A Study of E-Learning Architecture Based on Knowledge Innovation

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Abstract—This paper reveals weaknesses of existing e-learning system and puts forward a novel architecture of five layers from the perspective of knowledge innovation. Learner interface layer is a portal that learners enter the system and exploit the offered functionality. Layer of collaborative learning environment is the space where learners collaborate to learn and create new knowledge by doing projects. Knowledge processing layer processes knowledge produced and identifies whether is new. Knowledge access layer based on PHP is used to accessing knowledge and resource bases. The last layer is knowledge and resource bases which are supported by My SQL server.

Keywords— E-learning; architecture; knowledge innovation; project-based learning

I. INTRODUCTION

The greatest challenge to education in a knowledge society is how to effectively help learners to acquire a defined set of knowledge and skills, but in helping them to learn how to manage, work creatively with ideas and to contribute to the creation of new knowledge[1]. E-learning as a new educational paradigm, which refers to utilization of web-based technologies to deliver learning activities that enhance knowledge and performance, “should enable learners to participate in the creation of new knowledge as a normal part of their lives” [2], but “current e-learning efforts continue to put a heavy emphasis on content delivery and technology” [3]. That requires a change in focus from content-driven to innovative knowledge-driven, and from technology-driven to learner-driven models of e-learning, and that requires constructing an architecture in e-learning based on knowledge innovation and providing their learners with an innovative learning environment. Knowledge innovation in e-learning is a process that learners produce new viewpoints, thoughts and new problem solutions, change range and level of the existing knowledge structure, and eventually make new meaning through interaction and collaboration. Its key element is that new understanding emerges on the basis of original cognition. According to Bloom’s classification of learning objectives, the knowledge which learners produced through analyzing, synthesizing and appraising, belongs to knowledge of innovation[4].

E-learning combines human resources, knowledge, technologies and tools, so that learners can effectively and quickly accumulate, share and create new knowledge. Knowledge innovations in e-learning lay their mark on the learning culture which is learner-centered, project-based, integrated. That will be much more favorable to learning and development of new knowledge. Learners based on project “take charge of their own learning, taking responsibility for personal understanding and for the creation of knowledge artifacts” [5]. The ways of doing and approaching projects those are shared at a significant level among the learners, and thus learners can better promote knowledge when they answer the improvised and creative forms that the collaborators use to accomplish projects, and that the knowledge creating activities are not controlled.

Analysis of existing e-learning system reveals weaknesses including the absence of project-based learning and a focus on knowledge acquirement. Furthermore, although literatures have been written about several e-learning system architectures, most of them focus on re-creating traditional school education, and the use of new technologies to serve traditional learning models rather than an environment giving a clear insight into the innovative knowledge.

Based on those above, this paper presents a project-based, knowledge innovation-oriented e-learning architecture that aims at learners share and create new knowledge in supporting high-quality e-learning scenarios.

II. ARCHITECTURE BENCHMARKS BASED ON KNOWLEDGE INNOVATION IN E-LEARNING

A. Considerations of Needs

• Building collaborative learning environments (CLE) which include asynchronous and synchronous communication tools, supports collaborative learning, group instant meeting and decision-making, etc;

• Managing innovative learning project so that it is to be advanced conveniently;

• Retrieving knowledge easily so that learners obtain needed knowledge rapidly during innovative learning;

• Building dynamic interactive knowledge base and storing knowledge of different versions;

• Identifying and evaluating innovative knowledge, which judges innovative points, innovative validity and innovative levels.
B. Considerations of Knowledge Innovation-supporting
- Designing novel learning projects;
- Designing an innovative knowledge-stimulated learning environments;
- Designing socially interactive learning activities;
- Designing learning process which includes transformation, sharing and innovation of knowledge;
- Recording external knowledge which learners acquired and internal new knowledge they generated during performing a project;
- Providing various learning resources;
- Engaging learners in solving real-world projects;
- Activating existing knowledge as a foundation for new knowledge;
- Requiring learners to use their new knowledge or skill to solve problems;
- Encouraging learners to transfer the new knowledge or skill into their everyday life.

III. ARCHITECTURE FRAMEWORK

![Architecture framework diagram]

Figure 1. Architecture framework

An architecture based on knowledge innovation in e-learning is shown in figure 1. Learner interface layer is a portal that learners enter the system and exploit the offered functionality with an Internet connection and a Web browser. Several learning services can be implemented in learner interface, such as learner’s log-in, learning notice, learning calendar, news, learning communication. The learner interface is a single entry where the learner participates in project-based learning, and produces the individualized access, utilization and exchange of knowledge according to learner’s need. Using Ajax technology in the learner interface layer can improve the system interaction and individualized presentation greatly.

B. Collaborative Learning Environment

CLE is important as it is an enabler of innovation process implementation. CLE using knowledge innovation principles provides a flexible and open learning environment for practicing knowledge innovation, collaborative learning and converging collective wisdom, in which learners communicate information, discuss problems, pose new ideas, extend points of view, exchange learning experiences, debate opinions with each other and share a common understanding, and they also acquire, classify, store and share knowledge [6]. CLE facilitates social interaction between learners, groups or communities, and processes by means such as email, discussion forums, instant message, virtual whiteboards, document sharing, audio or video conferencing, and virtual team-room, and thus supporting learners in performing tasks collaboratively. Project-based and knowledge innovation-oriented CLE is shown in figure 2.

![Project-based and knowledge innovation-oriented CLE diagram]

Figure 2. Project-based and knowledge innovation-oriented CLE

The presumption is that learners construct new knowledge by solving real projects through planning and refining project objectives, gathering and sharing knowledge, resources in pre-project; conducting investigations and knowledge collaborating...
during project-performing; drawing innovative knowledge or artifacts, and reporting findings after project-performed. Of course, those innovative knowledge, artifacts and findings must be audited.

