The Lifelong Learning in the University: Learning Networks and Knowledge Transferring

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Abstract

Practitioners must continually update their skills to align their professional profile to market needs and social organizations in which they live, both characterized by extreme variability and volatility.
In this scenario, Universities, the traditional Institution for the knowledge transferring, assume the role of an institution dedicated to lifelong learning.
However the lifelong learning highlights several issues that make it unsuitable to the university instructional models.
In order to face this problem the authors propose to use a Learning Network model integrating a Knowledge Base Experience (Prometheus) to support distribution of contents and to the enhancement knowledge transferring.
The results of an empirical experimentation encourage their adoption in real contexts.

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1 Introduction

The European Society of Education Association (ESAE, 2007) defines the Lifelong Learning as "all learning activity throughout undertaken life, with the aim of improving knowledge, skills and competence, within a personal civic social and/or employment related perspective".

Lifelong Learning is able to support rapid changes, skills and processes typical of the providing benefits for information society both the individual and the context in which it operates. A summary of such benefits is in (Nordstrom, 2008) which underlines the benefits as related to the its increasing of the network of relationships; while commitments of the World Bank, of UNESCO (Delors, 1996) of OECD (Centre for Educational Research and Innovation, 2004) and the European Commission (Commission of European Community, 2000) emphasizes the value in the corporate environment and industry.

To promote the spread of lifelong learning, some authors have identified and addressed barriers to its introduction into society (Longworth, 2003). The obstacles were divided into cultural barriers, political / economic and technological. Technological obstacles refer the access to systems offering advice on training needs gained in lifetime.

ICT has made available to designers and educators network technologies to provide mobile access to distribution systems of knowledge. These technologies do not fully satisfy the need to overcome the barriers. It is therefore necessary to design facilities that adapt to individual differences in terms of knowledge, training priorities and environmental factors.

Universities, traditional teaching and research Institutions, are the natural candidates to face the challenges that lifelong learning implies since it may be a bridge for the professional training that will continue with the same institution to maintain a relationship of training.

The lifelong learning for University therefore requires a model that meets the needs outlined above. This model should consider also the difficulty of creating homogeneous classes because of the great diversity that characterizes the particular type of learner involved.

In such contexts, the University must adopt models of the Learning Network which promote the intrinsic satisfaction of the needs described above (Tattersal & Koper, 2004). However, the status of their application in practical contexts of actual use is limited, and therefore the effectiveness of a Learning Network is highly dependent on the tools that implement it. To this end, the authors propose, as part of the Learning Network, the use of a Knowledge Base Experience, called Prometheus (PROcess practices and Methods Evolution THrough Experience Unfolded Systematically), as an operational tool able to support distribution of contents and to enhance the knowledge transferring.

The rest of the paper is organized as follows: section 2 presents an overview of lifelong learning issues and illustrates the Learning Network model used as reference; section 3 illustrates the proposed approach for knowledge representation, a Knowledge Experience Base (KEB) called Prometheus, integrated in the Learning Network model; section 4 presents the controlled experiment aimed to confirm the effectiveness of Prometheus in knowledge transferring; finally conclusions are drawn.

2 Lifelong Learning Issues and the Learning Networks

According to the most works in literature the main requirements of lifelong learning could be resumed as follows:

- the centrality that the learner takes during learning makes him self-direct, impoverishing teachers and institutions of tasks related to the achievement of educational objectives (Shuell, 1992; Longworth, 2003).
- the learner can perform various learning activities in different contexts, at the same time (Brockett & Hiemstra, 1991; Candy, 1991). This is why he has to be able to access all the proposed educational activities in order to interact on his own learning path.
- participants in lifelong learning process use formal and informal activities. Thus they need mobile access points that support access to the facilities of the system (Hämäläinen *et al.*, 1996; Whelan, 1998).
- the need to maintain a record of a individual growth in competency in a persistent standard way. An approach currently receiving much interest is the definition and use of portable ePorfolios (Mason, 2004; Koper & Tattersal, 2004.

