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Technology Classification Framework for E-Learning Purposes from a Knowledge Management Perspective

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Abstract

Often there is skepticism whether there is an overestimation of the capabilities that the integration of Information Technology (IT) offers in learning. The fact that learning is contextual means that technology has to support this contextualism of the phenomenon. Many researchers claim that e-learning is just a waste of time as, the effectiveness and the performance of the effort undertaken is not interpreted in high retention rates or high learner's satisfaction. In this paper the intention is twofold: Firstly to apply a basic Knowledge Management approach in e-learning and to analyse the e-learning phenomenon as a process and as a product; secondly, to propose a Technology Classification Tool for the realization of the conceptual abstraction that the knowledge management oriented approach offers to e-learning.

Keywords: E-learning, knowledge management, applications classification, dynamic and flexible e-learning environments, metadata

Introduction

According to Ruttenberg *et al.* (2000), several vendors and various applications in the e-learning space provide a toolkit-based solution. The anticipated perception is that these platforms are the key points for the success and the implementation of e-learning. Another common approach in e-learning is the do-it-your self-way of implementation. In this case some technology experts develop a system through which learning content is delivered to learners. Some other implementations of e-learning systems are based on a combination of technologies that jointly formulate an e-learning "bouquet" within a specific business or academic context. The critical question concerning the selection of an appropriate technological solution deals with the assessment of the potential value of an e-learning platform.

Consequently, this starting point is forcing decision makers to seek for characteristics that the common practice pose as the typical standards for e-learning implementation. This kind of benchmarking is not the best guide. Many times the e-learning implementation suffers due to the inability to provide a value proposition to learners (Lytras and Pouloudi 2001a). But let us consider what an e-learner expects from an e-learning system: The main concern is to learn and overcome the fear to operate the technology supported e-learning environment. In other words learning is the ultimate objective and technology has just to play a supporting role securing the facilitation of learning process.

It is difficult to measure the learning outcome. The embedded learning pedagogy in e-learning platforms is not the key performance criterion in many cases of evaluation (Lytras and Doukidis 2001d). Many people have tried to propose ways for describing learning value. Two of the most important works in the field reported by Bloom and Krathwohl (1984) and Shuell (Shuell 1992) attempt to describe ways that the learning outcome varies in terms of different value layers. In such cases, a conceptual analysis can be undertaken, that can be embedded in e-learning systems. The major problem in technology-supported learning is not the technological availability. This paper investigates the role of technology in the e-learning landscape and it analyses it from two specific perspectives: (a) learning can be treated as a process and (b) as a product.

Investigating the Role of Technology in E-Learning Landscape

The activity perspective of e-learning is really challenging. In every e-learning implementation several entities interact formulating a context where a variety of issues pose a significant influence. The technology support can be revealed if the various interchange between the entities analysed in detail.

