntry* class. All the entries have an id defined in the OLAT system in the *OLATResorceImpl* class and each resource can point to other resources via *ReferenceImpl* class. The permissions of a user to do different kind of activities with the resource are noted in *PolicyImpl* class.

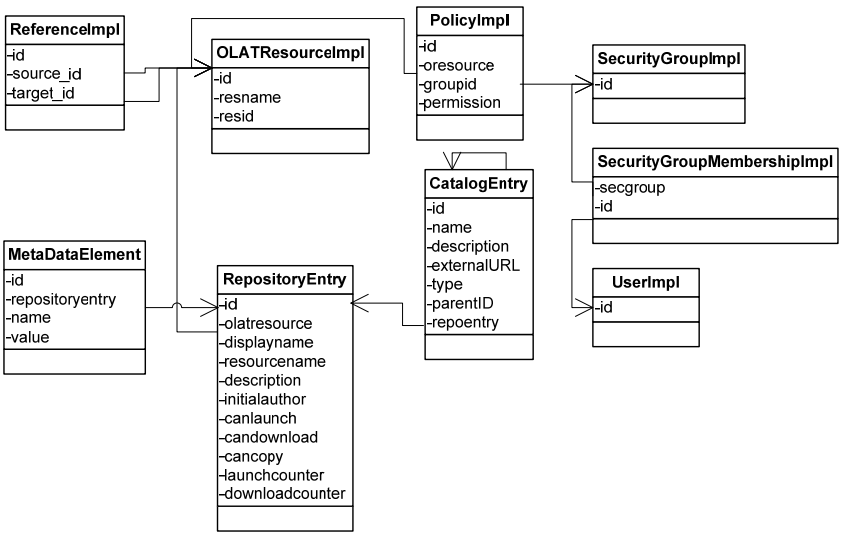

Fig. 6. LMS specific PIM for OLAT

In Moodle, in comparison, there is a course oriented system - each Course contains a list of resources of different types. They can be ordered with the help of *CourseMetaData* and they can be displayed to a User according to a *CourseDisplay* table.

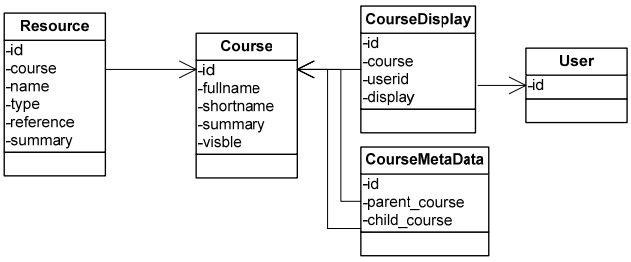

Fig. 7. LMS specific PIM for Moodle

Based on the PIM models of the systems we created a General PIM (see Figure 8) that contains the descriptions of both systems. The attributes of the resources (for example *General_Title*, *Technical_Size*) are based on IEEE Learning Object Metadata standard (LOM) [9]. This standard defines a set of elements ordered in categories. They can be used to describe learning resources. IEEE LOM is a part of SCORM specification and became standard of IEEE Computer ociety/Learning Technology Standards Committee in 2002.

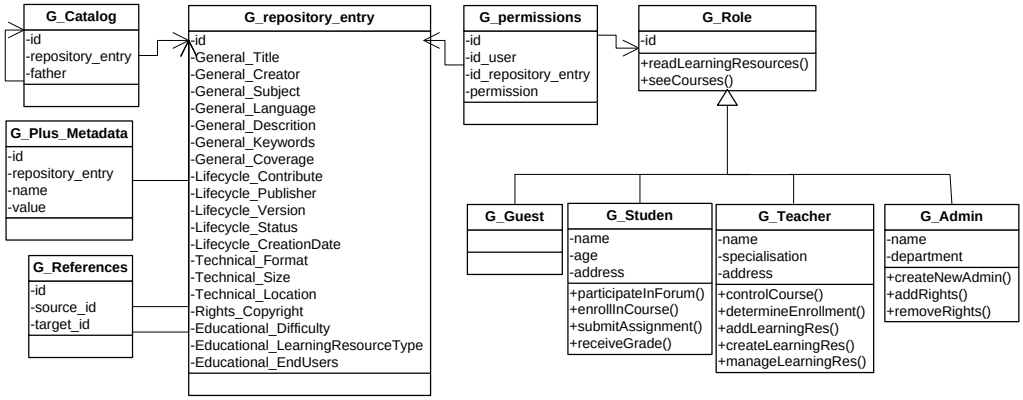

Fig. 8. General PIM – metadata are based on IEEE Learning Object Metadata

The repository entries can be ordered in a catalog (G_Catalog), they can be added any amount of extra metadata (G_Plus_Metadata), they can point the reference to any other entry (G_Reference) and they and they can be viewed and copied based on permissions of a given user (G_permissions). It is possible to map the attributes and relationships between models of LMS systems and General PIM based on certain mapping rules [12].

In this section we have proposed an example of how the integration strategy can be used for creation of the generalized PIM. The example has been shown on two opensource LMS systems – OLAT and Moodle in two sets of functions – one considering access rights, the other one considering management of learning objects in each of these systems. Figure 8 shows the model after these two steps. We have defined not only the model but also mapping of architectures of OLAT and Moodle from and to the General model.

5 Conclusion

This contribution presents an original approach to the problem of integrating LMSs of different architectures. In particular it proposes an integration strategy of LMSs into a generalized model of a LMS with an example of this integration strategy at two sets of functionalities – access rights and learning object management. In the example we modelled a PIM of two LMS systems (Moodle and OLAT) and showed how to map them to a generic General PIM. The framework still needs to be enriched by more examined LMS systems.

This staged concept is viewed as a foundation for providing ultimately an integrating LMS MDA model, with the goal to solve current challenges related to the multiplicity of the platforms, such as LMS management, comparison, and data share.

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Mobile Social Software with Context Awareness and Data Uncertainty for Technology-Enhanced Learning

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Abstract. Mobile computing technologies and social software have given new challenges to technology-enhanced learning. Simple e-learning system personalization, adaptation and authoring become only part of problems. Learning activities take place in certain contexts such as at a certain location in a certain period of time within certain communities. Learning content in the Web 2.0 era draws a large audience. There is yet little research work addressed to both context awareness and data uncertainty in mobile learning applications. My research focuses on identifying, analyzing and reducing data uncertainty problems for learning content in context aware technology enhanced learning systems. The concept of mobile social software is realized in the system Virtual Campfire which is a community knowledge management system for context-aware mobile learning. It supports learner communities to create, annotate, search, and share geographic and multimedia knowledge on mobile devices. At the same time, the problems of data uncertainty, data modeling and data semantic are explored.

Keywords. Social software, context awareness, technology-enhanced learning, data uncertainty, knowledge management.

1 Introduction

Learning is not a kind of activity limited in classroom any more since decades. Situated learning [6], informal learning, life-long learning have been proposed in recent decades. Therefore, context-aware mobile learning platforms play an important role. On the other hand, with the development of social software a great amount of user-generated content has been created on the Internet. Various resources of learning content like Wikipedia, professionals' Weblogs and bookmarks etc. can be easily accessible.

With the great impact of social software, user communities can't help addressing this question. Will the conventional e-learning systems such as course management systems (CMS) meet the community requirements of life-long learning? In the contrary, could learning easily supported by social software? A report shows that data volume increases all the time at a rate of 60% last year. Social software even creates more and more data in future. With this growth ratio knowledge management and information search and retrieval are getting more and more important. Learning communities want to get the right knowledge at right time. So certain context is crucial for this issue. Future technology-enhanced learning is supposed to support sufficient context awareness that learning communities need.

Web applications especially social software is based on ubiquitous content and communities. Diverse factors lead to data uncertainty and can be categorized in three groups. Firstly, spatial temporal uncertainty is highly relevant to context-aware technology-enhanced learning systems. Secondly, community uncertainty is represented by interests and vocabularies of communities. Among it, a lot of Web uncertainty representation [8] is associated tightly with communities. Thirdly, device uncertainty is resulted from limited capacity of mobile devices. An example of data uncertainty in context-aware technology-enhanced learning could be getting the right knowledge about a monument on site, since there is much uncertain data collected at research histories with historians' different induction and interpretation.

My research focuses on identifying, analyzing and reducing data uncertainty problems for learning content in context-aware learning social software. The research question could be decomposed as the following several sub questions. How is knowledge among various types of social software such as WiKis and Weblogs? What kind of data uncertainty is relevant for context-aware technology-enhanced learning? Consequently, how can it be reduced?

The concept is realized in the mobile social software Virtual Campfire which is a community knowledge management system for context-aware learning. It supports learner communities to create, annotate, search, and

share multimedia knowledge with context awareness on mobile devices. At the same times, the problems of data uncertainty, data modeling and data semantic are explored.

The rest of the paper is organized as follows. Section 2 outlines the current knowledge of the problem domain as well as the state of art solutions. My approach to knowledge management with Virtual Campfire is proposed in Section 3. Concrete applications are introduced in Section 4. Section 5 gives discussion about the contribution of the research and open questions.

2 Related work

Data quality is a general problem in data management. Hence, the data quality of e-learning systems is often assumed to be good. A great amount of data is generated by users. Correspondingly, the data quality of Web data for learning is especially crucial. In the real world, data could be incomplete, imprecise, and even maliciously manipulated.

Therefore, information quality is a crucial metric of the evaluation of information systems, together with the system quality metric. With the explosion of information in the Internet nowadays, information quality issues are taken more and more consideration in design, implementation and maintenance of information systems. Accordingly, the cost of improvement of information quality rises all the time.

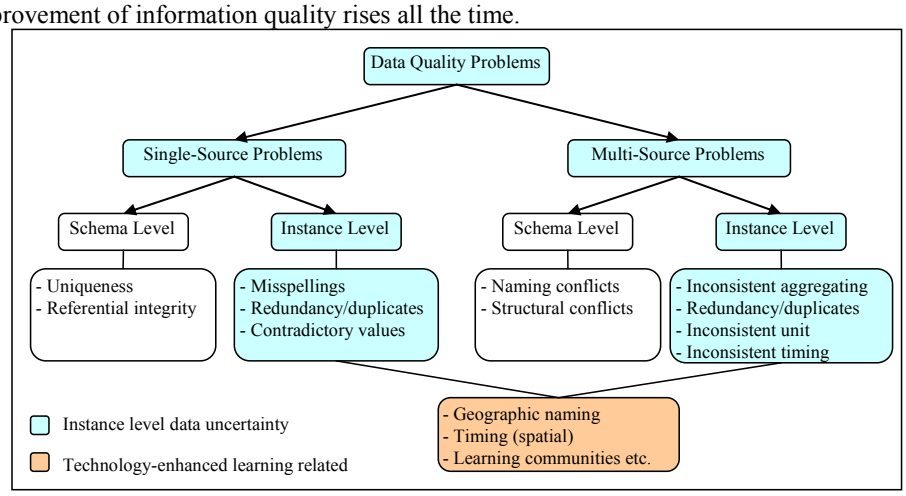

Fig. 1. Data quality classification schema (Adapted from [7])

Traditional information systems were applied to process business data, which often consists of exact numbers. There are no approximate or imprecise queries. Knowledge of the real world is almost always imperfect. Thus, how to manage information under uncertainty has been discussed as a challenge for the further development of database managements systems in future at the database Lowell meeting [1]. This problem is typical and acute in context-aware technology-enhanced learning. In most cases, however, data uncertainty problem has been recognized and paid attention in government, commercial and industrial environment. In scientific field, scientists have dealt with data uncertainty by means of mathematical methodology. For example, probabilistic theory and statistics [3] have been applied to handle sensor data and geospatial data. And spatial data uncertainty has been handled with spatial data mining techniques [5]. In conclusion, a data quality classification schema concluded in [7] is extended in Figure 1 for context-aware technology-enhanced learning.