In literature Learning Networks (LNs) are proposals to answer to the requirements presented. These networks supports seamless, ubiquitous access to learning facilities at work, at home and in schools and universities.

Software agents (Jennings, 1998) can be integrated in the architecture to support users, for example, provide recommendations on next content to study, to search and filter information and knowledge sources in the network and to help users in performing certain tasks, such as filling in forms or using the system.

In these networks the learners can be helped more efficiently while doing their homework's through the support of software agents that deal with the creation of customized learning path based on training needs identified by the learner in a process of extraction of knowledge defined by the designer of the course.

2.1 The Learning Networks Model

The Kooper – Tattersal conceptual learning network representing an LN as a graph of nodes in a disciplinary domain (Koper & Tattersal, 2004).

The nodes of the graph represent the available learning events, called Activity Nodes (ANs); AN refers to activities in support of learning. The ANs are described with their metadata (title, objective, etc) together with a link or reference to the actual AN (Koper & Tattersal, 2004).

LN represents a large system in continuous evolution, due to an Ultra Large Scale System (Software Engineering Institute, 2006). ANs provide different levels of competence within the domain of the discipline. When using the LN, actors travel from AN to AN. The path of ANs completed sequentially is called a "learning track" (Koper & Tattersal, 2004).

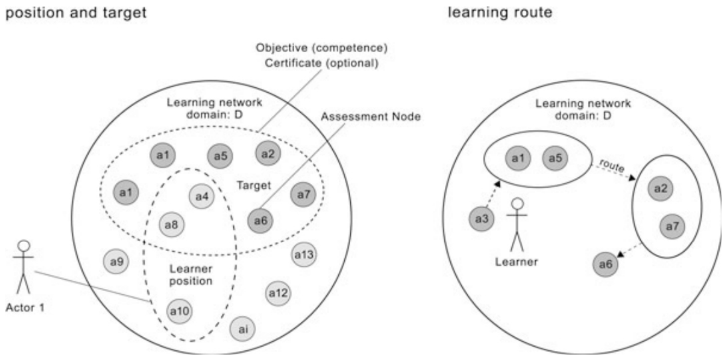

Fig. 1 - Learning network in domain D with activity nodes {a1,..., a13}

2.2 The Learning Networks Architecture

This model is specified as a UML class model (Booch *et al.*, 1999). It identifies those actors in a learning network and specifies the relationships between the entities (lines in Figure 2).

The main aspects of this architecture are:

The LNS available are listed on a website people can freely access. People can take on different roles in the LN according to certain criteria in the community. Members may be learners, teachers, experts, content providers of learning, etc. (Koper *et al.*, 2005).

The LNs themselves are not a part of the portal: the portal only describes the LNs and provides links to them. This allows also for the establishment of different portals, with world.