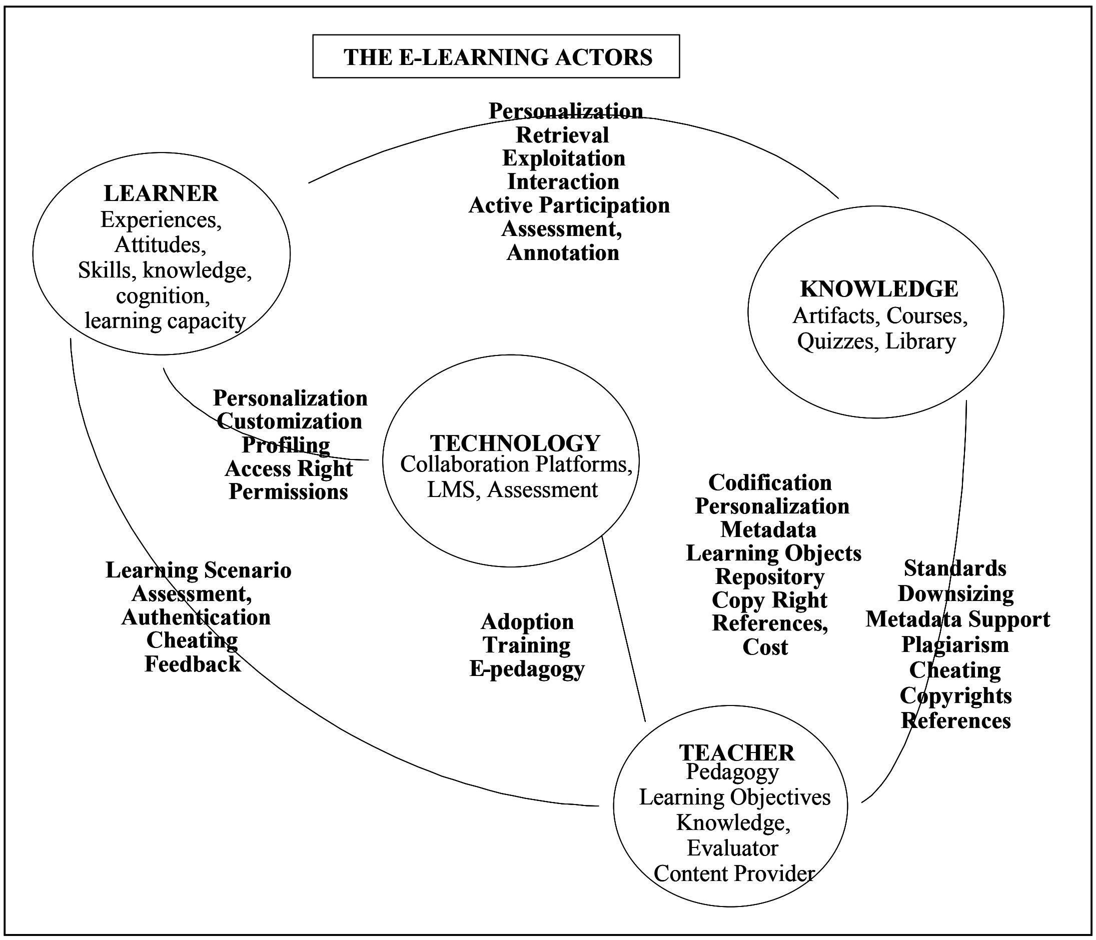

Figure 1. Issues Related to E-Learning Actors

The Learner–Knowledge Path

The learner–knowledge path depicted in Figure 1, highlights critical issues like:

- The personalization of knowledge to specific learner needs,
- The capabilities for effective retrieval of knowledge,
- The exploitation of knowledge through scenarios that do not simply post static content.
- The annotation of content and the reveal of tacit elements of knowledge

The case of knowledge and its embodiment on learning content is not an easy task. Especially in an e-learning environment the definition of what knowledge can be or which knowledge strategy can be implemented is of critical importance. Table 1 summarizes four knowledge approaches reported in normative literature. In Figure 1 Teacher, Learner, Knowledge and Technology define the basic construct of our analysis. The depicted linkages require an investigation concerning technological requirements.

Table 1. Knowledge Category Models

Framework	Categorization Dimension	Knowledge Types
Boisot (1987)	Diffusion / Codification	Proprietary, Personal, Public Knowledge, Common Sense
Hahn and Subramani (2000)	Locus of Knowledge / Level of a priori Structure	
Nonaka & Takeuchi (1995)	Codification	Tacit / Explicit
Heldund & Nonaka (1993)	Knowledge Agents / Codification	

The approaches of Nonaka and Takeuchi (1995), Heldund & Nonaka (1993) and Boisot (1987), provide an overview of the various knowledge types that can be found in an e-learning environment. From this perspective the knowledge can be *explicit* (implying codification and expression in standard format) and *tacit* (not espoused but silent and incorporated in perception, opinions, know how, experiences, and behavior). The diversity of personal characteristics of e-learners requires a twofold manipulation mechanism for both explicit and tacit knowledge in e-learning environments. The projection of this statement justifies the need to secure also except codified knowledge in artifacts (learning objects), un-codified knowledge, which resides in learners (according to (Hahn and Subramani 2000)).