3 Virtual Campfire: mobile knowledge management for context-aware technology-enhanced learning

In the conventional e-learning or course management systems, content has been created according to certain predefined course in school or high education. With the development of mobile technologies, more and more Internet applications will run on mobile devices. It makes context-aware learning anywhere at any time via handheld mobile devices possible. Future technology-enhanced learning will only be successful, if the running applications based on

low cost mobile network infrastructure are well developed to meet the requirements of context-aware learning content delivery. Performance, reliability, security and energy-efficiency are meanwhile important measurement.

I propose the concept of a category of mobile social software called Virtual Campfire for knowledge management (cf. Figure 2). It enables professionals to collect, manage and retrieve cultural heritage information and to create and share multimedia stories among wide learning communities with context awareness.

As declared in Web 2.0 motto, data is *the next Intel Inside*. Communities who generate data are in fact the main data creation source. Social network analysis methods are applied to visualize and discover development of communities. Communities enrich learning multimedia repositories in an informal way, for example, through taking videos and pictures as well as writing Weblogs. Furthermore, learning communities can create learning content by tagging existing multimedia content. Hence, a set of services such as location-based services and metadata based multimedia annotation tools can be applied to facilitate these functionalities. Meanwhile, not only multimedia but also spatiotemporal and cultural standards can be applied to organize the multimedia content on mobile devices.

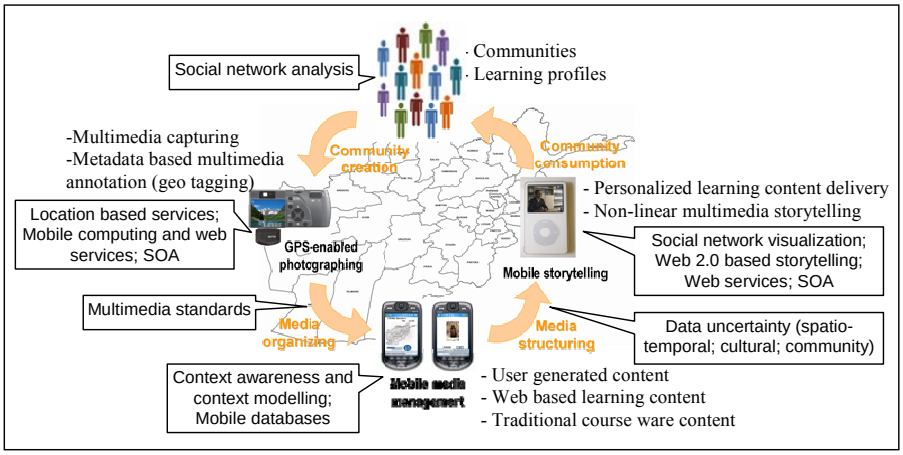

Fig. 2. Concept of Virtual Campfire as an example of mobile social software for technology-enhanced learning

Since context awareness has a wide spectrum of definition. Generally speaking, it is related to different aspects or factors according to the context. It differs quite greatly in business process modelling context and B2C eCommerce. Even in technology-enhanced learning environments, context can refers to distinguishing issues, if the professional communities vary. Physical contexts including spatiotemporal and device hardware and community contexts are to be modelled comprehensively.

Spatial data uncertainty has been an important issue in spatial data mining. Much important hidden uncertain information can be retrieved in the field of cultural heritage management by means of spatial data mining. My aim is to identify and analyze the problems of spatial data uncertainty that the learners encounter in cultural heritage management. In addition, data lineage retrieval [2][4], data modeling and metadata techniques are discussed to potentially manage and reduces uncertainty and to perform data cleaning in context-aware technology-enhanced learning applications.

Furthermore, storytelling has a great impact on human life. I aim at fostering this tradition with the state-of-the-art information technologies. Exploring digital storytelling with geographic information for learning purpose in the Web 2.0 era, three aspects non-linear storytelling for learning communities, location context, and metadata-driven multimedia integration need to be researched on. The virtual campfire system can be widely used and has its significance especially in communities which face problems at meeting up and storytelling in the real world.

In short, the context-aware learning multimedia life circle comes to a closure via the four main processes: community creation, media organizing, media structuring and community consumption (cf. Figure 2).

4 The UMIC project as a case study for proof of concept

The conceptual approaches for context-aware technology-enhanced learning can be realized within the excellence research cluster UMIC. Functional and non-functional requirements of future mobile web services and applications are analysed and adapted to the mobile contexts. Starting from the requirement analysis results I will design mobile applications to meet future use scenarios, based on context modelling and social network analysis approaches etc.

In mobile computing data uncertainty problems are raised at different layers ranging from devices, network layers to application layers. Varieties of mobile devices make diversity of information perception. Instability and inefficiency of mobile networks lead to further uncertain data. In the application domains especially in context-aware technology-enhanced learning, various user communities often have different data and data sources concerning trust, authorities and standardization factors. So data uncertainty is one of the most universal and typical challenges in mobile data management. In addition, Web 2.0 and social software give rise to new development paradigm in the mobile application area for mobile communities. Reliable infrastructures such as Service Oriented Architectures (SOA) are needed in order to support mobile communities and ubiquitous digital social networks. The research results may provide capabilities for more sophisticated approaches to cultural heritage management, crisis relief work and tourism guide on site.

Detailed research work is divided into mobile data management, mobile application architecture and on site evaluation. At the stage of system design of Virtual Campfire, the mobile social software platform Virtual Campfire is designed based on the pre-designed data model and requirement analysis. A data model for context-aware learning within cultural heritage learning communities has been proposed in Figure 3: left. The learning content consists of cultural heritage object, the related multimedia and events. The learning communities can be managed by the existing Light Application Server (LAS) framework with community hosting services. Data uncertainty problem might happen in each entity in various contexts. The potential minimization approach is the employment of XML based multimedia metadata such as MPEG-7 and the media-centric methodology.

A prototype for mobile data management is designed and implemented for demonstrations (cf. Figure 3: right). The prototype of Virtual Campfire will be evaluated on site for cultural heritage learning communities in Afghanistan. The evaluation result will be used to improve system implementation of Virtual Campfire.

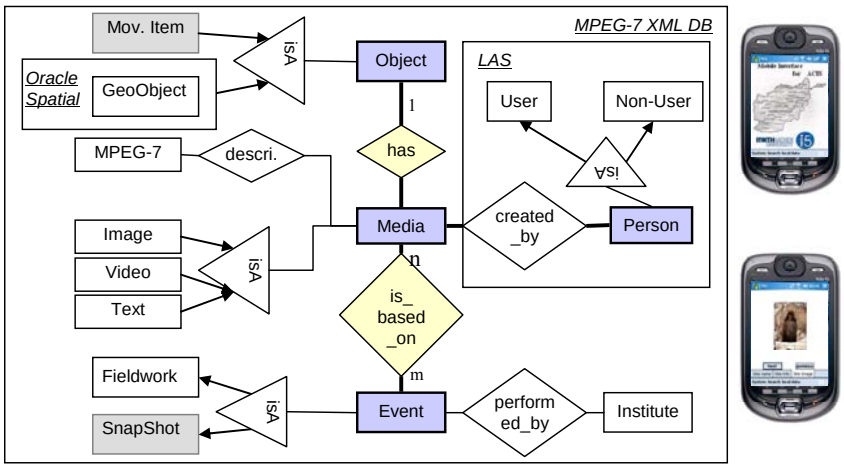

Fig. 3. left: Data modelling of Virtual Campfire; right: the screenshot of the first prototype with the map based search and multimedia search functions.

This sub component of Virtual Campfire can be used as a tool for technology enhanced learning within the professional cultural communities and can be further easily extended, thanks to the service oriented architecture. People who are interested in learning cultural heritage knowledge can use this platform to collect and create cultural heritage content on site with spatiotemporal and community context awareness. At this stage, data uncertainty aspects will be reduced through metadata based social tagging and the other functionalities. At the stage of learning content delivery, user interacted non-linear storytelling will be employed to reuse the learning content via some social ranking. Besides, Wikis, Weblogs and social bookmarking and the other desktop based social software can be integrated to enrich learning content for the cultural heritage learning communities.

5 Contributions and Discussion

In conclusion, my dissertation concentrates on two important questions in mobile computing for technology enhanced learning. One is the data uncertainty problem and the other is the context awareness problem. Hence, this

combined starting point is a new view point in this research area. There's little work done in mobile social software for learning, because social software is considered as more a successful market label than research challenge. I consider mobile social software an efficient context-aware technology-enhanced learning approach to open learning, informal learning and life-long learning. Meanwhile, diverse data uncertainty problems will be dealt with via data lineage tracing etc.

In my ongoing work, I will refine the data quality schema for context-aware technology-enhanced learning applications. Further research will be done to finish a context model for the context awareness, detailed design and implementation of the data lineage tracing method to uncertainty reduction. In addition, mobile technologies enable systems and platforms to be highly integrated and unified. The first mobile prototype has been developed. With the methodology of service oriented architecture, further services will be launched on various mobile devices ranging from iPod, cell phones to Pocket PCs.

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Integration in Generic Tool Learning Design to Support Complex Learning Methodologies

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Abstract: Current learning modelling languages do not allow formalization of scripts where generic tools are required. This limitation is especially relevant on remote courses when using collaborative models. Integrating information from external services into IMS LD will enhance its expressiveness by reducing the required administrative tasks at deploy time. This document analyzes external service requirements on learning model, and discusses a solution consisting on an extension to be used in conjunction with the current IMS LD specification.

Keywords: IMS LD, service integration, external tools, distance learning, standards, e-learning

Introduction

Availability of high quality learning objects does not guarantee the best results in a learning experience. Content must be used together with an appropriate pedagogical model. Learning modeling languages are a step towards reusability of learning materials. They allow course designers to create scripts where pedagogical models are formalized.

The IMS LD specification provides an activity-based modelling language with which a wide range of methodologies can be expressed. Content is delivered following a given path, satisfying requisites of the used pedagogy. Also, there are mechanisms to identify different user roles in the course, which allow working with collaborative learning models. Conditional behaviour of sequence of activities is also possible, by defining a property based course state and conditions related to the defined state.

Although the expressiveness of the LD specification is enough to formalize collaborative models, there are some features that are not still covered. For instance, the use of this kind of models on distance learning where communication tools are not enough and collaborative software is required. The problem with using external tools and services is the difficulty to integrate the information they provide and the formalized learning model. This document discusses the problem of generic services integration with the IMS LD specification.

This paper is organized as follows: First, an overview of the problem is given. Next section compiles current ideas or initiatives which address the problem. Last section summarizes the work done so far in the discussed area and presents the ideas to tackle the problem.

The problem of external tools usage on IMS LD

Learning Objects were born with the idea of encapsulating concepts atomically. Each Learning Object must be self-contained in order to guarantee reusability and portability.

However, a collection of Learning Objects is not enough when the aim is to provide high quality learning courses. The order in which content is delivered, the time spent in activities, and the contents that students require depending on their user profile are relevant in pedagogical models.

The IMS LD specification joins both learning methodologies and content, and packages them in a standard[1] format. The language has been designed to support a wide range of pedagogies in online learning, and it can be adapted to be used in other scenarios such as blended learning.

Units of Learning

In the context of IMS LD, when course designers finish the authoring stage, the result is a single compressed file (usually ZIP file) containing all the content and the instructions to deliver them at run-time. This file is called a Unit of Learning (henceforth UoL) and is the package that will be distributed to teachers.

To deploy the packaged course, a compatible engine is required. This is a software application able to read the file and deliver content in the expected sequence. Proper UoL creation guarantees the learning flow to be the same in different instances of the same course, with the condition of having a IMS LD compatible engine.

