

An Effective E-Learning System Based on Knowledge Management and Intelligent Agents

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ABSTRACT

In this paper, a Highly Efficient e-Learning System based on Knowledge Management and Intelligent Agents, KMIA-HELs, is proposed. The design concept is to use knowledge management and intelligent agent community to help the learners finding out the adapting courses and learning path. The system analyzes the causes of ineffective learning by portfolio and test-portfolio, and then provides personal courses to remedy learners' learning difficulties through the analyzed information. The features of the KMIA-HELs include analyzing the causes of learning inefficiency; promoting learners' learning efficiency by personalized courses and learning paths through the information analyzed by agents; spending less time in making teaching materials for teachers.

1: INTRODUCTION

In the new economy, knowledge is the only real competitive advantage. It makes the value of knowledge far more than other tangible assets. The e-learning combines both digital contents and knowledge management so that it not only takes an important role in education, but also be used by many enterprises on employee's training to promote competitiveness. Especially the characteristics of learning anytime and anywhere, it is much superior to traditional teaching method.

In recent years, learning by e-learning is getting more popular so research analysis of learning efficiency is very significant. Since the students and teacher are on different time and space in an e-learning environment, the learning status of a student is difficult to be controlled by teachers. For this reason, it is very important to offer more data on students' learning portfolio to teachers. Portfolio is a method to present self-ability in a lot of industries. For instance, architect, designer, engineer, painter, etc. can show and prove their ability by a complete portfolio. Because portfolio is purposefully built by collecting the works of the learning process of oneself, it can present learners' effort, progress and achievement in one or several fields. Therefore, using the concept of portfolio on e-learning, teachers can get learners' learning process, and at the same time, find out learners learning efficiency. Teachers then can adjust their teaching materials and learners' learning paths based on these portfolios.

In the current learning platforms, they neither analyze the causes of learning the inefficiency of users, nor generate new learning materials and testing. The former keeps the learners from not using these learning systems anymore because they are confusing; the latter leads to out-of-date materials and the learners could not get any new knowledge.

To sum up, the purposes of this research are listed in the following:

- (1) Teacher can make learners' individual course according to analyzing the causes of learning inefficiency.
- (2) By intelligent agent's guiding, reduce learners' learning confusion and overloading.
- (3) Using knowledge management activity can cost less time in making teaching materials for teacher.
- (4) Improving learning efficiency through intelligent assistance, knowledge management and learning feedback.

2: RELATED WORK

2.1: KNOWLEDGE MANAGEMENT

In studying the phases that organizational knowledge utilizes in any industry, as well as the activities performed upon knowledge, Wiig [17] proposed a five-phase knowledge evolution cycle. According to Wiig, the knowledge evolution cycle begins with the emergence of knowledge in the organization; relevant information about it is captured in explicit forms; the explicit knowledge is structured and classified; and the tacit and explicit knowledge are accessed and applied.

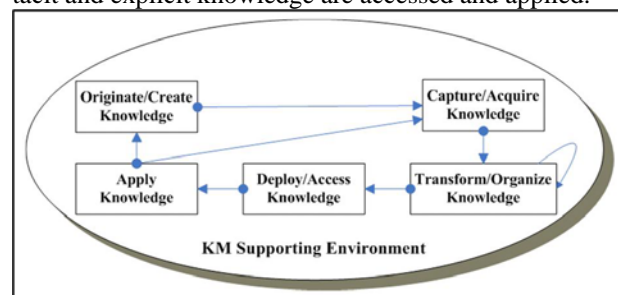


Fig. 1. Knowledge management environment to facilitate knowledge evolution cycle

Fig. 1 shows the minimum KM supporting environment and the core activities performed upon knowledge. The five boxes represent activities performed upon knowledge

and this architecture included Originate/Create Knowledge, Capture/Acquire Knowledge, Deploy/Access Knowledge, Transform/Organize Knowledge and Apply Knowledge [2, 17]:

Nonaka [11] defined knowledge management as a series of complex processes of creating, identifying, collecting, sharing, and adjusting organization knowledge in order to make organization knowledge carry the maximum benefit and feedback.