The proposition of Heldund and Nonaka (1993) is that the source of knowledge could be the individual the group or the organization. In an e-learning environment it is evident that these entities can be identified as knowledge sources. The individual as learner, teacher or content provider provides codified or un-codified knowledge to the system. Another important aspect in e-learning is the community of learners: individuals who use technological means and exchange parts of their cognitive or intellectual capacity (usually un-codified). From this perspective the way that experiences, opinions or annotations enrich a general knowledge base within an e-learning system are of high priority in the direction of e-learning performance. The simplest way of doing this could be through the annotation of learning content or the recording of on-line discussions.

Another important aspect of the knowledge management in an e-learning system is the diffusion of knowledge as it is defined in the model of Boisot (1987). The requirement to secure effective diffusion is depend on codification since this corresponds to personalization as well as on the specification of how knowledge is carried from its source to its users. In this direction the distinction of the model of (Hahn and Subramani 2000) that distinguish the locus of the knowledge and the level of a-priori structure is very interesting. It is not obvious in e-learning systems the capability of the available functionalities to manage structured or unstructured learning objects ((knowledge artifacts or individual experiences). Moreover, the investigation of the life cycle of knowledge within an e-learning system through transformation actions as described by Nonaka and Takeuchi (1995) (internalization, externalization, combination, socialization can be used to analyze the way that knowledge is generated and continuously renews the knowledge base of an e-learning system.

The Knowledge – Technology Path

In this path the technology is mainly responsible to provide support for the effective management of knowledge: In Figure 1, some important issues are illustrated:

- The codification that permits personalization
- The establishment of an effective metadata mechanism
- The realization of learning objects as well as learning objects repositories
- The cost of managing knowledge in terms of undertaken effort

The Knowledge – Teacher Path

The role of teacher or author providers within an e-learning context is mainly knowledge-oriented. The path that linkages these two entities incorporate a number of important issues such as:

- The adoption of standards that specify the adoption of knowledge to learning content
- The downsizing or book-based content to functional learning objects for e-learning exploitation
- The promotion of metadata that characterize the learning content and correspond to a clear pedagogy
- The protection of intellectual property rights

The Knowledge – Technology Path

In an e-learning system the teacher is directly linked to the technology that support the learning context. In this environment the most important issues are:

- The utilization of the technology for the adoption of several information sources to motivating, reusable learning content
- The training of teachers in the usage of technology (from basic computer skills to advanced e-learning technologies capabilities). This dimension of this path is affecting the performance of the whole implementation. Several times the limited ICT skills of teachers impact their capacity to initiate e-learning courses or to demand more from the technology.
- The embodiment of pedagogy through the selection of specific technologies. The learning emphasis on e-learning implies that the major effort has to be paid on pedagogical issues that justify the value aspect for e-learners.

Another very interesting but underestimated theme is the ethical dimension of technology usage, which is related to Copyrights, Intellectual property rights as well as licenses fees.

The Teacher – Learner Path

In an e-learning system the teacher and the learner(s) interacting through the available learning scenario. The technology has to support the assessment through authentication mechanisms permitting extensive feedback and no cheating.

The Technology – Learner Path

In this path the technology is mainly responsible for the personalization and the customization of learning content. The packaging of learning content to learning objects or learning modules is accomplished through technology. The secure of motivation, problem solving capabilities, and other dynamic features require more complex technology and increase the cost. The development of learning content is a time and money-consuming task. The establishment of dynamic mechanisms that diffuse the learning content to learners requires sophisticated technologies and more effort from content providers side.