IMS LD uses of IMS Content Packaging [1] to store the entire course related files, and extends this info with a pedagogic model. UoL behaviour can be described using the theatre metaphor [3]. A course is a theatrical play divided in one or more acts in which the actors (students and/or teachers) play different roles. The acts occur in sequence, but inside acts parallel situations may take place. During the course, a set of previously defined properties may change, allowing the content to be dynamically adjusted. The change of property values is done by events that are defined and packaged together with the course.

External requirements on collaborative schemes

The IMS LD specification allows using content, which is defined at design time, and services. That is, tools that support interactions with students. In IMS LD, only conference and send-mail services require the use of external tools. However, there are some learning schemes in which additional tools are required.

Collaborative schemes require high level of interaction between users. This means communication, resource exchange, creation and modification. As a result, this learning flow – when applied in distance learning – requires the use of specific tools, which are not integrated in the LD specification. A simple use case is an activity in which the learners must create a conceptual map, and they are required to do it in a shared board. The deployment of this activity requires the use of a tool which provides the shared board.

It is common in a UOL to have an activity that is open until the score obtained in a given test reaches a threshold. Working in groups may imply that this threshold is not only based in a personal score, but in the mean value of the entire group. As a result, the script language used to package a course might include a way to compile group and social network information.

The use of these tools is not granted by the specification, but the problem appeara when creating the course UOL. The use of external URLs to refer these services does not guarantee availability, and makes UOL not the self-contained.

In the way to integration: Existing initiatives

The current version of IMS LD (version 1.0) is recent (February 2003) and the existing tools for authoring and deploying UOLs require deep understanding of the specification. The specification is then at its “validation” stage, when actual problems are being identified. Despite of this, there are some initiatives providing certain amount of integration with other tools and/or specifications.

Low level integration

The use of external URLs integrates any kind of tool in a given course. This is a one way integration, meaning that the learning flow calls other resources to be used but these tools do not send back any information. The advantage of URLs is the simplicity of the solution. On the other hand, feedback from the external tool may be required from the learning flow in order to adjust property values and test conditions.

[11] The IMS LD specification has not been recognised as a standard, but it is the most used language to package courses.

Besides, the availability of external resources cannot be guaranteed by this method. A learning flow must not depend on availability of non-packaged tools, and since there is no expected feedback there is no way to check for.

QTI and SCORM: Integration with other standards

Similar to LD, IMS Question and Test Interoperability [1] provides a language to create, package and deploy assessments in an easy and interoperable format. Since one of the most relevant parts of any course is grading students, the integration of assessment in a packaged course becomes a desired feature. By combining this, it is desirable a way to package QTI resources within a UoL, having the possibility of manage the student results inside the LD flow.

This possibility is discussed in one of the guides provided by the IMS Consortium, in which a way to integrate properties from LD and QTI is provided. This integration leads to information exchange between engines, because LD and QTI players may be different software packages from different vendors. IMS guidelines do not cover the software architecture details and they are only related to the joint behavior. The implementation details of QTI and LD integration can be found at [9].

Analogously, the SCORM model could be used together with IMS LD. This would imply that a lot of existing SCORM packages could be reused within LD, which has the advantage of having a more powerful sequencing scheme. As a result, existing content would be used in courses with very different learning methodologies, including collaborative schemes.

The SCORM usage in IMSLD has been discussed at [4], but there is no example of use, or implementation guideline.

Communication between parallel data flows

The learning flow described by Learning Design can be expressed as an isolated data flow where the sequence of events depends on some events that are packaged together with the UoL. In this sense, the use of external tools can be described as an external data flow, whose information is susceptible to be used as LD events, meaning an external modification of the learning flow.

The composite-based approach [5] proposal is to use Workflow Process Definition Interface (XPDL) to manage the data flow and IMS LD to manage the learning flow. The required coordination between them can be reached with the use of a Petri Net Markup Language.

Integration with eGames

The e-Adventure project assumes the benefits that electronic games produce in learning schemes by allowing the creation of new games to non-expert authors. The project has as its main goal the creation of a gaming environment where graphical adventure videogames can be described by documents that contain the game behavior. These documents are written in a markup language called e-Adventure.

The e-Adventure is based on XML. This fact facilitates the integration of both technologies: the path of the course and its adaptation options can be defined using LD, and the states of the course can be defined by e-Adventure based activities.

In [8], a mechanism to reach this integration is described in detail. It is based on the IMS LD and QTI integration, which has been developed using the capabilities of Coppercore and the Coppercore Service Integration layer.

Generic Services Integration

The stages of the research project are outlined as follows.

- Implement of an IMS LD engine. This provides an experience to help the understanding of the specification from the technical point of view [6].
- Design courses with different requisites to increase the understanding of the LD capabilities, since course designer's requirements are rather different than the developers [2].

Current ideas

Depending on the nature of the external tool to be used by the UOL, the elements where the relevant information is stored may change significantly. For example, some tools store the level of participation, but others are focused just in the obtained results. This fact increases the complexity of the integration. The approach to solve the problem consists on external services integration in general terms, allowing particular tools to internally decide the behavior of specific details.

The idea is to increase the scope of the specification by proposing a new XML set of elements that enhances the functionality of the existing version of IMS LD. The use of the proposed set of elements is optional, so compatibility will be guaranteed. If the used tools and the IMS LD runtime environment support the new set of elements, it will be used and the course will be able to take advantage of this. On the other hand, if support is not available, the engine will follow the "simple" alternative, minimizing the impact over students.

One of the aims of the new element is to describe generic services similarly that current services do. Awareness box, shared board, file-storage are examples of services that are useful in collaborative learning and that can be described in the discussed work.

Moreover, the proposed XML application is able to capture external information and translate it on LD property values. This feature is similar to the integration of IMS LD with QTI, but including methods to define how to capture group information. To make possible this information exchange, an interface layer with a fixed API is required. Any tool willing to work with this scheme must provide support for this API.

The ideas in this document will be developed and deployed under .LRN [7], which is the platform where the LD engine has been created. Nevertheless, the XML application will not be focused on the capabilities of this LMS, and it will be generic enough to be deployed on any LD compliant software.

Differences and similarities with other solutions

Any proposed solution for the integration problem can be discussed in terms of simplicity of use, coverage of the problem and compatibility with current the version of specification.

- Simplicity of use: Since IMS LD is complex by itself; the aim of the generic services integration is not to increase this complexity. Of course, plain use of URL is the simplest solution, but it does not cover the whole problem. Communication between parallel data flows proposal implies the usage of at least three different languages, with the implicit increase of complexity on both design and deploy time.
- Coverage of the problem: The discussed approach will be developed to provide a realistic user interface for both designers and teachers, the coverage of new elements will be restricted to the most relevant issues. Despite the coverage is lower than in other solutions, it is not a disadvantage since all well known cases will be able to be used. This approach has been taken in CSCL by the use of patterns to ease course creation.
- Backward compatibility: Extending the specification does not take into account with compatibility issues. Due to this, all the proposed features will be complemented with an alternative in the learning flow in case the extra requirement is not supported. Backward compatibility issues during course design are also present in the composite-based approach, in which no changes in the specification are required.

Conclusions

Course packaging provides a way to easily create contents and design learning materials in and standard methodology. Main objective is reusability of courses, especially in those cases where complexity at runtime becomes a handicap for teachers.

Current modelling languages provides a way to design and package complex pedagogical models, without taking into account the problem of external services. In this sense, generic services integration has the idea of solving this problem, allowing the deployment of a wide range of learning methodologies also on distance learning.

To solve the difficulty with the integration of external tools in an IMS LD course, new *generic service integration* elements will complete the IMS LD specification, increasing its expressiveness and thus making it more versatile without having cost on usability.

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Lifecycle Information Management for Learning Resources and Knowledge Documents

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Abstract. Lifecycle information can be of great help in the retrieval, authoring and usage of both, Learning Resources and Knowledge Documents. In my PhD thesis I want to show how the different types of information can be captured, managed and utilized so that the persons involved in the lifecycle of these documents benefit from it in various ways. This article shows my overall strategy and my progresses in the different segments.

Keywords: Lifecycle Information, Document Management, Retrieval

1 Background and Motivation

Both, Learning Resources and Knowledge Documents, usually take part in various processes, where they are adapted, modularized, aggregated, re-purposed, generally re-used, updated or just plainly used. Commonly this is done by different persons. These processes generate a lot of information, which persons involved in the processes might take advantage of. If we consider a realistic scenario, where a lecturer re-uses some slides of several other professors, adapts them and - given he got the allowance to do so - puts them in his new presentation, and we assume that the slides he re-used were produced by the other professors in a similar way, we can conduct that all the presentations, the lecturer re-used slides from, are connected somehow with the presentations, the other professors got slides from. In such a scenario authors involved may want to know:

- Who is reusing my slides?
- Who has changed the slides in which way?
- In which context are the slides re-used?
- How often are the slides re-used?
- How popular are my slides?

On the other hand, users of the slides, or learners respectively, might want to know:

- Are there presentations related to the one I am currently viewing?
- Are there slides covering similar or related topics?
- Which slides are most popular?
- How can I retrieve the proper documents efficiently?

2 Identification of Research Questions

Unfortunately, with today's methods, we are not able to answer most of the aforementioned questions in a satisfying way. Even if every person, involved in the processes, would have used one and the same state of the art version control system - like CVS or SubVersion - we would not be able to reproduce all the information, generated during the processes described above. Therefore all the information needs to be captured at the moment it emerges, or otherwise is lost. This is one of the central issues of my PhD thesis. Among others, the following questions are of interest:

- What kinds of information emerge during the lifecycle of a document?
- Which information is important and can be helpful in later on processes on a document?

- How can the lifecycle of a document be modelled properly?
- How can the desired information be captured / collected?
- Which phases of a document's lifecycle provide which kinds of information?
- How can the information be stored and traversed beyond system borders?
- In which ways can the collected information be utilized?
- Is there a critical mass of information (relations) or documents for this approach to be effective

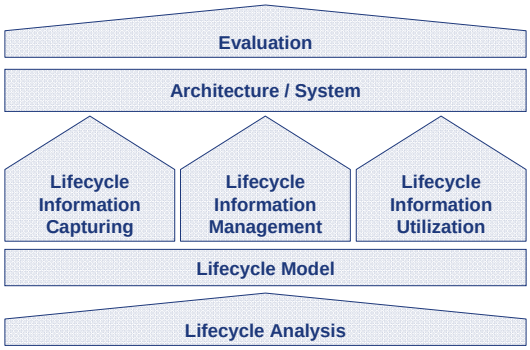

Figure 1: Concept of the Overall Approach

3 Overall Approach

To cope with the aforementioned challenges, we divided the overall problem into three segments: *Capturing*, *management* and *utilization*. Additionally, we start from a rather specialized domain - the one of learning resources - and try to transfer the results to the more general domain of what we call knowledge documents. We chose an analytical approach that we will prove with mostly user driven evaluations. Therefore we start from analyzing the lifecycle and the information generated herein. The results from this analysis are brought into a lifecycle model. Then, based on that, we cover the three above mentioned segments and derive a conceptual architecture. After the implementation work is done, the approach will be evaluated. This whole process is depicted in Figure 1.

4 Results, Solution Approaches and Work in Progress

At first, the results and progress in the domain of Learning Resources are described before we depict our approaches in the field of knowledge documents.

4.1 Learning Resources

For the field of Learning Resources the analysis of the lifecycle, the systems taking part in it and the information generated herein has been done. We differentiate two types of information that have to be handled, processed, as well as captured differently: **Context** and **relation** information. We modelled the lifecycle of Learning Resources and developed a schema to store this information [7]. Our first proof of concept for the overall approach was conducted in our Authoring by Aggregation environment ResourceCenter [5]. In [7] we have shown that the collection, management and utilization of lifecycle information for Learning Resources is possible and can support the users of the ResourceCenter in various ways. In [6] a more general approach, which is not dependent on one specific system, is described. We implemented a generic framework that is easily extendable and provides the infrastructure for arbitrary applications. Capture Components do the **capturing** of lifecycle information within the applications in use, like repositories, market places or authoring, re-authoring or authoring by aggregation tools. The Lifecycle Information System (LIS) is the central instance that manages, processes and distributes the collected information - in short: it is responsible for the **management** of lifecycle information. At last, the Accessing Components allow for the **utilization** of the processed information within the systems in use. Nevertheless, the evaluation of the approach is still missing. The components are described in detail in [6].