Spek and Spijkervet [15] indicated knowledge management that explicit control and manage organizational knowledge to achieve industry destination. Nonaka [11] proposed a kind of complicated procedure which knowledge management is used to create, collect, share and adjust organizational knowledge, in order to enable the enterprises' knowledge assets to create the best benefit and feedback.

In summary, the knowledge innovation, knowledge store, knowledge classification, knowledge sharing and knowledge recovery are the five major activities of knowledge management and are used to help learners get more knowledge in the e-learning environment.

2.2: INTELLIGENT AGENT

The Object Management Group (OMG) defines the following three characteristics of an agent:

- (1) Autonomous: an agent can control its inner states and act based on its experience.
- (2) Interactive: an agent can communicate with its environment and other agents to complete missions given by users.
- (3) Adaptive: an agent can respond to its environment and other agents, thereby determining its actions based on its experience.

The difference between an agent and traditional software is that an agent is personalized, autonomous, proactive, continuously running and adaptive.

Recently, the research on agent-oriented programming has begun because the intelligent agent technique has developed rapidly. For example, Roda et. al [13] presented an agent-based system designed to support the adoption of knowledge sharing practices within communities. The system is based on a conceptual framework that, by modeling the adoption of knowledge management practices as a change process, identifies the pedagogical strategies best suited to support users through the various stages of the adoption process. The resulting community-based system provides each member of the community with an artificial personal change-management agent capable of guiding users in the acquisition and adoption of new knowledge sharing practices by activating personalized and contextualized intervention.

Bobin [3] incorporated the theory of organizational influence to demonstrate the structural influence index within a network KMS. The benefits of structural indexing are identifying knowledge agents, evaluating knowledge sharing among organizational members, and objectively assessing the contribution of knowledge agents.

The topology affects the agents' ability to share knowledge, integrate knowledge, and make efficient use of knowledge in multi-agent system. Zhu [20] presented an overview of four major multi-agent system topologic models, assesses their advantages and disadvantages in terms of agent autonomy adaptation, scalability, and efficiency of cooperation.

In conclusion, the intelligent agent can automatically finish the work of users' appointment, therefore in our e-learning, an intelligent agent is added to help increase learners' efficiency and spend less time in making the teaching materials for teachers.

2.3: PORTFOLIO

Portfolio is used to record information of learner's learning process to discover and improve the learning efficiency of learners. Chang [4] gave a full and detailed account of the design and development of portfolio for authentic assessment, in record, display, and monitor student learning process. Morimoto et. al [10] proposed the framework of portfolio, using this framework, users can coordinate a series of activities to design portfolios, manage portfolios, and control portfolios. Su et. al [16] provided customized course according to individual learning characteristics and capabilities based on analyzing portfolio information of learner and Chen et. al [6] proposed scheme to help teachers to assess individual learners precisely utilizing only the learning portfolios in a web-based learning environment.

The information of analyzing portfolio can help teacher understand the learning behaviors of learners, discover the learning rules for understanding the reason why a learner got high or low grade [1, 5, 7, 9, 14, 16] and let learners' improve their inefficiency in learning and view and emulate better learning way of other learner. Therefore, the information in the portfolio can help teacher analyze the learning behaviors of learners and discover the learning rules for understanding the reason why a learner got high or low grade, and let learners' improve their inefficiency in learning and view better learning way. Therefore, the portfolio is used in this paper to analyze learners' efficiency.

2.4: TEST-PORTFOLIO

The learners' testing scores is always used to estimate their efficiency, and is divided into different levels in the traditional learning. In recent years these scores had been criticized, because these scores placed particular stress on a topic. Therefore numerous scholars propose portfolio to solve this problem. During the learning activity [16], learning behaviors of learners can be recorded in a database and this information can find out learners adaptation to the teaching material and modify the level of learners teaching materials. In several articles, we find that the portfolio has been used to provide the learners' efficiency for teachers by recording the learners' learning process, however, those records could not analyze the causes of learning inefficiency of users.

