Individualized e-Learning System: Agent for Learning Mathematics in Primary Education in Thailand

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Abstract

At present e-Learning systems are widely introduced in education. There are various systems developed and implemented for learners. However, most of these systems are static and inflexible. These traditional systems are developed on the basis of “one-size-fit-all”. They cannot be adjusted to fit the individual’s capability. In this paper the user-centric approach is applied to improve the performance, effectiveness and usability of the system. This paper proposes an agent for learning mathematics in primary education. This agent provides material for both teachers and students. For teachers, it gives advice in preparing teaching materials and methods based on student background. These recommendations can be procedures such as specific activities, or content including lessons in mathematics. For students, the system provides lessons to them as a result of the pretest for mathematics skills. The system was examined by three groups including teachers, software developers and education students. Descriptive analysis was performed and results indicate that the system was acceptable and satisfactory. Further research is suggested.

Keywords: e-Learning, individualized, mathematics, Thailand, primary education

1. INTRODUCTION

Currently, information technology (IT) plays important roles in various industries including manufacturing, finance, services, and education. IT has been applied in classrooms, and distance learning by using the Internet. Learning via the Internet is quite popular because it has no limit in time and place. E-Learning is already implemented in many international universities which offer e-Learning programs for both local and overseas students. E-Learning in Thailand is in the early stage, many institutes are interested in starting e-Learning in their organisations. However, the usage of e-Learning is very limited since there are difficulties in educational policy, society and technology (Srivihok and Intrapairote 2003). Further, the systems are rigid and inflexible to be customized for learners (Blochl et al, 2003). All students start learning with the same materials for the same class. Learners with different academic backgrounds always begin learning with the same lessons in one class. This system is time consuming and it decreases learner attention for advanced learners. The adaptive system for e-Learning should be developed to solve these difficulties.

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The purpose of this study is to describe the agent which can be used as an individualized e-Learning system for teaching mathematics in primary schools in Thailand. The development of an adaptive e-Learning system is done by using a rule-based decision tree and forward chaining algorithm in managing contents for individual users. The following section presents related work in e-Learning and its agent. Section 3 discusses the design of the system. Section 4 provides the results of surveys for systems evaluation on performance and user interface. The last section presents the conclusions of the study.

2. Related work

E-Learning has been recognized as the new wave in education. It allows learners to study with unlimited time and space as 24x7 which is cost-effective. Further, it is considered as a key strategy for increasing human capital in the knowledge society. It can be used in the organization for in-house training. Despite the advantages of e-Learning, this system has not been well designed to be customized for individual users. There are many comments about the “one-size-fits-all” philosophy, which results in too much information for users and lack of personalization (Blochl et al, 2003).

An adaptive e-Learning system has been proposed by Blochl et. al (2003). This system applied the user-centric approach to improve its usability and acceptance by users. E-learner requirements are introduced to the system including user skills, learning styles and learning strategy and user profile (Blochl et al, 2003). In this system the user learning activities are observed and combined into user profile. Also, the e-Learning system is adjusted according to the dynamic user profile. However, this system is limited to one e-Learning system - there should be a system for e-Learning portal or multiple e-Learning systems.

Component technologies and artificial intelligence were used to deliver e-Learning. These components include (1) pedagogy agents, (2) interactivity level, (3) quality of feedback, (4) control strategies, (5) tutorial remediation, and (6) student model. Pedagogy agents are used for integrating the behavior of users and e-learning components of the system. Interactivity level, e-Learning interaction can be used to represent conversations, understanding and social learning among students by integrating instructional tasks and social interactions. Pedagogy agents can be used to check student participation, track student progress through task procedures, and addresses students’ errors. Intelligent agents can be used as tools for feedback. User performance during instruction and tutoring should be analyzed to effectively monitor learning. Control strategies, planning for content and delivery strategies should be based on learner knowledge, concept structure such as the curriculum. Tutorial remediation, is the component responsible for selecting appropriate actions to be performed to accomplish a pedagogy task. Student model can be used to render individualized instruction in the system. Students instructional activities can be filtered, analyzed and sorted based on individual profile. This system is proposed to be adapted to changing knowledge requirements of user, be interactive and provide regular access to resource materials (Atolagbe, 2002).

Web-mining techniques have been used to build a recommended agent for e-Learning systems. This agent recommends activities to a learner based on his/her access history. The recommendation should be an on-line activity including doing an exercise, providing messages
on conferencing systems, running an on-line simulation, or web resources. This agent is claimed to improve course material navigation and assist the on-line learning process (Zaiane, 2002).

An agent-based programming language support system for programmers in distance-learning environment has been described. By observing user typing events, behaviors on studying lessons on web browser, tasks and examples, error made by users, and debugging events on the editor, the agent understands user behaviors (Mungunsukh, and Cheng, 2002).