4.2 Knowledge Documents

In our understanding the knowledge documents do not have a strict definition. It is rather the case that we discovered a group of documents with certain attributes and tried to find a name for it. Our definition of knowledge follows the definition of Probst et al. in [14]. Here, characters become data if syntax is added, data becomes information when context is added and information becomes knowledge when the linking of information is given. Documents are in that case digital text-based documents, which can have various formats and contain different types of media like images, audio, animation etc. Starting there from, we define knowledge documents as documents with the following attributes:

- Documents containing (codified) knowledge
- Digital, text-based
- High potential and probability of re-use
- Often created in collaborative processes

Typical knowledge documents are slides, reports, papers or articles, in contrast to bills, receipts, invoices or telephone books, since these contain information at most. We found that in this domain lifecycle information can be of even more value than for Learning Resources, since existing Document Management Systems do not take into account the huge amounts of information generated during the documents' lifecycle.

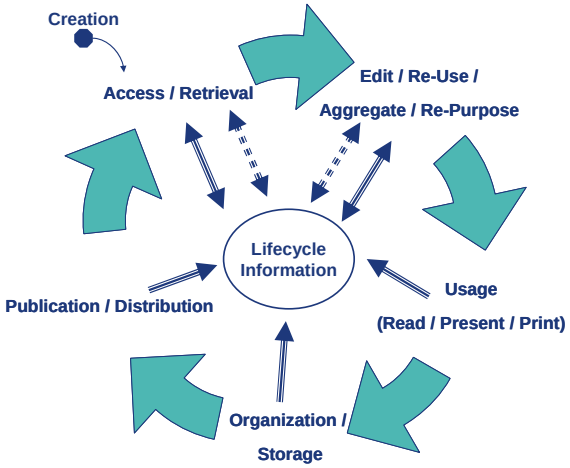

Figure 2: Schematic Knowledge Document Lifecycle

So far, we have developed a schematic model for their lifecycle and we are currently analyzing the different types of lifecycle information emerging in the different phases, in order to put them into a proper schema. We decided to stay with the division in context and relation information. Figure 2 shows the schematic lifecycle for knowledge documents, we propose. Here, the arrows show, where information emerges (arrows to the middle) and where information is utilized (arrows from the middle). The dotted arrows represent relation information while the other ones depict context information. In order to have this lifecycle properly analyzed, we have to generate views from different perspectives, including a system view, considering the applications involved, and an instance view, where the proceeding of one instance of a knowledge document through the lifecycle is shown. In addition, we have transferred the existing architecture concept to cope with the new situation. Here, we adapted the framework we designed for Learning Resources to the new usage context [8].

5 Related Work

Several approaches within this domain show, that the collection, management and utilization of lifecycle information are important issues in ongoing research. The ecological approach [2], [9] states that there should not only be a dedicated labelling phase for learning objects in the beginning of their lifecycle, but metadata should be created during the whole lifecycle of a learning object, which motivates the capturing of lifecycle information. On top of that, the capturing of usage information is proposed in order to improve user or learner modelling.

The research works around the Attention Metadata framework [12] is actually dealing with a special sort of contextual usage information to help in retrieving - e.g. ranking and recommending - learning objects [13], learner modelling [11] or in semantic desktop search [3]. However relation information seems to be not captured at all and there is no publication to be found where this kind of information is taken into account. Thus a lot of potential value is dismissed here.

Systems and approaches that take relations between documents into account are rather sparse. In [10] a concept for a management of change for collaborative authoring of structured and unstructured documents is proposed. This is somehow build upon relations but mostly relies on semantic, intra-document relations that are inevitable for a consistent management of change, but do not make use of typed relations that connect different instances of documents like we do.

In the HyLOS system [4] relations between instances of learning objects are used to provide additional links to learners in order to support constructivist learning. However, these relations are generated at most semi-automatically and are not caught while they occur. Nevertheless the HyLOS system uses algebraic rules to enrich existing relation information sets.

Additionally there are several frameworks, systems or approaches where this work might fit in nicely. Semantic Desktops [15] for instance, deal with the retrieval of documents in desktop environments; they already make some use of basic lifecycle information, like e-mail context or information gathered from the file system. Nevertheless, the consequent capturing and utilization of lifecycle information might make these tools even more powerful.

6 Conclusions and Future Work

The attention in the research community shows that the capturing, management and utilization of lifecycle information is an important and interesting research task. We have shown that in the domain of learning resources - under the given conditions - our approach is reasonable and applicable [6], [7]. The next steps will have to prove, if our approach can be generalized and transferred to the domain of knowledge documents, where it could serve an even bigger target group and likely have more impact. They include:

- Evaluation of the implementation in the ResourceCenter
- Refinement of the lifecycle model and the lifecycle information schemas for knowledge documents
- Refinement and implementation of the above concepts
- User driven evaluation of the developed system

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Service-oriented Knowledge Architectures – Integrating Learning and Business Information Systems

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Abstract. This paper presents a dissertation project on business-integrated, service-oriented learning architectures. The isolation of corporate learning management from core business functions at all levels of a coherent socio-technical enterprise system (task, technology and people) motivates the objective to integrate learning into business information systems. Connecting to related standards and frameworks, the thesis is to make a case why SOA qualifies not only from a technical but also from an organizational perspective. The paper sketches the problem situation of non-integrated learning and knowledge management and derives a research agenda that aims for a conceptual and technical reference architecture. The dissertation thesis is conducted in the context of the EC-funded research project PROLIX that promotes process-oriented learning and knowledge exchange in corporate environments.

Keywords: Service-oriented Architectures, Business Process Management, Web Services, Technology-Enhanced Learning, Interoperability

1 Motivation and State-of-the-Art

Enterprises of various sizes and industries have adopted business information systems for the past thirty years. Operational transaction systems (such as enterprise resource planning (ERP) systems) and strategic management information systems (such as business intelligence applications) have focused on the universal objective to integrate structured business data and business functions [16] [15]. Increasing flexibility demands on business processes and on supportive IT Systems have forced software providers and CIOs to evaluate possibilities to assemble IT-supported functions on-demand. The potential of service-oriented software architectures had been recognized previously. Looking back at a history of distributed communication standards such as DCOM, CORBA or RPC, service-orientation is not a new architectural pattern in itself [1]. The commoditization of internet communication and the strong demand for flexible distributed software systems, though, have pushed industry initiatives to develop web service standards, some of which have reached a level of maturity in the meanwhile. Via web services business software applications can interoperate flexibly over internet protocols and standardized interfaces [24]. Their continuous dissemination has been promoted by the software industry's product portfolio (SAP with Enterprise SOA, Oracle with Fusion, IBM with Websphere, etc.) and the industry-wide provision and adoption of service-oriented business software is on the horizon.

Beyond the demand for flexible IT resources, the recognition of human resources being equally important business factors to achieve strategic objectives and maintain competitiveness has spread across industries [17] [5]. Harvesting and developing employees' knowledge and competences effectively is perceived as strategic HR management activity across industries. However, leaving corresponding tasks to HR departments often causes learning management being detached from overall business strategy. This misalignment affects four interdependent HR related functions – HR administration, knowledge management, personnel development and corporate training. Due to their isolation from core business functions they are often falling short of meeting learning and knowledge requirements of both day-to-day tasks and business strategy. This entails frustrated, little motivated employees on the individual side and negligence of a strategically aligned human resource development on the organizational side.

KM- and learning related functions and business management are not only segregated organizationally. Information technology has supported learning management so far only by isolated, monolithic learning and knowledge software [15], nearly cut off from any organization-wide integrated IT infrastructure. Additionally, there are only a few approaches to have learning systems and operational transaction systems or management information systems flexibly and dynamically interact [4]. In consequence, the following problems on the business level arise:

- *Informational Discontinuity* between business strategy and competency management: Lacking integration of competency-relevant systems (e.g. learning management systems, HR systems) and management information systems (e.g. ERP, business intelligence, business process management, etc. software) implicates gaps between business requirements and employee competences, which are managed individually according to job description, role profiles or career objectives [13].
- *Redundant Knowledge Explication:* Identification and explication of knowledge usually occurs locally and centrally [18] [19]. Both approaches entail redundancies, as knowledge is not only explicated for learning purposes but also for other business functions (e.g. documentation, marketing, R&D,etc.). Lacking any system integration, functionalities and data are often created and maintained redundantly.
- *Decoupled Knowledge Distribution and Acquisition:* The phase of distributing and acquiring knowledge during formal and informal learning processes are mostly separated from applying and developing knowledge (internalization and socialization) during the actual business activities [18] [19]. Business information systems detached from learning systems reinforce this segregation, hindering a context-driven, personalized and most of all need-driven knowledge distribution.
- *Redundant Administration Functionalities:* Similar or equivalent functionalities of learning systems e.g. resource and budget planning, competence management, employee data management are covered by multiple information systems. Redundant, inconsistent data and multiprocessing are the consequences.

Service-oriented architectures promise to tackle those challenges by offering standardized service interfaces that can be invoked by any software systems. Thus, they provide a mean to have single software functionalities flexibly integrate and interact along a process previously defined or dynamically composed. Business information systems – within and across organizational borders – are moving towards a distributed system of loosely coupled services, which needs to react flexibly and execute business requirements ad-hoc [24]. Equally, learning software providers are slowly adopting benefits of a SOA [6]. Existing approaches rest on proof-of-concept solutions and are limited to educational organizations without focusing on enterprise-specific challenges (vgl. [3];[2];[22];[9];[23];[21];[10];). Despite those approaches there is no initiative to be identified that explores the potentials of service-oriented architectures to integrate learning and business infrastructures both technically and conceptionally.

Other means of software integration would possibly also qualify to overcome the segregation of human resource management and core business management. However, the thesis is to argue that SOA offers not only a technological interoperability platform but specifically targets at a non-technical notion of integrating business functions across organizational borders. By introducing universal software paradigms (modularity, reusability, standardized interfaces etc.) to business design decisions, this conception propagates to fully align business and IT. Thus, unlike other integration technologies SOA proposes a shared syntax and semantics to align activities across domains vertically (e.g. HR and core business units) and horizontally by using services as universal entities.

2 Research Objectives

The gap between learning and business infrastructures appears to be approximately closed by the increasing adoption of standardized service architectures on both sides. In the context of this system evolution towards SOA the research question central for this thesis arises:

> *How does service-oriented architecture has to be designed in order to allow for flexible interaction between learning and business applications realizing integrated scenarios?*

Knowledge about a suitable design of corporate learning services in a corporate environment is – unlike business service design – still in a rudimental state. This deficit needs to be tackled by considering the interplay among learning services and business services (Enterprise Learning Service Architecture). Business processes provide the contextual basis both for business and learning activities. Moreover, they are a central object of SOA since services can flexibly be assembled to business processes [14]. The objective is to realize the IT-supported alignment of individual learning and organizational knowledge needs by a process-oriented learning service architecture. The thesis is to go beyond a purely technical integration but develop an organizationally integrated service-oriented learning management. This vision motivates the following research objectives:

- *Analysis of existent service-oriented frameworks:* Existing concepts, frameworks and standards for either business or learning-related services are to be examined and checked for transfer and compatibility potentials for the specific case of business-integrated, service-oriented learning management.