Thus, in this paper, we propose test-portfolio to understand the causes of inefficiency. Proposing the test-portfolio has following objectives:

- (1) The concept is the same as the portfolio; collect testing scores and find the learning efficiency according to this information.
- (2) Analyze the causes of learning inefficiency by data mining the portfolio and test-portfolio.
- (3) Making personal courses based on the portfolio and test-portfolio.

3: KMIA-HELs

In the following, a high-efficiency e-learning system based on knowledge management and intelligent agent, KMIA-HELs, is proposed in the following.

3.1: THE ARCHITECTURE OF KMIA-HELs

The architecture of KMIA-HELs is shown in Fig.2, including intelligent agent and database.

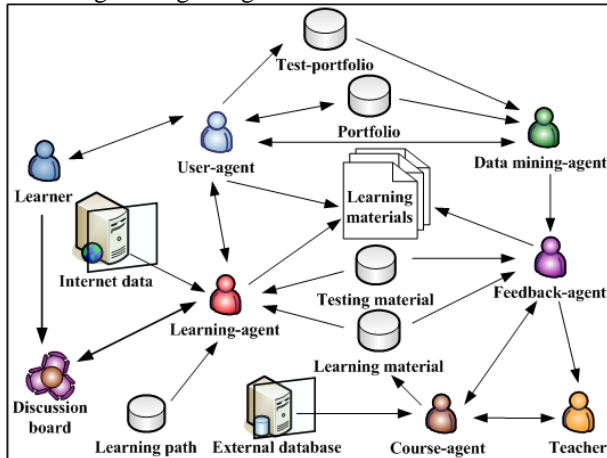


Fig. 2. The architecture of KMIA-HELs

3.1.1: INTELLIGENT AGENT. Five intelligent agents are designed in KMIA-HELs to improve learners' learning efficiency and to operate knowledge management. The functions of each agent are shown in Table 1. According to the different functions of system KMIA-HELs, the amount of Learning-agent, Data Mining-agent, Feedback-agent and course-agent are all 1. In addition, each user owns a User-agent.

Agent	Functions
User-agent	<ol style="list-style-type: none"> 1. Collecting precise portfolios and test-portfolios for each learner. 2. Sending message to the learner when the learner' posted articles has been replied, new articles or questions are generated.
Learning-agent	<ol style="list-style-type: none"> 1. Finding appropriate learning path for learners and guiding the learning process. It helps learners spend less time in learning useful course materials. 2. Filtering the resources of the teaching material in accordance with

	<p>learner's ability to reach adaptive learning.</p> <ol style="list-style-type: none"> 3. Monitoring the discussion board and sends messages to the corresponding user-agents, when new articles or questions are generated needed for learners. 4. Finding useful articles or interesting materials in the network and discussions, and send them to the corresponding user-agent.
Data mining-agent	<ol style="list-style-type: none"> 1. Analyzing the causes of learners' learning inefficiency through the portfolio and test-portfolio. 2. Finding out learner's interests for the course material, via portfolio.
Feedback-agent	Feedback the personalized courses upon obtaining learners' causes of learning inefficiency via the Data mining-agent.
Course-agent	<ol style="list-style-type: none"> 1. If there are no appropriate courses in the course database to offer for learners, feedback-agent will send the requirement to this agent. As obtained the request, this agent will search relevant materials on internet. 2. Avoiding collecting large useless courses, it will send these relevant materials to teachers to evaluate first, and then store these materials into Learning material database.

Table 1. Functions of intelligent agent

3.1.2: DATABASE. Learning material database, testing material database, learners' portfolios database, learners' test-portfolios database and learning path database are included in this Database. The purpose and functions of these databases are described as follows:

(1) Learning material database

The learning materials relation design is based on ontology concept. This is to effectively reduce teachers' time in making the learning material and increase more and more learning material to make best personal courses. Some important fields and their corresponding functions in this database are shown in Table 2.