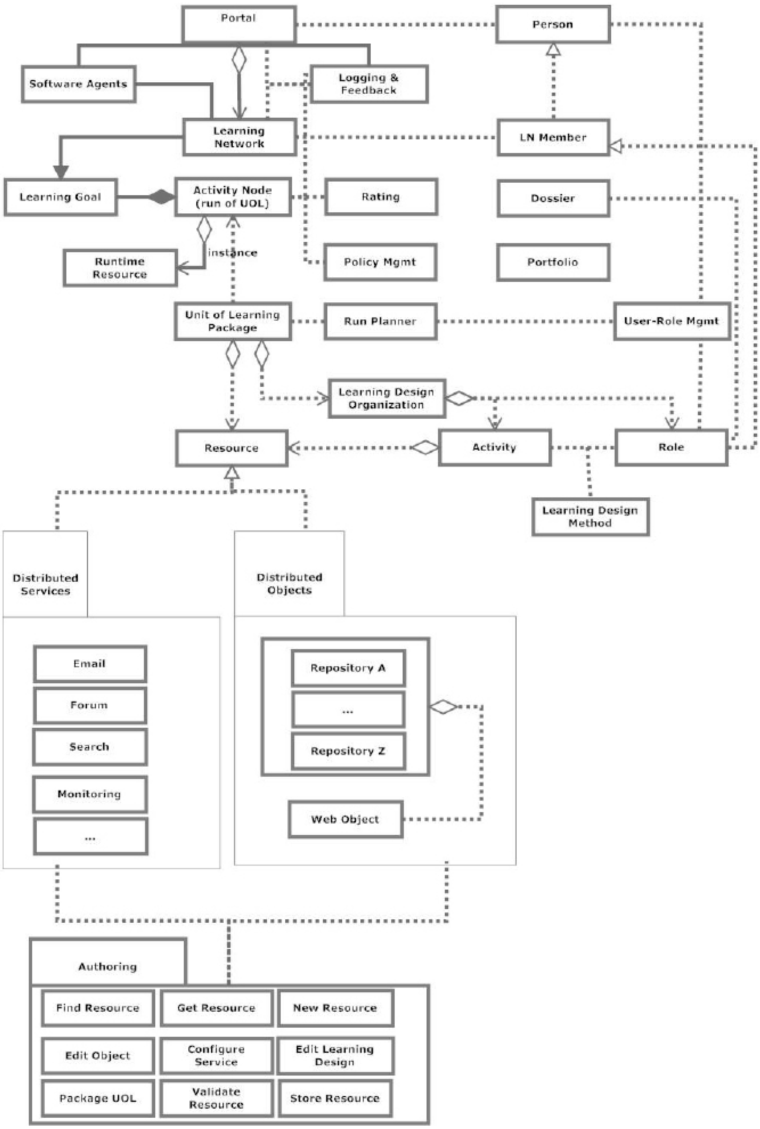

Fig. 2 - A conceptual model of the architectural learning network

3 Prometheus

Prometheus is a professional training-oriented Knowledge Experience Base (KEB) realized by the authors, more details in (Ardimento *et al.*, 2010).

The proposed approach involves the integration of Prometheus, as a specific repository in the Distributed Objects package, in the LN model shown in figure

2. The goal of the integration is to propose a way of knowledge transferring between communities that is more effectiveness than the traditional learning objects (LO).

Using Prometheus each user can access one of the package components and then navigate along all the components of the same package according to her/his training or education needs. Search inside the package starting from any of its components is facilitated by the "attributes".

It can be seen in the figure 3 that the Art & Practices is the central one. It contains the knowledge package expressed in text form, with figures, graphs, formulas and whatever else may help to understand the content (Knowledge Content – KC). The content is organized as a tree, starting from the level0 descent to the lower levels (level1, level2, …) is through pointers.