- *Integration Requirements and Scenarios:* Integrating learning and business processes enabled by SOA asks for an in-depth study of synergy potentials in integration scenarios. Specifying the requirements for service-oriented integration of learning systems and business information systems encompasses elicitating and structuring domain-specific requirements and technical constraints.
- *Reference Architecture for enterprise learning services:* On the basis of existing standards and integration requirements identified, a reference architecture for enterprise learning services that closes the gap between learning management and business management is to be designed conceptually as well as technically and to be implemented prototypically.

3 Preliminary Ideas and Early Results

The dissertation is planned to be structured into seven chapters, which include five main chapters complemented by an exposition and a conclusion. The first chapter motivates the thesis and presents research objectives. The second chapter introduces basics of learning management, business process management and service oriented architecture, relevant for the succeeding analysis. Based on the terminology and state-of-the-art research introduced, the third chapter specifies the requirements for an integrated Enterprise Learning Service Architecture. The fourth chapter proposes a reference framework of learning service, events and data specifications that allow flexible interaction with business services composed to new types of business and learning processes. The conceptual and technical design is documented in semi-formal information models and implemented into a reference architecture in chapter 5. To validate and demonstrate the usage of the proposed service-oriented learning architecture, chapter six outlines up to four concrete case studies and prototypes of the telecommunication, pharmaceutical, social care and financial services sectors.

Research activities within two ongoing research projects contribute to the thesis' work. The EC-funded PROLIX project envisions a service-oriented environment for process-oriented learning and information exchange. The project work is based upon the PROLIX learning lifecycle (PLLC) and will lead to a reference framework named OBELIX. Pursuing the SOA paradigm, services can be orchestrated to flexible workflows one of them being the PLLC. Amongst others the thesis presents the PLLC as a reference example for a workflow composed by the learning services specified. As a first result, the PLLC has been designed and documented according to the requirements of the industry parties and constraints of the component providers. It is a exemplary workflow of learning-related services consisting of the following five iterative phases:

- modelling competency-enriched business processes to specify the learning context
- deriving competency gaps
- deriving and designing suitable learning processes
- executing learning processes
- monitoring learning and business process performance

Generalizing this specific workflow into a more universal process model including a wide range of possible application scenarios, the thesis is to take such a universal PLLC as a basis to derive service, data and event specifications for the reference architecture. As OBELIX it builds upon existing standardization activities and connects to other reference architectures in both the learning/knowledge management community and the business (process) management community. The thesis will elaborate in detail on the OBELIX framework and break it down into various specific parts. To validate the OBELIX framework, a prototypical implementation will be presented as reference software architecture. Finally, case studies from PROLIX industry partners will demonstrate variations of the OBELIX reference framework and architecture. From a conceptual point of view the PLLC is adapted to a workflow that suits individual needs of the organization. From an implementation point of view the OBELIX reference bus architecture is configured to meet organization-specific needs.

4 Related Aspects

It is important to note, that PROLIX looks at business processes as a requirements basis for individually and organizationally suitable learning processes. Thus, it focuses only on the build-time of formal learning and structured business processes. The execution of learning processes (the actual learning) by employees may still take place

independently – in terms of time and place – from business operations. Looking at integrated learning and business processes at run-time (i.e. the actual process of knowledge acquisition during day-to-day work) shifts the focus to informal learning activities that occur intermingled with business activities. Again, service-oriented computing promises to dynamically compose fine-grained learning services with business services to knowledge-enriched business processes.

Also, PROLIX considers only structured business processes and formal learning neglecting unstructured ad-hoc business processes often related with informal learning. Extending the approach by these aspects will bring Web2.0 into play as an innovative mean of informal learning and technologically related to SOA. It remains to examine how Web2.0 principles are to be applied to service-oriented learning management. The nationally funded EXPLAIN project develops a web-based authoring management system and looks into service-oriented and Web2.0 related concepts. It provides the work with insights on distributed content production and delivery processes. Whereas PROLIX considers business processes as business context providing requirements on learning, business processes also include learning and authoring management activities and therefore organize learning-related operations within the company. In EXPLAIN, processes are not used to describe the business context of learning but rather to structure and organize supportive learning management activities such as authoring processes themselves. Thus, the dimension of integrated learning and business processes is further enriched by another perspective, which may complement the thesis additionally.

Whether such run-time and informal learning aspects will be covered by the thesis or left for future work, remains to be decided.

5 Research Methodology

The thesis is based on a socio-technical notion of business information systems that are made up of three interacting elements: work, technology and human [8]. Analogously information systems sciences understand themselves mediating between business management, computer science and sociology [12].

All three aspects are tackled by this thesis: The perspective of computer sciences contributes the concept of service oriented architectures, which promises an unprecedented degree of integration on the system and conceptual level. On the other hand, SOA is conceived as far reaching paradigm affecting management and culture of organizations; thus, holding business challenges and chances. In the context of business administration organizational theory and personnel development play a decisive role, as they embrace – in terms of change management principles – the continuous adaptation of organizational competency needs and individual competency profiles. Therefore the interdisciplinary approach includes ultimately also social sciences in general and psychology specifically. It provides the thesis with a psychological foundation in respect of knowledge processes.

Despite (or maybe just because of) this multi-dimensional perspective, the thesis is to be classified into the field of information systems. It applies the general question on how to design application systems and organizations correspondingly to requirements of their environment at the best to the specific case of integrated learning systems in the corporate environment and attempts to provide a solution via SOA.

The thesis adheres to the engineering phase model, well-established in information systems: specifying the problem situation, conceptual design, technical design and implementation [20]. In order to grasp the problem situation, analyzing and evaluating state-of-the-art SOA concepts both for business and learning systems is based on a profound literature analysis (and qualitative expert interviews). The requirements specification of the learning service architecture follows a deductive-dogmatic approach, i.e. deriving conclusions form generally accepted theories for the specific object of research [7]. The objective to integrate learning systems with business information systems via SOA puts the focus on a design-oriented perspective, which concentrates on the design of innovative artifacts extending human and organizational abilities [11]. The implementation of a reference prototype and its enterprise-specific configurations acknowledges the application oriented character of information systems, as they demonstrate and validate the results of this thesis in practice.

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A methodological proposal to analyse interactions in online collaborative learning environments

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Abstract. Interaction analysis within online educational contexts based on collaborative learning strategies requires a multidimensional model taking into account social, emotional and cognitive components. Starting from the assumption that only through correlation of these three dimensions it's possible to capture and understand the generative processes of learning in CSCL, this research is aimed at studying the existing analysis models (generally one- or bi-dimensional) and developing a new integrated model to investigate how these dimensions concur to the achievement of relevant learning within online educational contexts. The analysis is retrospective and carried out within several contexts.

Keywords: interaction analysis, online assessment, computer supported collaborative learning, technology enhanced learning.

1 Formulation of the research question

Online courses based on collaborative learning have gained the attention of several researchers from the educational field in the last two decades. There is evidence that these courses are crucial to promote sharing, management and building of knowledge. The collaborative strategy employed in these courses is based on the exchange of a high number of online asynchronous interactions among the participants within computer conferencing systems. According with the social constructivist approach, participants learn achieving collaborative activities aimed at the realisation of a common task like the solution of a problem, the analysis of a case study or the production of artefacts.

The proliferation of online courses has made compelling within the scientific community the development of design and validation methodologies aimed at distinguishing, within the huge offer of elearning solutions, those courses leading to successful learning outcomes. One of the most recent research trends within this topic concerns analysis of transcripts. As a matter of fact, computer-supported collaborative learning (CSCL) engenders high-level and very complex interactions among learners which require, to be deeply investigated, an appropriate model enhancing content analysis of conference transcripts. This analysis should not only ensure individual assessment and self-regulation of learners, but achieve also the overall aim of exploring the quality of collaborative processes and the nature of learning within computer mediated educational environments. This research is aimed at offering, developing such a model, an innovative and effective contribution to the current knowledge on design and management of online courses.

2 Significant problems in this field of research

The major problem in the field of content analysis of CSCL environments is the lack of both effective and reliable techniques and of a theoretical framework capable of leading the building of techniques and the interpretation of results.

The coding system and procedures adopted for the analysis of transcripts should, on the one hand, ensure the classification of content in consistent and mutual exclusive categories and, on the other hand, should warrant reliability among different researchers. To accomplish these requirements the coding system shouldn't be too complex, while the unit of analysis should be univocal and clear.

Transcript analysis is often carried out mainly at a surface level, i.e. counting messages or calculating the threads length. With this type of analysis the risk lies in drawing rash conclusions like correlating positively a high number of words in a message with the quality of the content, or associating the high amount of messages sent by a participant with the success of the learning process. Furthermore, sample data are usually not so high: the number of participants and of conferences, or the amount of transcripts are not relevant for statistical purposes and for comparative studies.

The methodology adopted to study interactions should not provide a rough analysis of communication, but rather a deep analysis of social and cognitive dynamics, and of contextual factors affecting these processes. Researchers are not always aware of the complex social and cognitive dynamics characterising online collaborative activities, and this lack impacts also on educators' capability to assess learners. Systematic studies on this topic, based on structured and relevant sets of assumptions, ideas and concepts, and sustained by a unique theoretical perspective, are needed, since many studies connect in a unique model a mixture of techniques inspired by different and incompatible paradigms. If the constructivist perspective is adopted, for instance, the transcript analysis technique should consider interactions dynamically in terms of collaborative construction of knowledge, and not prescriptively as definite and countable behavioural data. Moreover, models tailored for analysis of cognitive aspects usually capture only external cognitive behaviours, without considering internal and implicit processes.

Another problem lies in the methodological approach underlying most models: approaches are usually exclusively qualitative or only quantitative, even if it's recognised that within social and educational research qualitative methods have to be consciously combined with quantitative methods, according with a "mixed approach".

3 Outline of the current knowledge of the problem domain

The exploratory nature characterising the present studies of the topic described above is probably due to the immaturity of research in this field, or to the lack of reliability of the coding systems elaborated so far. The pioneer work of Henri [3] generated a lot of studies, but nobody replicated either that model and its updated versions, or the alternative models which have been developed by several researchers in recent years. Moreover, most studies are mainly descriptive, while only a few adopt an experimental design.

The majority models are one-dimensional, detecting mainly participation. Even in so called multidimensional models, the main dimension investigated is social presence, while other relevant dimensions like the cognitive or the affective ones are not deeply analysed. Rourke et al [4], for instance, focus only on one element of the model, social presence, providing a template for assessing it through content analysis of transcripts and testing the efficacy of this tool.

The most well-known multi-dimensional models for content analysis developed so far adhere to one of two distinct paradigms.

The aforementioned Henri's model is grounded according with a cognitivistic vision of learning which emphasizes the individual aspects of knowledge. The multidimensional model developed by Garrison et al [1] instead, aimed at guiding the use of CSCL to support critical thinking, and that of Gunadwardena et al [2], which have built a five-phase tool to analyse knowledge construction, follow social constructivist theories and thus consider learning as socially grounded.

4 Preliminary ideas, the proposed approach and the results achieved so far

The main epistemological assumption of this research project is that learning results from the interaction of three core components: the cognitive dimension, the social dimension and the affective one. These dimensions are being investigated both separately – trying to understand dynamics at cognitive, social and emotional level – and jointly, according with an holistic approach, in order to detect possible correlations or relations of any other kind. The analysis is carried out both at individual and at group level (Fig. 1). Potential surveys will investigate, concerning social dimension, if and to what degree relational dynamics triggered from the assumption of implicit – or explicit – roles or attitudes are crucial for the general affective climate and for knowledge building of individual and groups. At a cognitive level, the possible effects of building and negotiation of meaning on socio-affective dynamics will be investigated as well. With regard to the affective dimension, it will be examined to what extent specific emotional and motivational states affect cognitive processes.