Field	Description of functions
Index	The index of teaching materials.
Tag of difficulty	Tag is used to indicate the degree of difficulty of this material, which is divided into easy, moderate and difficulty.

Table 2. Learning material database

(2) Testing material database

Testing is conducted to find out learners' weakness and learning efficiency which help teachers to adjust the teaching materials and teaching tactics. Some important fields and their corresponding functions in this database are shown in Table 3.

Field	Description of Functions
Type of testing material	Using different testing ways to find out learners' learning effect.
Difficulty of testing material	Offering adapted testing material in accordance with the learners' level

Table 3. Testing material database

(3) Learners' portfolios database

The Learners' portfolios database is used to record learners' learning process. Learners can know self growth by this database. It can provide the evidence of learning for teachers. Some important fields and their corresponding functions in this database are shown in Table 4.

Field	Description of functions
Time of learn material	Recording time of learning provides teachers information whether the courses are apt to learning or not.
Path of learning material	Recording learners' learning path can find out the best and fastest learning path in this system.
Frequency of browsing articles	It can provide new knowledge for learners by learners' preference.

Table 4. Learners' portfolios database

(4) Learners' test-portfolios database

The learners' test-portfolios database is used to analyze the causes of ineffective learning and provide personal courses for learners. Some important fields and their corresponding functions in this database are shown in Table 5.

Field	Description of functions
Testing questions	To know the questions which learners answer wrong. It can find out learners' weakness which should put more effort on.
Score of testing	Recording learners' level of understanding in testing courses or units.

Table 5. Learners' test-portfolios database

(5) Learning path database

Guiding the learners' learning process in accordance with the best learning methods to avoid learning controlling, losing and improve learning effect. Some important fields and their corresponding functions in this database are shown in Table 6.

Field	Description of functions
Course of learners' level	Guide the learner learning path through the learners' level.
Learning effect information	To show learners' learning efficiency which each path brings out.

Table 6. Learning path database

3.1.3: SYSTEM FEATURES. The KMIA-HELs has the following features:

- (1) Make personal course to promote learners' learning efficiency based on the analysis of the causes of learning inefficiency.
- (2) Spend less time in making the teaching materials for teachers and guiding the learning process by agent.
- (3) Generate new knowledge to learners and teachers by knowledge management activity, that is, knowledge store, knowledge classification, knowledge sharing, knowledge innovation and knowledge recovery.
- (4) Agent filtering of the learning material can reduce the overload of learning information.

3.2: THE RELATION OF KNOWLEDGE MANAGEMENT AND INTELLIGENT AGENT

In the KMIA-HELs system, the intelligent agents execute major activities including knowledge innovation, knowledge store, knowledge classification, knowledge sharing, and knowledge recovery. The details are described in the following:

(1) Knowledge innovation

Learners get new knowledge and discuss the confusing courses with teachers or other learners by the discussion function in this system. On the other hand, intelligent agent generates new teaching materials, test content and other learning paths through analyzing the data in the database. Also, it provides learners learning content in accordance with learners' weaknesses. There are four methods of knowledge innovation described as follows:

A. Learners generate new articles by discussion:

Learners generate new issues of knowledge to discuss with teachers and other learners by discussion board in KMIA-HELs. As shown in Fig.3, when user-agents get new articles through discussion board, they will pass it out to the corresponding learners' interesting on such articles. The information will be past to teachers to filter useless information.

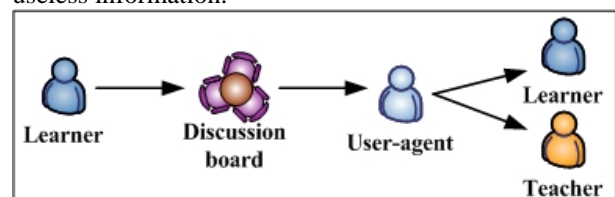


Fig. 3. Knowledge innovation-discussion board

B. Generating new courses and test materials for learners' requirement:

Fig.4 shows that the data mining agent analyzes the causes of learning inefficiency from the portfolio database and test-portfolio database to generate the learners' requirement information. This information then help teachers modify and make courses and test materials. It is shown in Fig. 4.