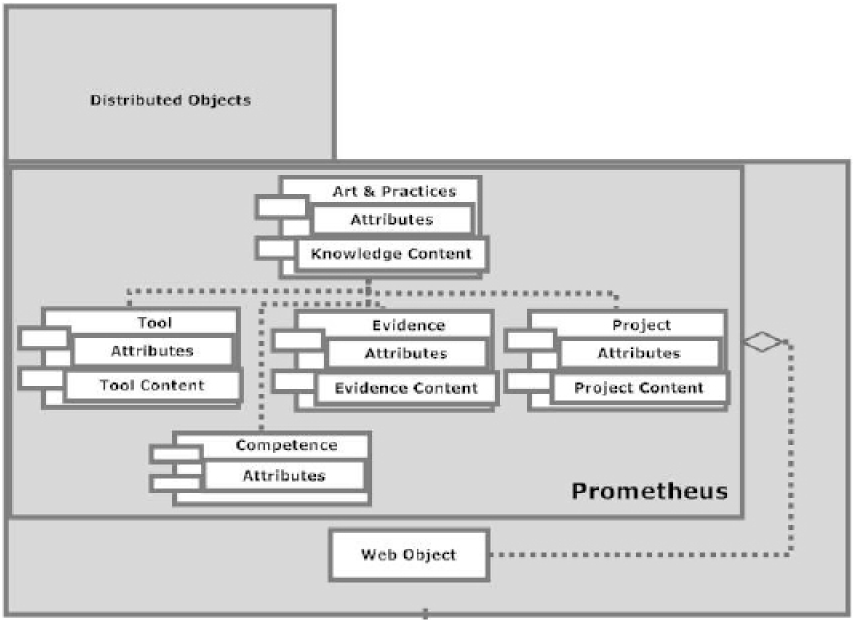

Fig. 3 - Conceptual model of the architectural learning network integrated with Prometheus

The content consists of the following: research results for reference, analysis of how far the results on which the innovation should be built can be integrated into the system; analysis of the methods for transferring them into the business processes; details on the indicators listed in the attributes of the KC inherent to the specific package, analyzing and generalizing the experimental data evinced from the evidence (Evidence component) and associated projects (Project component); analysis of the results of any applications of the package in one or more projects, demonstrating the success of the application or any improvements required, made or in course; details on how to acquire the package. The research results integrated by a package may be contained within the same knowledge base or derive from other knowledge bases or other laboratories.

To integrate the knowledge package with the competences, KC refers to a list of resources possessing the necessary knowledge, collected in the Competence component (CM). When a package also has support tools, rather than merely demonstration prototypes, KC links the user to the available tool; the tools are collected in the Tools Component (TO).

As shown in Figure 3, each component in the knowledge package has its own attributes structure to allow rapid selection of the relative elements in the knowledge base. The most important attributes, more details in (Ardimento *et al.*, 2010), are the following ones: skills required to acquire it, prerequisite conditions for correct working of the package, acquisition plans describing how to acquire the package and estimating the resources required for each activity. To assess the benefits of acquisition, also these attributes there are: the economic impact generated by application of the package; the impact on the value chain, describing the impact acquisition would have on the value of all the processes in the production cycle; the value for the stakeholders in the firm that might be interested in acquiring the innovation.

4 Empirical Validation: Case Study

The investigation aims to verify the efficacy of knowledge represented through KEP collected in Prometheus compared with equivalent knowledge expressed by a sequence of learning objects (LOs)

For efficacy we investigated whether the analysis and extraction of knowledge through a KEP requires less effort, in terms of time, than through traditional LOs. The following Research Goal has been defined:

- Analyze knowledge extraction using a Knowledge Experience Package (KEP) with the aim of evaluating it with respect to efficacy (compared to knowledge extracted from LOs) from the view point of the practitioners in the context of a controlled experiment on Prometheus.
- In accordance to the goal, the following research hypothesis has been made:
- H_{EFF0}: there are no statistically significant differences in terms of effort for solving problems assigned using KEP rather than LOs.
- H_{EFF1}: there are statistically significant differences in terms of effort for solving problems assigned using KEP rather than LOs.

4.1 Experiment Description

The dependent variable of the study is Efficacy that indicates to what point the Knowledge Representation criteria is effective for extracting knowledge and answering a specific set of questions. The independent variables are the problems examined with KEP and with traditional LOs. Two different types of problems were investigated: Software Dependability with GQM, Balanced Score Card with GQM.

We defined four questions for each problem and we chose this number because we considered it an appropriate number that balances the need for a sufficient amount of data without having to count on an excessive amount of effort and risk to bore some experimental subjects. About questions the first two questions have analogous complexity levels for both treatments: KEP and LOs. While, for the other two the complexities are different between treatments: not complex for a treatment and complex for the other and vice versa. For clearness, the answer is classified as easy to search if it can be localized in a part of the learning object, not larger than a page; rather it is considered complex if the answer to the question refers to information sparse in multiple parts of the LO that cover an area which is greater than a page. Due to the different structures of KEP and LOs, the same question may have different complexity level, depending on the knowledge representation method used.