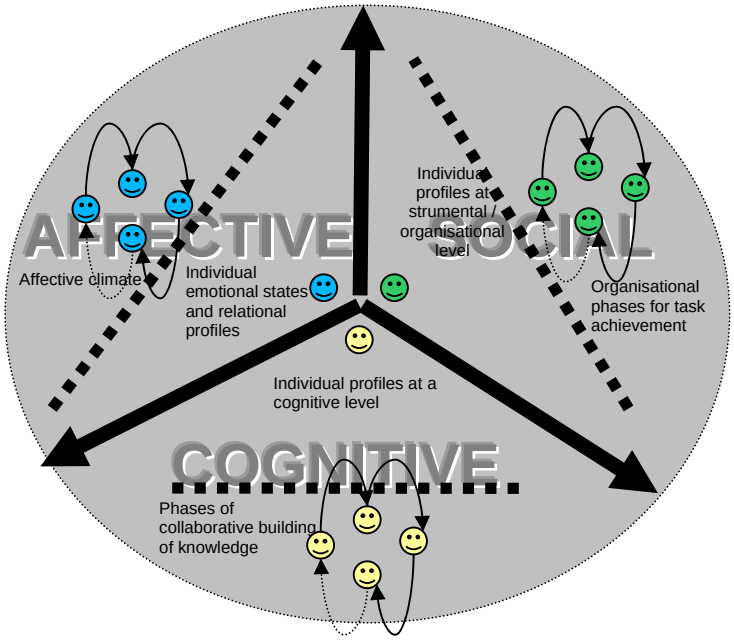

Fig. 1. A representation of the three dimensions of the model investigated at an individual and group level.

Starting from the investigated phenomena, the main tendencies, patterns and configurations will be detected to better understand which elements and conditions render these situations virtuous or critical for individual and collective learning. At an individual level, a range of possible profiles assumed by learners will be sketched; at collective level, typical phases (organisational, affective and cognitive) crossed by groups during a series of collaborative activities will be identified.

These information will take into account also data gathered from the analysis of tutor's interaction with learners, in order to identify situations in which he/her has played a crucial role on cognitive, social and affective dynamics of learners.

Investigation of these three dimensions requires an integrated multidimensional model for the analysis of conferencing transcripts, aimed at detecting to what extent these components concur in triggering relevant learning within computer mediated environments. The analysis is retrospective and is carried out in various contexts (higher education, doctorate school, pre-service teacher training, and continuous professional development).

Categories and indicators for analyzing the conferencing transcripts have been identified through a recursive process, combining a data-driven approach with a theory-driven approach. Firstly indicators were derived from those used in literature on interaction analysis or adapted from scholarship on interaction in traditional face to face learning contexts. These indicators have been assigned to broad categories. Secondly, additional indicators were inferred from readings of the transcripts. Further work is undergoing to verify consistence of both categories and indicators. The next step will be detecting these indicators during the analysis of conferencing transcripts, which are structured in weeklong and self-contained discussions focusing on a specific topic, through the development of a *segmentation procedure* [5] and the adoption of a coding scheme based on the established categories and indicators. The unit of analysis of these transcripts will be sentences meaningful in themselves that will be imported in the analysis tool Atlas-ti. This tool will allow the segmentation process according with the coding scheme. The analysis will be carried out by two independent coders to check and ensure inter-rater reliability. Whereas reliability will be too low, categories and related indicators will be reviewed.

The model developed so far includes three components (cognitive, social and affective), organised in 5 categories and about 30 indicators[2]. A self-assessment questionnaire consisting of several items scored on a five-point Likert-type scale has been developed to detect the same process indicators investigated in transcripts. This questionnaire, if administered at the end of each learning activity, stimulates meta-reflection of learners and promotes self-regulation of learning. If used by researchers and crossed with results obtained through transcript analysis, it provides further information for aspects more latent or implicit. Till now, a wide sample of about 300 learners have compiled this questionnaire, in order to test the proposed methodology with a wide sample of groups of participants; nevertheless, this model can be replicated with few groups of people, even by the tutor herself, in a more cost-effective way.

5 Sketch of the applied research methodology

The methodological approach applied to the analysis of transcripts is both quantitative and qualitative. The former is based on the grounded theory and consists on codification through the software Atlas-ti and statistical elaboration of data with SPSS, combined with interaction analysis carried out through SNA tools (Social Network Analysis). The latter relies on a parallel analysis process leaded through the ethnographical method: a subjective judgement for each category formulated on the basis of the accurate reading of transcripts will be given on a five level-scale basis (from null to excellent). This two-fold analysis process is triangulated with learners' subjective perceptions of cognitive, social and emotional aspects - obtained through the questionnaire - and with objective measures of the learning outcomes (the individual and collective products and final grades).

In the crucial phases of the research, data obtained with different tools will be integrated developing equivalence tables among results gained with qualitative methods and those attained with quantitative techniques. Finally, data describing each dimension will be aggregated through techniques of multivariate analysis in order to determine how each indicator influences the dimension to which it belongs and to what extent the three explored dimensions are correlated in the generation of relevant learning.

Hence, part of the research will be carried out on an empirical level according with an experimental perspective, through techniques gathering highly structured data organised in matrices and analysed with statistical elaborations; another part of the research will instead realised through an hermeneutic approach, by means of qualitative techniques like discourse analysis and conversational analyses, which capture not quantifiable either formalisable aspects.

6 Description of the Ph.D. project's contribution to the problem solution

This research should have implications and benefits not only for researchers, but even for course developers, instructors, tutors and for the students themselves.

The model of analysis under development can be used easily by educators, who don't need to be trained to use it; they will be offered an innovative approach for formative and summative assessment of learners. Tutors and instructors will be supported with a set of criteria through which monitoring and detecting critical situations and drawing suggestions on how to manage them. These criteria will enhance them to opportunely intervene on various levels and to regulate interaction in order to improve the use of high level cognitive abilities, to increase participation and collaboration processes, and to maintain an optimal affective climate.

At the same time, this model could represent a reliable scientific tool for online courses design. Considerations emerging from the research results on the profiles of individuals and on the dynamic configurations that groups can take in the different steps of a collaborative work, may support the planning of effective learning activities and orient the formation of heterogeneous and well-balanced groups.

Assessment results may be interpreted also from learners, who can improve their metareflection capabilities and, if timely informed during the course, are able to self-regulate constructively learning.

During the research project strengths and weaknesses of all the previous relevant techniques and methods will be taken into account as a basis for the development of the new model of analysis.

[2] Two categories correspond to the social and to the emotional dimensions; the other three represent the articulation of the cognitive one in three subdimensions (individual learning, metacognition and construction of knowledge). The indicators are particular attitudes that can be detected through transcript analysis (i.e. correctness of concepts or the argumentation of one's personal point of view are indicators for individual learning).

With respect to the contribution for progress in the educational sciences, the application of this integrated model to a wide sample of discussion transcripts is an attempt to explain in which conditions and to what degree the investigated components of the model concur in generating relevant learning.

The remaining work to be done is huge and there will be many obstacles to overcome; however the results achieved so far are encouraging.

7 How the suggested solution is different, new, or better as compared to existing approaches

The mixed approach adopted in this research project, as a unique perspective unifying qualitative and quantitative knowledge, is an optimum within educational research. According with the foundations of contemporary epistemology, the qualitative knowledge precedes the quantitative one, orienting it and verifying its results.

In the same way, the approach adopted within this research enhances investigation of educational interactions in their own complexity. Unlike most other existing approaches, the suggested solution consider the relative importance of each indicator on the dimension to which it belongs, and even the relations between different dimensions, providing empirical evidence with the analysed data. Major importance is given to the affective dimension, an aspect that, in spite of the spreading of last research on emotions and motivational aspects, is usually neglected or underrated in the relevant literature on interaction analysis.

Thanks to this approach it's possible not only to have an effective tool to monitor and assess learners – the majority of the present solutions address this issue - but even to explore at a deeper level the nature of learning within virtual learning environments.

Furthermore, the present research project addresses not only a specific target of learners or a single course, but several ones. The selection of wide samples of data from a rich database of courses is an added value derived from the opportunity to attend - during this research and also previously – an high number of courses at different titles (as a student, as a tutor, as a coordinator of tutors, as a designer of courses), and to develop a deep knowledge of interaction occurred there.

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Organizational Collaborative Model of Small and Medium Enterprises in the Extended Enterprise Era

Lessons to Learn from a Large Automotive Company and its dealers's network

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Abstract. Large firms tend to overlap their boundaries in unstable environments and create strategic alliances and collaborations with their suppliers, customers and partners. In the automobile sector, firms are extended enterprises continuously innovating and creating new products through their dynamic capabilities. A large automotive company seeks to leverage its relationships with its customers and suppliers through networks creation. More specifically, partnering with the organizations, constituting a Dealers' network- providing after sales services to customers as assisting, selling, and repairing cars. The dealers' network consists of small and medium organizations that represent the automotive company and are the intermediary among it and its customers. Through this research, we are elaborating a model representing the collaborative relationship among the automotive company and its dealers' network that leads to knowledge creation and sharing about the automobiles components and services of this extended enterprise. We present a model illustrating the dealers' network organization and its interaction with the large firm. The collaborative knowledge network (CKN) contributes to the sustainability of the new product development (NPD) process of the automotive company.

1 Introduction

In the digital era, the extended enterprise is continuously creating new collaborations with external actors basically on information and communication technologies. Besides, it is aware of the importance of external actors in the creation of innovative products. Gathering external actors -especially professional and expert ones, in networks in which they can create and share their know-how and experience, is a critical step toward integrating strategic knowledge in the new product development of the extended enterprise that has absorptive and dynamic capacities to keep up with the complex business environment.

In this paper, we are presenting the case of a large automotive- extended enterprise that decided to take action and takes care of its dealers network that are external actors interacting directly with the customers of the EE. We first present a literature review to clarify the reasons behind the importance of partnering with external actors for new product development and innovation, then we describe the CKN among the EE and its dealers´ network, and finally we discuss the organizational, technological and strategic dimensions of these interactions presenting some challenges facing the CKN and also especially some important factors that are leading to the success which is the creation, sharing and integration of knowledge in the new product development process of the extended enterprise.

2 Literature review

2.1- Strategic alliances with external actors for innovation

The complexity and increasing turbulence of the environment is leading the extended enterprise to seriously strengthen its inter-firm relationships for knowledge creation and competitive advantage. The strategic alliances are important for business performance and innovation. Many scholars have studied the relationship among a firm strategic alliances and its innovative performance [1-3] Thus, we consider the capabilities to manage strategic alliances and the related organizational capabilities of learning and communicating as key-enablers for the process of knowledge creation and sharing. The strategic alliances are efficient instruments allowing access to external

resources and overlapping firm's boundaries [4], therefore firms focus on knowledge acquisition and sharing through the network of partners. Strategic networks [5-6], as the strategic alliances, are composed of inter-organizational ties that are based on social, professional and exchange relationships. Thus, collaboration at the inter-firm level is a critical vehicle of the exploration of novel technologies and capabilities. For instance, in automobile development studies, collaboration between firms enhances the knowledge exchange for exploratory problem-solving in product development process [4, 7-9].

For the creation of competitive advantage, the involvement of external actors in the new product development is essential. Thus, innovation is distributed across different actors such as lead users [10-11] in order to extend the areas of innovators outside the firm. Considered as co-creators, the external actors are regarded as partners and their knowledge is integrated in the innovation process of the extended enterprise [12] and work jointly and efficiently. Besides, since innovation is a complex process, firms adopt systemic approaches to manage knowledge. Thus, it is a good strategy to adopt knowledge management systems to capture, create and use knowledge to enhance the organizational performance.