C. Recording and Retrieving Knowledge

Learning is the process which implies the discovery, the memorizing and the exploitation of stored knowledge [7]. Thus, recording and retrieving knowledge seems indispensable for innovative learning. Recorded knowledge provides a mechanism for compatible knowledge representation, as well as a common interface for sharing knowledge, resources and competencies. It can include at the same time explicit knowledge like reports, articles, learning notes, reflective logs, but also information expressed traditionally without physical support such as knowledge, experiments, critical incidents or details on the decision-making, and ideas produced or improved, by the learners during their projects. This tacit or explicit knowledge is the key of innovative learning.

Knowledge retrieval is a process by which knowledge is reconstituted or reconstructed and made available, and it consists of search and decoding processes. Therefore, it is useful to divide the retrieval process into two steps: the identification of knowledge, and the learners’ individual decodification of the accessed knowledge [8]. Knowledge retrieval means are individual memory, social capital and network, knowledge base, e-learning community. In knowledge base, methods of knowledge search include direct search (simple search, word search, full-text search, full-text search with regular expressions, combined search), Semantic search, and agent-based expert queries.

D. Tracking Innovative Process

Innovative process-tracking tracks all aspects of the innovative process execution, integrates the learners, the structure, and the knowledge sources such as knowledge base, project base, resources base, communicational tools and collaborative applications, indicates a project how to be decomposed into tasks that can be allocated to learners, specifies when and how the project and tasks are performed, and seeks who performs what tasks and with what tools, and therefore tracks production, sharing, application and innovation of knowledge during performing the project.

An innovative process-tracking tool (see figure 3) can be used to capturing the innovative process. Therefore, the learners have the ability to find out the knowledge produced by other learners who are working on the same project. Such features encourage collaboratively creating knowledge among learners and help to identify groups of learners suitable for collaboration.

E. Identifying and Evaluating Innovative Knowledge

While judging a knowledge point whether it is original, it is lower efficient and stronger subjective that relies on a learner comparing knowledge through reading all from knowledge base or outside. Therefore, this system rates innovative grade by two ways firstly, then carries on weighting of results of the two ways, and gives the innovative level eventually.

The first way adopts potential semantic analysis to calculate similar degree between texts of the knowledge title, and evaluates the grade according to the similar size. The weight of this way is 0.3.

The second way used to innovative appraisal of knowledge produced is the statistical analysis method, the weight is 0.7. Learners can carry on quantitative innovative appraisal to all knowledge produced, and then the system carries on statistical analysis and confirms a grade to all appraisal results.

Finally, the system calculates the innovative level of this knowledge point according to 3:7 in proportion, thus helping learners to judge rapidly whether the knowledge that they produced is innovative.

F. Knowledge Base

In E-learning, the generated knowledge based on project learning and knowledge innovation is very precious to the learners. In order to maintain the knowledge and facilitate further sharing, it is important to have a knowledge base for maintaining all critical knowledge. Therefore, knowledge base is used for storing project-related knowledge and the new knowledge produced by finishing the project. Knowledge base is a centralized repository which brings together knowledge from various knowledge sources, “providing a unified access point and reducing knowledge search costs” [9]. In general, knowledge base is not a static collection of knowledge, but a dynamic resource continuously updated by learners and teachers with new content based on learner support issues, online discussions, project analysis, task-processing, problem-solving. Knowledge base includes knowledge attribute and knowledge link. Knowledge link used mainly in knowledge reasoning reflects knowledge relation and hierarchical structure order.

1) Attribute of knowledge

The attribute of knowledge as following:

a) Number of knowledge, having uniqueness and major key;

b) Type of knowledge: fact, concept, Skill, process, principle, problem-solving, etc;

c) Difficult level of knowledge: easy, general, difficult, and very difficult;

Figure 3. Tracking innovative processes
The attribute of knowledge link as following:

a) Number of knowledge, having uniqueness;

b) Point of father knowledge, point of son knowledge, point of brother knowledge, giving some hierarchy of knowledge, and being used for searching and finding;

c) Knowledge number of predecessor or successor, reflecting the order of knowledge, and being used for navigation;

d) Knowledge source;

e) The person who adds knowledge;

f) Time when knowledge is added.

Item a), b), c), d) constitute attribute form of knowledge link.

Item a), d), e), f) constitute attribute form of knowledge about the project or task. System evaluates innovative rating of knowledge only when attribute of “knowledge source” is “Original”.

IV. CONCLUSIONS AND FUTURE WORK

E-learning as a new educational paradigm, which refers to utilization of web-based technologies to deliver learning activities that enhance knowledge and performance, requires a change in focus from content-driven to innovative knowledge-driven, and from technology-driven to learner-driven models of e-learning, and that requires constructing an architecture in e-learning based on knowledge innovation and providing their learners with an innovative learning environment.

The novel five-layer architecture of E-learning system is put forward in this paper, which is based on knowledge innovation and project learning. Learner interface layer is a portal that learners enter the system and exploit the offered functionality with an Internet connection and a Web browser. CLE layer is the space where learners collaborate to learn and create new knowledge by doing projects. Knowledge processing layer processes knowledge produced and identifies whether is new or not. Knowledge access layer based on PHP is used to accessing knowledge and resource bases. The last layer is knowledge and resource bases supported by My SQL server.

Our goal was not to develop a complete content management system of E-learning, but to can be used to support educational scenarios that support knowledge innovation-oriented.

We have developed a platform based on our architecture. We will conduct field trials in order to gain insights to the issues involved in the system, and therefore the system architecture will be improved and platform performances will be optimized.

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