A Twofold Approach to E-Learning

The previous section highlights several aspects of the e-learning landscape. The justification of technological requirements for effective e-learning implementation requires scalability. The technological complexity seems to affect the e-learning effectiveness which means that the more sophisticated the technology the more effective the e-learning it is. But sophisticated technology is not panacea. The existing technologies are so flexible and dynamic that through their integration can support sophisticated solutions. Several approaches from Knowledge Management literature investigate this phenomenon from two perspectives: The perspective of knowledge as a *process* and the perspective of knowledge as a *product*. The authors believe that this contextual abstraction can facilitate the analysis of the e-learning. The reason for this is that e-learning is (a) a process, which indicates specific transformation and (b) diffuses as a product to learners. This admission consequently poses two critical questions:

1) Can we distinguish processes that describe the phenomenon of e-learning exploitation?
2) Can we define the ingredients of the e-learning product?

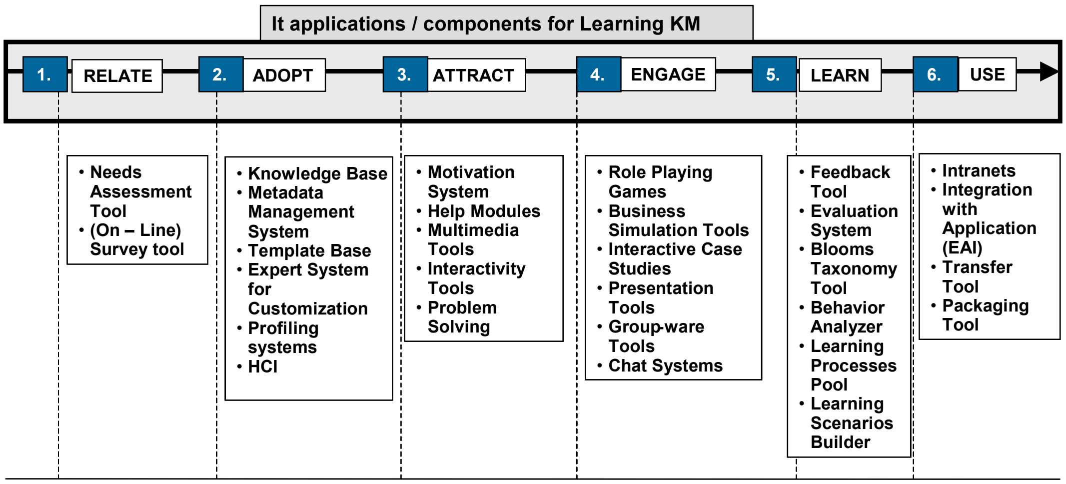

Figure 2. IT Applications for Learning Support (Source: Lytras and Doukidis, 2000)

Lytras *et al.* (2001g), investigate a number of application modules based on the Multidimensional Dynamic E-learning Model. This model recognizes three critical dimensions for the effectiveness of learning initiatives that utilize information and communication technologies: Knowledge Management, E-learning pedagogy and Enterprise Application Integration (EAI).

A first implication of this approach is the capacity to propose a two-dimensional map according to the model proposed by (Woods 1998) which emphasize on the categorization of several applications that support learning. In Figure 3, learning as a process and learning as a product are depicted in the two axes. In each dimension there is a scaling according to the distinctions that where made: Learning Product is a combination of six elements as well as there are 6 learning processes that describe the life cycle of learning.