The process of knowledge exploration and exploitation is speeding up the new product development process and innovation may require the creation of organized entities representing the external actors such as research groups, communities of interest, communities of practice [13-14] and other organizational structures that are separated from the main organization but still connected to it [15]. The information and communication technologies play the role of enablers of communication activities among the external actors- combined into entities- and the main organization. Through the use of information and communication technologies, the interaction among the firm and its external actors groups is leveraged and new knowledge is integrated in the new product development process.

2.2 The virtual communities of practice

The information and communication technologies allow organizations to overlap their boundaries and be more open to collaboration and cooperation. The use of ICTs creates a virtual environment in which its inter-organizational distributed members –in space and time [16] can effectively work toward a common goal [17]. The authors [18] define the virtual organization as one that coordinates operations, among people from different locations, using ICTs. The authors [16] define the virtual team as 'a group of people who interact through interdependent tasks guided by common purpose' across organizational boundaries using communication technologies. The virtual organization is characterized by an inter-organizational relationship- based on information technologies- in which knowledge is shared and created [19].

The use of virtual teams for new product development is rapidly growing and organizations can be dependent on it to sustain competitive advantage. To accelerate the innovation process, the use of virtual communities of practice (VCoP) is becoming an important way to access external actors novel knowledge. The ICT-based collaboration for knowledge sharing among cross-border virtual teams members generates positive impacts on the new product development of the organization.

The virtual communities of practice are ICT-based communities of practice (CoP) which bring together a group of people sharing a concern, a set of problems, an expertise or a passion about a topic [14, 20]. The CoPs are usually spontaneously emerging groups [14], however, in the actual unstable environment, organizations play an important role in their creation, support and development [21].

Furthermore, many scholars showed the role of trust through an efficient ICT-based collaboration. Trust is no longer a matter of face to face interactions. Within the virtual community of practice, the members are the basis for its efficiency; If members have strong ties, trust is one of the key determining factors for achieving innovative outcomes. In the VCoP, not all members know each other, thus acting as if trust is already existing and this is referred to as the swift trust developed by [22]. As the VCoP grows and its achievements are tangible as swift trust becomes more important.

The authors [23] have developed strategies and behaviours to facilitate trust building in virtual teams. Among others, optimistic team-spirit and dynamic leadership are of high importance. The first one is related to motivation; motivation raises trust [24] and knowledge sharing, in the VCoP, requires motivation and more precisely intrinsic motivation. For that, reward systems are efficient methods providing incentives to the VCoP members. In the literature, there are two different points of view regarding the reward systems; some state the non-financial (intrinsic) reward systems contribution to the enhancement of knowledge sharing [25, 26], whereas others discuss the financial (extrinsic) [27] reward systems; our case study uses a non-financial reward system.

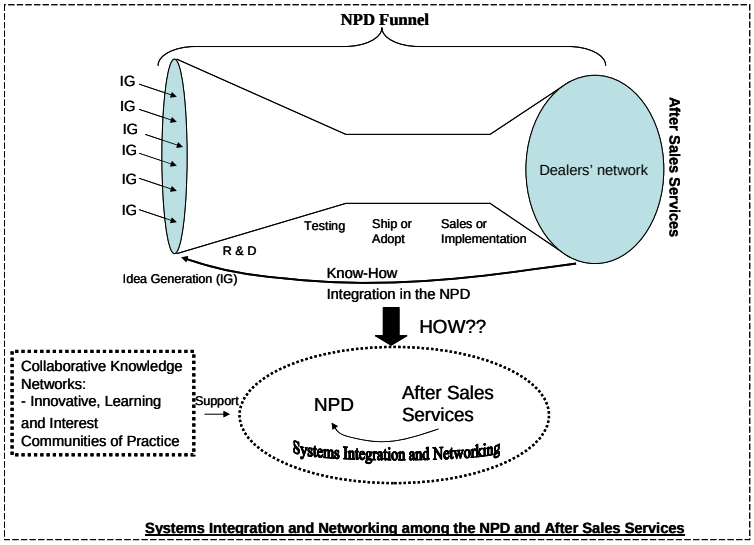
On the other side, dynamic leadership is related to the catalysts monitoring and organizing the entire virtual community of practice. The development and performance of the VCoP is also depending on the catalysts. In the

literature, they are called knowledge brokers [28-29] and gatekeepers [30-31]. The gatekeeper is a boundary spanner responsible of monitoring the external knowledge coming inside the organization and deciding on the relevant knowledge to the innovative activities of the organization.

3 Case study

3.1 Our model: The innovation funnel of the automotive company

By applying the concept of the innovation funnel, the dealers' network know-how can be integrated in the NPD processes, and by this increasing the innovative performance of the automotive company. The innovation funnel represents the innovation steps by which the product goes before being produced. The automotive company is following the fifth generation innovation model based on [32]. This model- Systems integration and Networking (SIN) model considers the creation of networks for the integration of new expertise and know-how in the innovation process. In fact, by creating networks among the dealers' network and NPD process of the automotive company, it is possible to improve the innovative performance of the extended enterprise.



Besides, as an extended enterprise, the automotive company has unclear boundaries and applies a win-win approach with its partners. For that, its interactions with the dealers' network take the shape of CKN [33] in which knowledge is created and shared. Therefore, the CKN for learning and knowledge sharing allows the continuous development of the innovation process.

3.2 Research questions

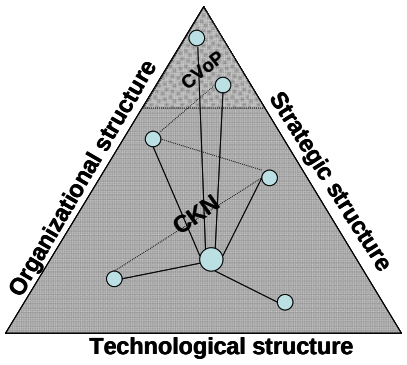
Through this paper, we are elaborating a model representing the collaborative relationships among the automotive company and its dealers' network that leads to knowledge creation and sharing about the automobiles components and services of this extended enterprise.
To address this issue, this study framed the following research questions:
- How are the mechanisms involved in the interaction among the extended enterprise and the dealers' network?
- How do the collaborative tools and processes impact on the CKN?
- What are the successful outcomes and challenges of the CKN among the extended enterprise and the dealers' network?

3.3 Research Method

Research into the CKN was undertaken using case study method [34]. Individuals involved in the management of the CKN were identified and interviewed using a semi-structured questionnaire. The reason behind choosing this type of interviews is to encourage the interviewees to provide detailed, elaborated answers. The interviewees are the top-managers responsible of the entire dealer's network, and the middle managers responsible of specific activities carried out within the CKN. Thus, data were representing different levels and perspectives of management.
Besides, we analyzed the state of the art of the interaction among the dealers' network and the automotive company. We noticed that the CKN among the automotive company and the dealers' network is mainly supported by information and communications technologies and professional trainings for knowledge sharing and learning. Through a questionnaire, dedicated to the members of the dealers' network, we investigated on the perceived ease of use and usefulness of those two previous main collaboration means in the development of the CKN. This questionnaire was dedicated to a significant representing sample from the very large population of the dealers' network.

4 Exploratory Results and Discussion

The interaction among the automotive company and the dealers' network takes the shape of a collaborative knowledge network through which informal and formal linkages are created. The main player in the CKN is the automotive company orchestrating the interaction among all the actors of the CKN. The dealers' members of the CKN are embedded to the EE through weak and strong ties. However, some CKN members have an additional special relationship with the EE in which they interact directly with it; they formed a virtual community of practice (VCoP) in which more technical knowledge is shared and integrated in the new product development of the EE.
The organizational, strategic and technological dimensions of the interaction among the CKN members represent the way in which the EE deals with its external partners providing after sales services to the EE customers. Through the following sections, we describe the three dimensions of the embeddedness in the form of mechanisms to explain the interaction among the CKN members, the success factors providing competitive advantage to the EE and some challenges to analyze in order to sustain the EE development.



Title: Three dimensions of the organizational model representing the automotive company and the expert dealers and dealers network interactions

4.1 Collaborative knowledge network mechanisms

On one hand, mainly, most of the collaboration among the automotive company and its dealers' network is ICT-based. Many tools are used to satisfy different purposes but always creating a bi-directional knowledge sharing

environment among the automotive company and the dealers' network. For instance, one of the IT tools, analyzed during the research, is dedicated to solving technical problems related to cars. An efficient procedure is followed in which one of the dealers' network members communicate interactively the car problem faced to the automotive company and this later gives feedbacks to the entire dealers' network in the form of e-service news, thus, spreading one CKN member knowledge in the whole CKN- this is a part of the codification strategy [35] of the automotive company in which it calls for a high codification infrastructure which results in more knowledge reuse via person-to-document exchange.
Another instance is when the automotive company provides the dealers' network, on a regular basis, with an updated IT tool for diagnosis analysis for the inconveniences in cars brought by customers in the dealers' workshops. These tools support the technicians in their labor on cars. Thus, through the diagnosis tool, the automotive company shared its knowledge with dealers about the way the inconveniences in cars might be discovered.
On the other hand, the CKN is profiting from professional trainings for knowledge sharing. The purpose of the professional trainings is to gather the members of the dealers' network, in a face-to-face manner, to share their knowledge with each other and especially to grasp and exchange new knowledge with the automotive company. The technicians of each dealer's network member are the main focus of these initiatives since they are the knowledge workers directly interested by the professional trainings. In fact, in addition to the IT tools mentioned in the first paragraph, the professional trainings are efficient means of creating, processing and enhancing the technical knowledge of the dealers' network knowledge workers.
The ICT-based collaboration among the CKN members encouraged the creation of work groups, and communities mainly based on ICTs. For that, the expert dealers VCoP do not meet any barriers to its development. Since the expert dealers are already adapted to the use of ICTs provided by the automotive company, the ease in which they use the VCoP webpage to share their knowledge allow us to state that the VCoP relies productively on ICTs. The expert dealers VCoP webpage is hosted by several other ICTs used by the entire dealers' network, but obviously only the members have access to it.

4.2 Some success factors

There are many factors leading the CKN to be successful and innovative. From the organizational point of view, the CKN members are all from the same country which facilitates communication and avoids possible misunderstandings that might occur generally as a result of different cultures, and more specifically as a result of different work processes, different languages, and/or different types of leadership [20]. In fact, belonging to different enterprises and being geographically dispersed in their nation did not create any major obstacle to their collaborative knowledge network. As small and medium enterprises, and independent organizations from the automotive company, the dealers' network members take advantage of the ICT-based collaboration and of the sustainable opportunities offered by the automotive company to create an inter-organization collaboration based on trust and motivation.
Besides, the expert dealers have some privileges in comparison with the other dealers in the network, thus, this can encourage the dealers' network members to work more dynamically to attempt to integrate the VCoP. In fact, as members of the VCoP, the expert dealers have more advantages than other dealers in the automobile market; Informing the dealer's customers of its membership in a dynamic VCoP created by the automotive company can have a positive impact on the image and credibility of the dealer and offer the VCoP members prerogatives in the dealers' network.
The VCoP members receive direct resources from the EE and are officially sanctioned by the organization. Since the VCoP has been created by the automotive company, it is fully financed by this later and even provides incentives to the expert dealers to increase the chance of their participation to the VCoP; The reward system is non-financial and provide good incentives to the VCoP members each time their contribution to the VCoP is valuable and significant. Thus, the organizational structure of the VCoP promises significant outcomes and important changes in the new product development of the automotive company.
The main objective behind the creation of the expert dealers VCoP is the integration of their know-how in the new product development process of the large automotive company. For that, the VCoP catalysts consider the expert dealers as dynamic and in possess of innovative capacities that contribute to the sustainability of the products and services of the automotive company. Not only does the VCoP catalyst have the expert dealers trust, built through a long-term collaboration with the automotive company, but they also show them that their participation in the VCoP is very significant and highly appreciated by the EE. This creates a sense of belonging and motivation among the

VCoP expert dealers and they fully agree on sharing their know-how and experience with the automotive company through the expert dealers VCoP.
In addition to their role as leaders in the expert dealers VCoP, the catalysts are also the gatekeepers of the community. In fact, they are the ones responsible of filtering the knowledge shared by the expert dealers and evaluating its relevance to the new product development process of the automotive company. As a strategic position in the VCoP, the gatekeeper must have expertise in the dealers' field and have a critical attitude toward the knowledge shared to extract the most relevant one.

