# An Adaptive E-Learning System Based on Intelligent Agents

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*ABSTRACT:* In this paper, an adaptive e-Learning System based Intelligent Agents, IAELS, is proposed. The design concept is to use 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 IAELS 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.

*Keywords*: Adaptive E-Learning System, Intelligent Agents

## 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 teachers 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 connect 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 processes, 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 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) Agent 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) Improving learning efficiency through intelligent assistance, and learning feedback.

# 2 RELATED WORK

## 2.1 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 it 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 [9] 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 [2] 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 [12] 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.

## 2.2 PORTFOLIO

Portfolio is used to record information of learner's learning process to discover and improve the learning efficiency of learners. Chang [3] 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 [8] 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 [11] provided customized course according to individual learning characteristics and capabilities based on analyzing portfolio information of learner and Chen et. al [5] 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 teachers understand the learning behaviors of learners, discover the learning rules for understanding the reason why a learner got high or low grade [1, 4, 6, 7, 10, 11] 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 teachers 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 in this paper was designed to analyze learners' efficiency.

## 2.3 TEST-PORTFOLIO

E 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 [11], 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, study finds that the portfolio has been used to provide the learners' efficiency for teachers by recording the learners' learning processes; however, those records could not analyze the causes of learning inefficiency of users.

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

The concept is the same as the portfolio;

(1) To collect testing scores and find the learning efficiency according to this information.

(2) To analyze the causes of learning inefficiency by data mining the portfolio and test-portfolio.

(3) To make personal courses based on the portfolio and test-portfolio.

# 3 THE ARCHITECTURE OF IAELS

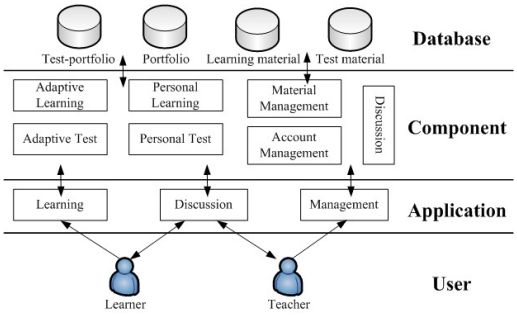


**Fig 1. the Architecture of IAELS**

The architecture of IAELS is shown in Figure 1, there are three layers. The application layer includes learning module, discussion module and management module, it integrates the component layer's function for learners and teachers use this system easily. The component layer shows this system function, it includes adaptive learning and test, personal learning and test, material management and account management. The adaptive learning and test are generated according to learner's level different from the personal learning and tests are generated according to analyzing the causes of learning inefficiency. In the database layer includes test-portfolio database, portfolio database, learning material database and test material database is used to save the learner information and teaching material.

The agent collects precise portfolios and test-portfolios for each learner when learner is learning and testing, finds appropriate learning path for learner and guides the learning process. It helps learner spend less time in learning useful course materials.

# 4 Implement AND Experimental Results

## 4.1 Implement

As shown in Figure 2, agent finds out teaching materials according to learner's level, when learners login. In Figure 3, agent makes learners' individual course according to analyzing the causes of learning inefficiency. Agent will pass message to learner when learner's posted article has been replied by the other learners is shown in Figure 4.

**Fig 2 Agent Finds Out Teaching Materials According to Learner's Level**

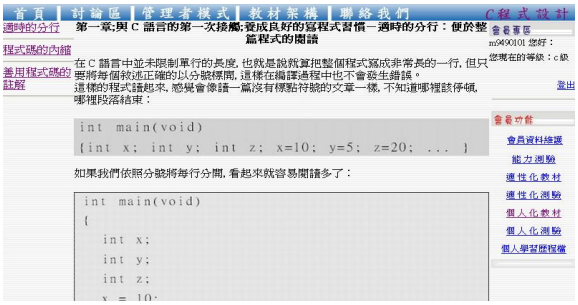

**Fig 3. Agent Makes Individual Course According to Learner Learning Inefficiency**

**Fig4. agent pass message to learner**

## 4.2 Experimental Results

The evaluate data of the IAELS is shown the table 1, there is sixty learner. We used the five-point scales to evaluate the learning efficiency and learning satisfaction. The most common measure used is Likert scale. In this study we set from 1 to 5. Generally, 1 indicates "strongly disagree", 2 is

"disagree", 3 is "unsure", 4 is "agree" and 5 is "strongly agree". The results shown IAELS can provide teaching materials according to learner's level and can make learners' individual course according to analyzing the causes of learning inefficiency, so learners will get more knowledge from this system and this system can help for learners' study.

| No. | Content | Mean | Variance |
|---|---|---|---|
| 1. | I feel that KMIA-HELS instructional design really help in my study | 3.87 | 0.49 |
| 2. | KMIA-HELS provides learning process files help my learning progress and improve learning efficiency | 3.69 | 0.56 |
| 3. | KMIA-HELS provides adaptive instructional materials and tests according to my learning speed and capability | 3.76 | 0.53 |
| 4. | KMIA-HELS provides personalized material and tests according to my learning weakness | 3.87 | 0.53 |
| 5. | I read many in depth or difficulty course contents in KMIA-HELS | 2.48 | 0.48 |
| 6. | KMIA-HELS provides the best learning short cut and is really helpful to the nest learning | 3.65 | 0.38 |
| 7. | KMIA-HELS reminds your post feedbacks which may reduce your possible time spent on discussion | 3.83 | 0.48 |
| 8. | After completion of the course learning, I can study more about programming language | 4 | 0.52 |

**Table 1. The Evaluate Data of the IAELS**

# 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 were unable to get new knowledge from discussions. Therefore, this research proposes an adaptive learning system based on 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, 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, we believed that it will greatly improve the work of studying.

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