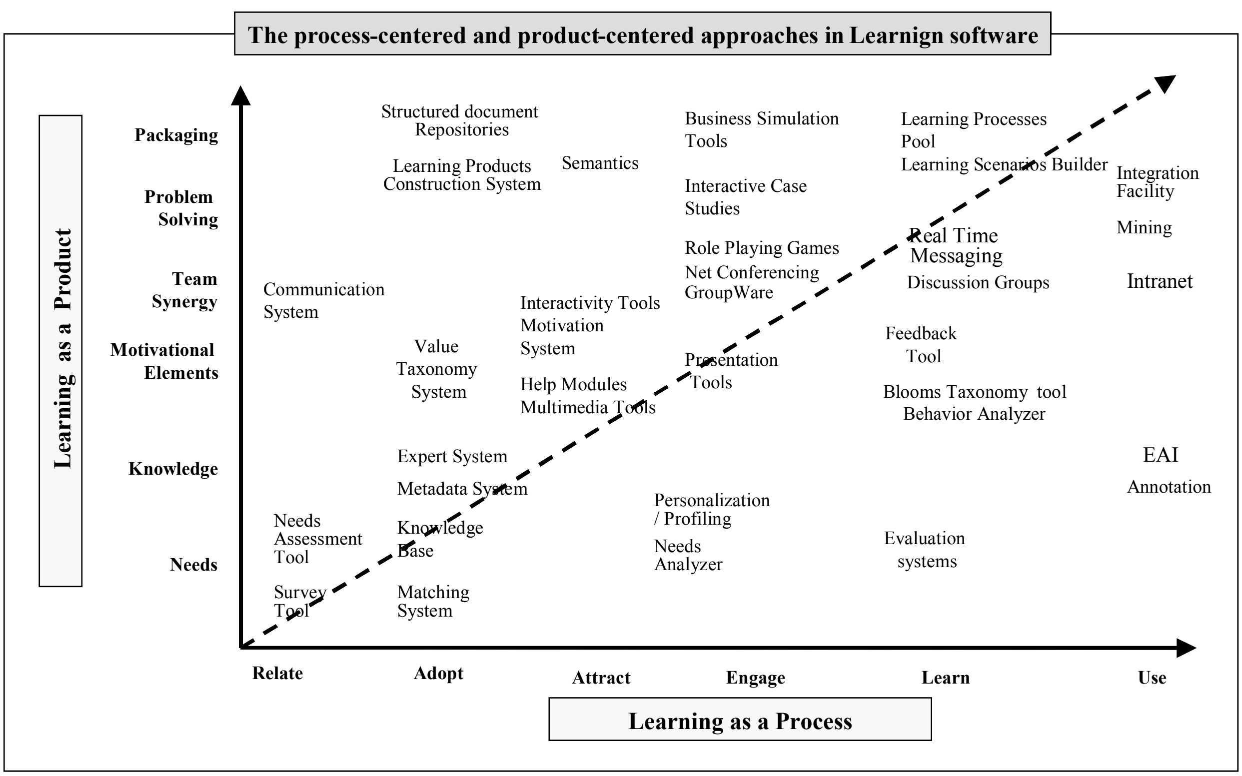

Figure 3. The Process and Product-Centered Approaches in E-Learning

This two dimensional abstraction can be used to provide an overview of technological components that potentially empower the e-learning performance. The proposed categorization of Figure 3 provides an insight on how several applications support specific value constellations within a business context from a learning perspective. In this categorization the specified scaling permits the anticipation of the potential capacity of each technological component to realize the several value components of learning product as well as to support specific learning processes. This map requires an extensive explanation. The basic idea is that the twofold approach to learning can be realized in business units if a number of infrastructures provide knowledge and a learning web. The infrastructure refers not only to IT applications but also to "soft" issues that reveal the role of the social parameters that constitute a socio-technical environment.

The two axis of the depicted model present a scaling. The allocation seems to be incrementally but the scope of the matrix is not to provide a value hierarchy. It could be manipulated in a way that the scaling and the depicted points in each axis could be from the lower value to the higher. This is maybe another research task. But to the point the initial research objective is to promote a technological classification tools that corresponds to each conceptual perception several application modules.

The two dimensions in figure three are closely related. In the horizontal axis the depicted processes that formulate the e-learning spectrum from a process perspective are namely:

1. Relate [to learning needs],
2. Adopt [to functional learning content],
3. Attract [to motivate learners]
4. Engage [to foster active participation and knowledge exploitation]
5. Learn [through activation of previous experiences and tacit and explicit knowledge exchanges]
6. Use [to solve problems].