4.3 Some challenges

The main issue that can probably slow down the CKN operations is the computer self-efficacy [36] of the dealers' network members. In fact, computer self-efficacy refers to a judgment of one's capability to use a computer. The dealers' network members are small and medium enterprises consisting of average skilled technicians in ICT use, thus, often their use of computer is limited since their work-focus is mainly cars. However, the automotive company is aware of that and offering professional trainings and tutoring to facilitate the dealers' network members understanding of the importance of being able to use computers in their everyday work.
Besides, it is important to mention that the dealers' network members' perceived ease of use and usefulness of the IT tools provided for the collaboration in the CKN is critical for an efficient collaboration. Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance [37] and perceived ease of use, in contrast, refers to the degree to which a person believes that using a particular system would be free of effort [37]. These two concepts are directly connected with the computer self-efficacy level of the dealers' network but also with the efficiency of the IT tools provided by the automotive company. These two concepts give good insights on IT elements that might need some modifications for better outcomes.
Finally, concerning the CKN organizational structure, we noticed that the small and medium dealers enterprises have different connections' types with the automotive company; the medium enterprises are connected directly and have strong ties with the EE, whereas the small ones have weak ties with the automotive company since the medium ones play an intermediary role among them and the automotive company. According to [38], weak ties increase innovative capacities, allows a faster working process, and facilitates access to resources. However, the small dealers' enterprises still have some difficulties to access IT resources because of the medium ones' intermediary role.

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Knowledge Repositories for Rural Communities of Learning

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Abstract. Knowledge Repositories can be a potential solution in order to cover agricultural professionals' lifelong learning needs. An application area of particular interest is the one of digital learning repositories (LORs) which are digital repositories that are created in order to provide access to digital educational materials and the nature of their content or metadata reflects an interest in those materials being used in an educational context. In such repositories, educational metadata play an important role since they allow the description and categorisation of learning resources using widely-accepted, interoperable and reusable metadata specifications and standards. In this initial stages of my PhD research, we study the design of appropriate educational metadata for LORs that aims to support vocational training of small and medium enterprises (SMEs) communities in rural areas and also we will develop a final repository system. Finally we will identify the lines of initial stages of my PhD research based on the convergence of these areas and we will outline the proposed directions of this research.

Key Words: *Agricultural Education, Knowledge Management Systems, Learning Communities, Metadata.*

1. Introduction

Information and telecommunication technologies have greatly enhanced access to learning for people living and working in rural and remote locations, which are unable to attend campus-based institutions. This fact has been widely recognized by both learning institutions and rural and remote communities for many years [1].

Even today, that we can approach knowledge more easily, still there are special groups of people that cannot reach knowledge or hesitate to approach it. One characteristic case is the rural sector, where specialists (e.g. agriculturist) and also the final receivers/enterprises (e.g. farmers) in Greece, cannot have access to this knowledge. The country's geography, with thousands of islands and varied morphology all over Greece makes traditional learning methods to be hardly adjustable, especially to these educational groups.

A study of USDA Agricultural Resource Management [2] shows that 55% of farmers had PC and 43% of farmers had connection with the Internet in America. A study from UK Department for Environment, Food and Rural Affairs [3] shows that in UK 60% of farmers had PC and 23%

connection with the Internet. A national research for ICT use in Greece shows that 34% of SMEs have PC and only 18% use internet.

In this part, we should add in order to understand the meaning of knowledge technology not being concluded in the agricultural field and the importance of the agricultural field in Greek and European economy. The rural sector participates in his employment of one fifth almost active population, (opposite 6% in the E.C. (European Community)). The Greek farmers exceed the 10% of farmers of E.C., the moment while the population of our country constitutes hardly the 3% of population of the E.C. The rural sector contributes in the 12% of G.N.P. (Gross National Product) and possesses the 30% of total of exports of our country. More specific the Greek plant products constitute the 6.3% of E.C. plant production, and animal cover the 2.5% of E.C. animal production [4].

Internet increasingly becomes a dominant medium for learning, training and working, and learning resources are continuously been made available online in a digital format. There is a foreseen potential for agricultural stakeholders, such as small and medium enterprises (SMEs) in rural areas, from having access to such online resources. Agricultural stakeholders represent groups of potential learners with particular educational needs, which require them to be continuously trained on new topics and subjects.

The aims of this PhD project research are:

1. To develop a LOR for agricultural users.
2. To facilitate creation of several pilot online learning communities of agricultural actors (SMEs from the business sector of agriculture and new farmers).
3. To execute evaluation experiments on the use/adoption of the LORs from the pilot communities.

2. Problem domain and research questions

A new farmer should know how his professional environment will be. The factors however that influence long-lasting the international and E.C. agriculture are so fluid that any forecast becomes impossible. We can however appreciate that the progress of technology and biotechnology will involve increase in the offer and in the variety of rural products. While by the side of demand is expected increase because doubling of population of ground. The Greek agriculture faces today the challenge to be adapted in a particularly difficult and permanently altered international environment. For this Greek agriculture should overcome structural weaknesses and develop its comparative advantages.

The prospect actually is found in the new farmers and we speak substantially for a new generation of farmers which have in their disposal more enterprising motives, the possibility of acquisition, of viable exploitation and mainly more knowledge from the older generations. Perhaps the most important supply for a new farmer is information and that is because as a businessman he should know the market, the possibilities that are offered to him through programs, but also to be informed on time, for the development of new technologies and new cultures or methods of culture. Right and convenient information gives the possibility of taking right decisions and drawing in the long run. The season where the farmers without education,

transmitted the knowledge and their experiences orally from generation to generation has expired. The current requirements are high and require high agricultural education.

All this changes affect also the agriculture universities which must face the challenge of providing education based in the rapidly growing, increasingly global, and highly technological food, fiber, and natural resource system [5].

The learning environment for agricultural students is as difficult as the teaching environment for agricultural faculty. Generally distance education students are older and are coordinating various job and family commitments with their learning opportunities [6]. Obviously they don't have as much communication with each other as in a traditional class and they are forced to rely on the technology and their good knowledge of it in order to complete the online course successfully.

Educational metadata play an important role in LORs, since they make access to the learning resources faster, easier and more effective. To support the development of LORs, using recognised metadata standards is important for a variety of reasons: metadata descriptions may be exchanged among different LORs, search queries may be propagated among different (and interconnected) LORs, and generally the integration of data from different sources is facilitated. An issue that requires particular care when developing LORs for agricultural and rural stakeholders, is the fact that learning resources for such learners have to reflect and match their special requirements (e.g. linguistic preferences, regional geographical coverage, particularity of covered topics, and educational level of addressed audience). This calls for the development of standard-based, context-specialised metadata when building LORs for agricultural and rural stakeholders.

Identifying problems:

1. Unexploited opportunities offered by Technology Enhanced Learning (TEL) and LORs in specific.
2. Late adoption of LORs from agriculture actors.
3. The existing pilot studies that do not cover all the parameters of TEL applications in agriculture.

So the research questions are:

1. What specific design and development is required for agricultural LORs?
2. What kind of learning communities can emerge?
3. How useful/effective do the community members find the integration of LORs in this learning activities?

3. Methodology

3.1. Creating LOM Application Profiles for Agriculture

A common vision that may serve as an enabler for sustainable development, environmental preservation, and fighting hunger in the world, is the involvement, collaboration and coordination of activities dealing with the production, organisation and exchange of agricultural resources. In

this direction, initiatives such as the Agricultural Information Management Standards (AIMS) of the Food and Agriculture Organisation of the United Nations (FAO) have been launched to involve as wide a sector of the agricultural community as possible [7]. The use of agricultural metadata standards makes it easier to integrate data from different sources allowing for creation of value added services such as simple aggregated subject-based views, automatic news feed services etc. Important results have been produced as an outcome of this collaborative effort, and are already put in practice around the world.

There have been several approaches in developing educational metadata schemas or application profiles for agricultural learning resources. Several approaches are application profiles of the IEEE LOM standard. For instance, the CGIAR LOM Core has been created by the Consultative Group on International Agricultural Research (CGIAR) in order to describe its learning resources in a manner that best suits its content, purpose and audience [8]. Another IEEE LOM application profile if the one from the Bio@gro initiative [9] which was created in order to categorise available online educational resources that are related with Organic Agriculture topics. A recent approach is FAO's Learning Resources Metadata [10], which is based on Dublin Core metadata standard [11], also borrowing some elements taken from IEEE LOM.

3.2 LORs with agricultural Repository development

Our aim is the design of a LOR that it will focus in education of SMEs of rural sector of region and new farmers. For this aim a web based repository will be developed and afterwards a network environment for access and search in the content of this repository. The system will include advanced search of learning objects, which will be based on the experience of previous users (as this it has been recorded in the evaluations that will be available in the web based system).

3.3 Content that experts will populate

Then experts will give content on using e-services for farmers and other small entrepreneurs of rural areas, and content on agricultural and geosciences topics for young agricultural experts and students of agricultural universities.

3.4 The Community Environment

Our next step is to use existing communities that will use the system for their educational needs. For this reason we will locate existing communities and then we will go over these communities trying to find out their special characteristics and their educational needs. These communities will constitute the sample of our experiment and they will include SMEs from the business sector of agriculture and new farmers. A recent research on these groups has shown that 55% of these groups classify themselves as having either a very good or good PC skills. Also 56% considered that they had either a great deal or a lot of internet experience and 63% had a broadband connection [18].

3.5 Design and execute pilot testing in selected communities

Afterwards some pilot trials with real users will accomplished, and results will be collected and analysed, in order to trace a control mechanism of old users' choices. Then it will provide in the users indications of appropriateness and usefulness for the training objects of the repository.

4. Progress so far

At the time of writing, the most developed PhD research has been done in the field of existing LORs. A survey of 59 well-known repositories with learning resources has been done and their characteristics have been examined [12]. From them a set of 27 covering agricultural topics have been identified. The results of this study revealed that there are indeed LORs that offer learning resources that are of interest for the agricultural actors. The main topics covered are agricultural and forestry equipment, agricultural chemicals, agricultural systems, agricultural waste, agronomy, biotechnology, cultivation and harvesting, environmental impact of agriculture, farm and horticultural structures, farm diversification, organic farming etc. This initial PhD research gave us the opportunity to formulate a general picture about their nature and status of development of the most well known existing LORs. The contributions so far in this direction can be considered so far rather sporadic, focused on very particular topics, or restricted in coverage. This is also shown and from the fact that from 881000 resources only 3200 have a direct relation with agriculture [13] [14] [15] [16] [17].

Currently we are going to develop a LOR with resources for the vocational training of rural SMEs on e-Government services and technologies, allowing users to search, locate and access listings of training resources. This requires the development of an appropriate metadata schema that will implemented to support LORs functionalities. For the description and classification of the Learning Objects of the LORs, an application profile of the IEEE LOM standard has been developed. More specifically, an IEEE LOM application profile is proposed with particular attention to language, audience and classification according to our community needs.

5. Discussion and Conclusions

In this research we present the general plan and the initial work that has started being carried out in my PhD. The main goal of our work is to develop a LOR specially design according to agricultural users needs. We also plan to facilitate creation of several pilot online learning communities of agricultural actors in order to execute evaluation experiments on the use/adoption of the LORs from the pilot communities. The suggested solution is different because there are no similar studies in the field of evolution and also there are open research questions at the development of agricultural Application Profiles for Learning Resources (FAO).

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