The experimental subjects involved in the experimentation are ICT practitioners. A total of 24 practitioners have been divided in two groups (Group A and Group B) with random assignment to each one. Each group was asked to answer questions assigned using, alternatively KEP or LOs.

The experiment was organized in two experimental runs, RUN1 and RUN2, one per day in two consecutive days. Each run applied the design above. During each run we changed the content of the KEP/LOs and the content of the questions used to extract information from the source. Moreover, in RUN1, the KEP/LOs content, along with the questions for extracting information, related to Balanced Scorecard with GQM; in RUN2 they referred to Software Dependability with GQM.

Table 1 shows that within the same run the subjects use the same topic and the questions are the same.

TABLE 1
Summary of assignments for each experimental run

	RUN1	RUN2
Group A	Subjects of group use KEP on Balanced Scorecard and answer to all questions Q_1, Q_2, Q_3, Q_4	Subjects of group use LO on Balanced Scorecard and answer questions Q_1', Q_2', Q_3', Q_4'
Group B	Subjects of group use LO on Software Dependability with GQM and answer questions Q_1, Q_2, Q_3, Q_4	Subjects of group use KEP on Software Dependability with GQM answer questions Q_1', Q_2', Q_3', Q_4'

4.2 Instrumentation

During each experimental run, for each analyzed problem, experimental subjects were provided the following instrumentation: general description of the problem; the KEP or set of LOs concerning the thesis topic; set of questions related to the topic; data form in which each experimental subject must report their name, start and end time, and answers to the questions.

4.3 Measurement Model

Given the above research goal and the research hypotheses, Efficacy Factor, collected on both types of knowledge extraction treatments, is measured as the average of points P_{ij} attributed for answering the i-th question of the j-th experimental subject. The researchers, as domain experts involved in the investigation, evaluated all the answers to the questions given by the experimental subjects according to the interval scale reported below:

- Wrong Answer: the j-the subject gave a wrong answer to the i-th question: 0 points (P_{ij})
- Lacking Answer: the question was not answered by the j-the subject: 2 points (P_{ij})
- Incomplete Answer: the j-the subject gave a partially correct answer to the i-th question: 4 points (P_{ij})
- Complete Answer: the i-th question has received a correct answer by the j-th subject: 6 points (P_{ij}).

The data collected during the experimentation have been analyzed through hypothesis testing and validated with respect to a significance level of α= 5%. While, the experimental design, a 2X4 analysis of variance with a between-factor (Knowledge Representation: Prometheus vs LOs) of two levels, and a within-factor (TOPICS: Q_1, Q_2, Q_3, Q_4) of four levels was carried out, i.e. an ANOVA repeated measures analysis was carried out.

Table 2 shows that the differences in terms of mean square between Efficacy values, to each question Qi (i=1,..,4), are all significant, as it arises from the p-levels reported. In other terms we can say that KEP requires less effort for extracting information searched with respect to traditional LOs.

TABLE 2
TUnivariate test of significance for Efficacy in RUN1 and RUN2

		Mean Square	p-level	Mean Square	p-level
		RUN1	RUN1	RUN2	RUN2
Variable	Q_1	5,879	0,007	5,827	0,0151
	Q_2	18,769	0,0006	75,451	0,000000
	Q_3	47,137	0,0001	31,575	0,008
	Q_4	56,987	0,000002	30,3423	0,008

Conclusions

International indicators show the high growth of lifelong learning. The universities will have to confront in the coming years a new market, both in terms of the contents of the mode of access to them. They will be competitors with a number of Educational Institutions under and institutions in which the innovation will be the key to competitive advantage. In the paper we presented a Learning Network that integrates Prometheus in the activities of technology transfer-oriented professionals. Experimental evidence has confirmed the effectiveness but the results must be validated in a real learning network. At the same time, it checks the value perceived by the learners for integration in a business context.

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