In the vertical axis 6 e-learning product ingredients are distinguished:

1. Needs [refer to learning needs]
2. Knowledge [both explicit and explicit / codified – un-codified]
3. Motivational Elements [to secure attractiveness of learning product]
4. Team Synergy [to foster team learning and to exploit the effects of putting together minds]
5. Problem solving [to enhance the applicability of the delivered learning content in real word settings]
6. Packaging [to tap learning content in functional pieces that permit reusability and flexible diffusion].

From this point of view in a real case of e-learning system design and implementation then the critical decision is to select the processes that will be supported through technology and the components of the learning product that have to be incorporated to the product at the stage of its development.

The presented classification can be read in three ways: Interpreting the required applications for each dimension exclusively or jointly. So we can investigate applications that are required for the realization of each process as well as applications that secure the embodiment of the various ingredients to the learning product. In the first case the table 2 summarizes the required applications for the e-learning as a process support.

Table 2. E-Learning as a Process and IT Applications Support

Process	IT Application
Relate	Survey, needs assessment tool, communication system
Adopt	Knowledge base, metadata system, matching system, expert system, value taxonomy system, learning products construction system, structured documents repositories
Attract	Multimedia tools, help modules, interactivity tools, semantics, FSQ, problem solving
Engage	Personalization, profiling, needs analyser, presentation tools, group ware, net conferencing, role playing games, interactive case studies, business simulation tools
Learn	Evaluation system, feedback tool, Bloom's taxonomy and behavior analyser, real time messaging
Use	Integration facility, mining, Intranet, EAI, annotation system

The items classified in Table 2 do not represent every application that could facilitate e-learning as a process. Our intention was to map the most important and also to promote the idea than to reveal all the possible applications.

Table 3. E-Learning as a Product and IT Applications Support

Product Ingredient	IT Application
Needs	Survey & needs assessment tool, needs analyser, evaluation system
Knowledge	Expert system, metadata system, knowledge base, personalization / profiling, annotation, EAI module
Motivational Elements	Value taxonomy system, interactivity tools, help modules, multimedia tools, motivation system, presentation tools, feedback tools, Bloom taxonomy and behavior analyser
Team Synergy	Communicatoin system, role playing games, net conerencing, group ware, real time messaging, discussion groups, Intranet
Problem Solving	Interactive case studies, role playing games, learning scenarios builder, mining, integration facility
Packaging	Structured document repositories, learning products construction system, semantics, business simulation tools, learning proesses pool

Table 3 can be used as a tool, since it permits the e-learning designers to consider which ingredients of the e-learning product are willing to realize in an e-learning environment. The proposed approach of learning ingredients and e-learning processes is not exhaustive in the manner that we claim that only the depicted items in the scaling exist. Far from it, we propose a scalable approach to e-learning where researchers just have to consider more items in each scale. This modularity and scalability of our approach is a strong point since the technological engagement in e-learning is based on a conceptualisation, which justifies the e-learning as a value added process.

The third way for the translation of the classification tool that is depicted in figure 3 requires a two-fold consideration. We have concurrently to analyse the capacity of the technological application to support both dimensions of e-learning: The product centric as well as the process centric. In a way two coordinates specify the position of each ICT application in the tool. Below some examples are given:

In the position where RELATE phase realizes the NEEDS component of e-learning product the depicted applications are survey and needs assessment tools. In the industry several vendors provide questionnaire and survey tools that in way gather information concerning attitudes and perceptions. So in an e-learning system tools like these would be very important. Of course in the majority of e-learning implementations the needs assessment is something taken from granted through teachers general conceptions concerning the needs of his students. Some tools in the classification are may be confusing since their description permits many interpretations. In the next paragraph we provide a short description of their role and their functionality within an e-learning system.