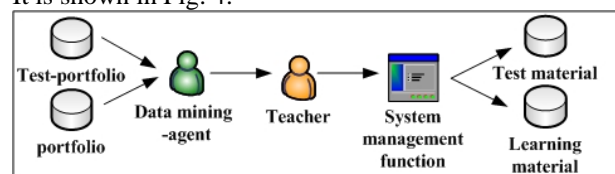


Fig. 4. Knowledge innovation-Teaching material

C. Generate new learning path from learners' portfolios database:

The data mining agent generates new learning path information of learners to teachers for reference from the learners' portfolios database as shown in Fig.5. Teachers can use this information to update new learning paths for learners through system's management function.

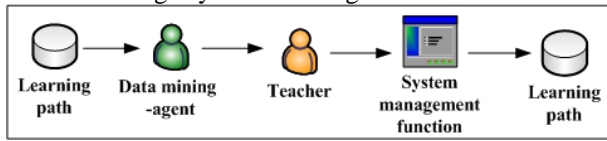


Fig. 5. Knowledge innovation-learning path

D. Creating personal course:

The process of generating personal course is shown in Fig. 6. The learning material content has changed by the learners' learning progress, it can meet learners' requirement and adapt the learners' level. The data mining agent analyzes learner's requirement and the causes of learning inefficiency from the portfolio database and test-portfolio database, and then pass these information to the feedback-agent. When the feedback agent gets these information, it will search suitable courses in the course material database and test material database to create feedback materials which can improve the learners' weakness.

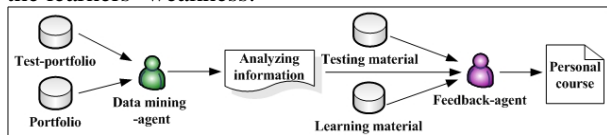


Fig. 6. Knowledge innovation-personal course

1.1 Features of knowledge innovation:

Intelligent agent analyzes the information of learning efficiency to find out whether the causes can improve learners' learning inefficiency by learners' portfolio and test-portfolio. The former will provide a personal course based on learners' learning information. The difference between the traditional course and the present one is that this course is created by analyzing learners' learning weaknesses. The latter generates the need for improving information on the course material and test material. It helps teachers find out which material will be modified and make the material by the system management function.

(2) Knowledge store and knowledge classification

The intelligent agent classifies articles according to the keywords posted by the learners and teachers in the articles and then stores the teaching material in the learning material database and test material database in accordance with teaching material category. There are two methods for the knowledge store and knowledge classification as described in the following:

A. Store and classify discussion articles:

When learners post articles of new knowledge, the intelligent agent classifies them by key words of title, and then posts them in the discussion group as shown in Fig. 7.

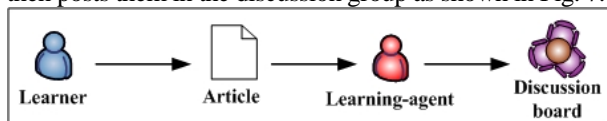


Fig. 7. Knowledge store and classification-discussion board

B. Store and classify teaching material:

The intelligent agent analyzes the material which is short to learners. And teachers create new courses and test the material according to these data. The intelligent agent will classify and store this material database and test the material database by the category and level as shown in Fig. 8.

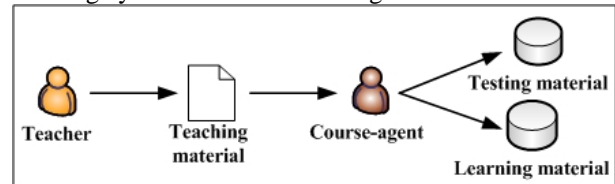


Fig. 8. Knowledge store and classification-teaching material

2.1 Features of knowledge store and knowledge classification:

The classified articles and teaching material by the intelligent agent can quickly share and search for learners based on their interests. Also, it helps the intelligent agent generate new personal courses according to this classification.

(3) Knowledge share

The knowledge sharing process is shown in Fig. 9. Learners turn tacit knowledge into explicit knowledge and teachers share the teaching material content, test material content and practice the learning path through discussion. The intelligent agent gets new knowledge by discussion, it will pass to teachers first to filter out the useless articles and then pass useful articles to learners in accordance with their interests. This filter method can reduce learners' information overload.

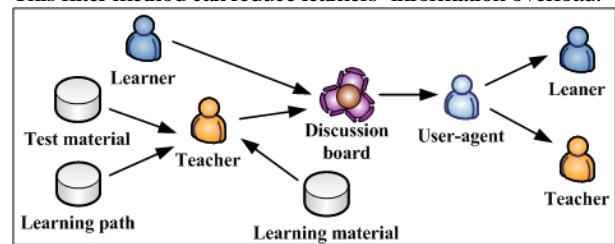


Fig. 9. Knowledge share

3.1 Features of knowledge share:

In addition to teaching and testing, this architecture integrates knowledge management. It can make learners to get more and more information, and then improve the learning efficiency of learners. Also, intelligent agent notices learners to get their interesting knowledge new generated in discussion board.

(4) Knowledge recovery

The process of knowledge recovery is shown in Fig. 10. To keep the correct articles in the discussion board and avoid learners from learning wrong knowledge, when the out-of data or incorrect articles in the discussion board are found out by agents, teachers can update these articles by assigning intelligent agent to search relative knowledge on the Internet.

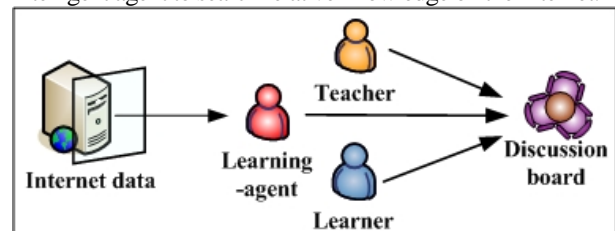


Fig. 10. Knowledge recovery

4.1 Features of knowledge recovery:

Since the discussion is managed by the intelligent agent, this system can reduce out-of-date or incorrect knowledge in the discussion board, avoid learners from learning wrong knowledge which may influence learning efficiency. Also, the intelligent agent automatically searches the required knowledge for teachers.

4: EXPECTED RESULT

In order to find out the learners' learning effect, this proposed system will be completed and be put into action on line. It can analyze learners' misunderstanding about the teaching materials more exactly than the other learning systems. The system gives learners feedbacks and materials which they need at the right time. It also attracts learners to study through e-learning system to improve the learning efficiency, provides the needed information for teachers so that they can modify their teaching materials and methods.

5: CONCLUSION AND FUTURE WORKS

This paper improves the disadvantage of e-learning systems in the past that gave the learners study materials only arranged by teachers but can't analyze the causes of learning inefficiency, teachers need to spend a lot of time updating the teaching material, and learners are unable to get new knowledge from discussions. Therefore, this research proposes an efficient learning system based on knowledge management and the intelligent agent to improve learner's learning and reduce their overloading. Teachers can spend less time making the teaching materials as well.

In the future, the intelligent agent can answer learners' questions immediately, when learners get confusion of teaching material. In the learning process, when learners have any problems, they can communicate with the intelligent agent immediately to solve the confusion of them.

Some clustering technologies such as ontology can be used to enhance the accuracy for classification of knowledge. It's quite important to provide the correct knowledge as learners look for answers through discussion. If the intelligent agent is like teachers or experts who provide correct knowledge to learners' problems, it is believed that it can greatly improve learning.

6: ACKNOWLEDGEMENT

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