Learning Processes Pool: This module is responsible for the realization of several learning processes. The main idea of our approach is that e-learning must investigate new ways for the diffusion of learning content and instead of building learning scenarios around static sequential modules it would be interesting to investigate the learning processes as value containers. Tom Shuel's (Shuell 1992) work on learning functions as well as Blooms taxonomy of educational goals (Bloom and Krathwohl 1984) have been the basis for the proposition of 9 learning processes (Lytras *et al.* 2002c). It's of them corresponds to a layout which is embedded by learning objects that are jointly formulated by knowledge and metadata.

Matching System: is an advanced mechanism, which is used in order to specify the required learning processes for a specific business case. Lets us consider that the e-learning system supports the process of e-commerce applications development and diffused learning content for this course. This general learning objective refers to a specific business process. This business process can be break down in several tasks, which have to be supported through an e-learning and knowledge management mechanism. Each business task has a different degree of difficulty for its effective execution. From this perspective the routine type of required work or the knowledge intensiveness for the accomplishment of each task demands different learning approaches.

Value Taxonomy System: is an advanced mechanism that calculates for each learning product or for each case the embodied value. The main data for its utilization are derived from the e-learning pedagogy, where the learning processes that can manipulate each learning object provide a first measure for value delivery. In most of the cases we see e-learning implementations where the only available facility is the sequential browsing of static learning modules usually written in html, or PowerPoint presentations with static content.

Needs Analyzer: is an advanced facility, which can be used in order to determine for each user (learner) of the whole system the appropriate learning products for the knowledge exploitation as well as the recommendation of a dynamic mixture of learning processes that constitute its dynamic learning scene. In the most advanced evolution of this system the whole facility will be substituted by a well functioning expert system.

Towards the Proposition of Standards

According to Jakobs (1999), standardization is an extremely simple procedure from the business process point of view. A perceived need is identified within/outside a standards setting body. Thus, the first step for a standard is the need to overcome a problematic situation. The indexing of learning objects it seems to be a management facility with limited impact on the realization of engagement of learners. A lot of approaches concerning metadata have been proposed for general or learning purposes. An initial criticism is that the attachment of general metadata elements or semantics as proposed by organizations such as IEEE, ARIADNE, IMS, Dublin Core, GEM are of critical importance but unfortunately do not pay enough attention to the learning dimension of e-learning. At this point the authors describe a gap in the context of reusability:

Consider an HTML page that describes generations of e-business applications. General metadata that could be attached to this resource could be: Title, Author, Description, Keywords, Date, Language, Format, Purpose, Difficulty, coverage, Intended end user role, and many others that can be found in the web site of major standardization organizations. Now assume that this learning object has been incorporated in the knowledge base of an e-learning system. The critical question is:

- Can this metadata support dynamic learning setting?
- Is it value added to a learner to be able to retrieve content according to the general metadata that described?
- Would be more worthy if the metadata are learning oriented or pedagogical oriented and instead of general *descriptive information provide guidance for learning exploitation?*

As a result, the authors propose, *that the semantically enrichment of learning objects with metadata that refer to learning exploitation is the key issue for the enhancement of e-learning.* Otherwise the high dropout rates in e learning will continue to weaken the value proposition of the phenomenon. At the current stage a metadata schema has been identified. More work is done by authors on XML specifications for the systematic description of the various elements.

The depicted applications in Figure 4 provide a general framework, which is not descriptive but rather normative since it triggers the underlying logic of positioning. This framework does not intend to became a how to guide. Even though it can be used for guidance the next step of the research requires an integrative approach. The contextual character of knowledge and learning demand a holistic approach of knowledge management. Knowledge management is not only descriptive but has to be interpreted as a facilitating backstage of the daily actors in an e-learning system. This understanding will release the myopic distinction of knowledge and learning. The ultimate objective is the integration of dispersed applications in order to realize the Knowledge Management and learning infrastructure as the backstage of an effective e-learning environment. The knowledge value chain of Lee & Hong (Lee and Hong 2002) has to support the four areas of knowledge management emphasis proposed by Wiig (1998) and in this direction the contribution of learning convergence proposed by Lytras, Pouloudi & Poulymenakou (2002a) is of critical importance. This integration is summarized in Figure 4.

The main underlying concept is the critical role of knowledge management in E-learning. Knowledge management is not a technological phenomenon; it is a qualitative shift in people' s behavior within business environments that challenges the knowledge sharing. Since learning is the main carrier of behavioral changes and a facilitator of commitment these two archetypes converge. Especially in the case of knowledge intensive organizations where knowledge creation is the prerequisite for the secure of viability the learning performance relates directly to the knowledge management effectiveness. The Knowledge management infrastructure as a theoretical abstraction incorporates 3 of the 4 areas that were depicted by Wiig, and additionally incorporates the alignment of Organizational Strategy to a knowledge management philosophy direction. In the knowledge management processes section of the figure the detailed analysis of the life cycle KM models are summarized in 6 processes. In the centre of the value chain the learning infrastructure is highlighted. Learning as a function and as a cornerstone in knowledge exploitation impacts every aspect of the whole model.

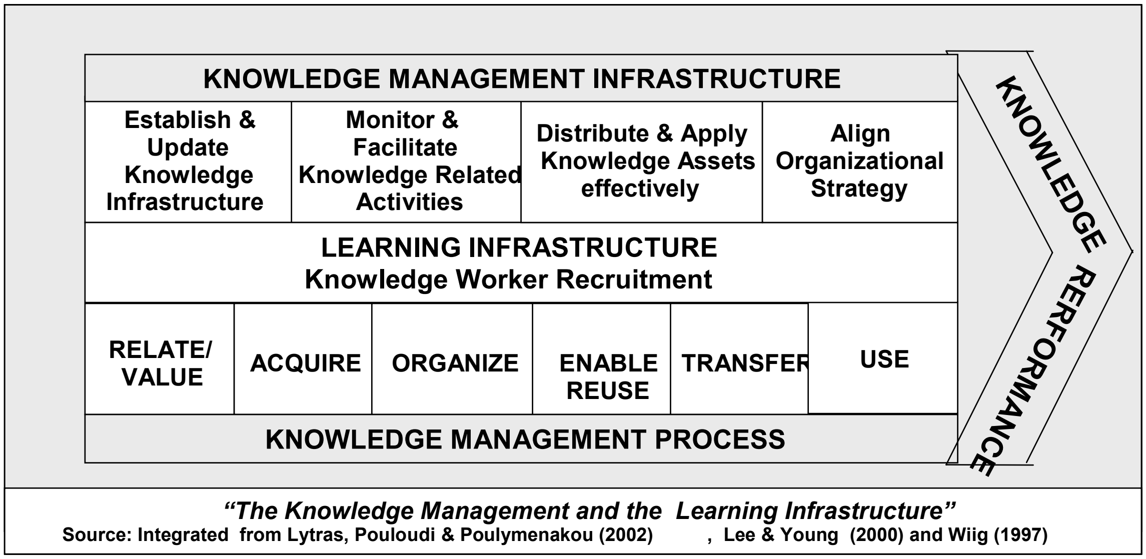

Figure 4. The Knowledge Management and the Learning Infrastructure

Conclusions

This paper intended to reveal a debate concerning the Knowledge Management and Learning convergence. The paper investigates the role of technology in an e-learning landscape and identifies different paths and actors in the e-learning environment. In doing so, four actors: learner, teacher, technology and knowledge are identified. In addition, critical issues related to these four actors are specified. As a result, different models can be used to reflect these actors and their associated issues.

The proposed frameworks and models are examples of the continuous quest by the academic community to describe two of the most important human resources: knowledge and learning. The authors of this paper propose that e-learning can be seen as (a) a process and (b) a product to learners. Moreover, the importance of the use of standards and metadata is highlighted in this paper. As a result, the authors suggest that the semantically enrichment of learning objects with metadata that refer to learning exploitation is the key issue for the enhancement of e-learning. Further research is needed to test these approaches in a practical arena and contribute to the body of knowledge.

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