Chen et al. (2004) proposed a personalized e-learning system using the Item Response Theory. This system combines course material difficulty and learner ability as input to provide individual learning paths for learners. The item characteristic function, the maximum likelihood estimation (MLE), is applied to estimate learner ability based on explicit learner feedback. Further, this study proposes a collaborative voting approach for adjusting course material difficulty in order to determine an appropriate level of difficulty parameter for the course material. It was suggested that the system can achieve personalized learning and help learners to learn more effectively and efficiently.

3. Design of the individualized system

The proposed e-Learning system is designed for both mathematics teachers and learners in elementary schools in Thailand. For teachers, it gives advice in preparing teaching materials and protocol based on student backgrounds. These recommendations can be procedures such as specific activities, or content including lessons or in mathematics. For students, the system provides lessons to them as a result of the pretest for mathematics skills.

The system consists of learning interface, access control, analyzer agent, tasks and lesson contents (Figure 1). Users get access to the system via learning interface. The analyzer agent is responsible for extracting the users’ background by using provided input data, and user profile and it is referenced with the provided knowledge base. Advise message, lessons, hints, activities and support actions for teaching and learning are prepared and also authoring interface is updated by domain experts. Learning interface consists of Visual Basics and Web browser integrated in a stand alone environment. Knowledge base includes lectures, teaching guides for elementary teachers in mathematics, rules, and techniques in teaching elementary schools, principles and procedures, and evaluation methods.
Analyzer agent
The agent is the prime section of the system which resides in the server. The analyzer agent gets data from all users including teachers and learners. It identifies learners profile and characteristics from input data given by teachers. The input data is tested with predefined rules which consists of 345 rules in knowledge base which is a part of the inference engine. Forward chaining is used for giving advice in teaching mathematics. The agent sends messages to teachers including the series of contents recommended for teaching.

Figure 2 reveals the table contains a frame of 345 rules. This table is the collection of questions, information and contents of Mathematics course from grade 1 to grade 6 defined by the Ministry of Education. Another source of information obtained from hand books of Mathematic teachers and text books in Mathematics. The table structure includes index, purpose, move, example and content. Index is record number (rule), purpose is the criteria for testing, move is number of records to be skipped, example is question(s) to be asked on the system, and content is materials to be advised for learning.
Figure 2. Rules and conditions in knowledge base

For the student case, there are 12 tests and 20 items kept in the knowledge base. Learners are provided with the test sets to determine their mathematics background. After that, the analyzer recommends practical lessons to the learners.

The system contains five functions: (1) teachers, (2) students, (3) teaching manual, (4) about the system, and (5) edit knowledgebase (authoring interface). Teachers who registered on the system are allowed to manage the knowledgebase by using authoring interface. With this function, the teacher can add, delete or update information/content in the system. Figure 3 shows a home page of the system.

Figure 3. Home page of the system.
Figure 4. Example of a pretest exam for mathematics learners.

Figure 5. Report providing test scores and recommended lessons for the learner.

4. System Evaluation

There are two parts of system evaluations. First part is system efficiency and second is system performance evaluation. Survey questionnaires were distributed to three groups of respondents, ten respondents in each group. The first group consisted of undergraduate students majoring in teaching mathematics, the second were mathematics teachers and third were Web developers. Participants were asked to rate the system efficiency and system interface which included communication skills, comprehension, ease of use, and relevance of the question answering system. A Likert scale ranging from 1 to 5 was used for responses to the questions: 1 represents the lowest score while 5 represents the highest score. Descriptive statistics was used in data analysis.
The system efficiency included smart content sequencing, analysis of solution, adaptive content, text presentation, provided questions, examples, system guidance, reasoning and saving output. Figure 6 shows the system efficiency evaluation. The first six bar graphs represent overall evaluation, while the last four bar graphs represent an evaluation for student modules. Results show that the system efficiency is good, the lowest score is 3.83 (system guidance and reasoning) and the highest is 4.2 (system questions). All scores are higher than the median score (3.0), which can be inferred that the respondents were satisfied with the system.

Results of the system interface evaluations (Figure 7) were not good as system efficiency. The highest score was on save output (3.40), and the lowest one was on screen layout (2.43). Almost all scores (except save output) were lower than the median score (3.0). This indicates that majority of the user interface design slightly satisfied the examiners. There should be some improvement for user interface design.

Overall, the examiners’ evaluations revealed that the user evaluation of system efficiency was good (79.47%) and the system interface including friendliness, screen color, characteristics, text style, navigation guidance and layout is average (55.73%).
5. Conclusions

The approach for developing an agent for the e-learning system has been introduced in this study. This system is based on the integration of individualized learning systems which can be used by both teachers and learners. The concept of this system is to build a knowledge base, frame and rule base for an analyzer agent. As a result, this system will dissolve the problem on “one lesson for all students” limitations and will provide more learner-centric actions.

Future work is recommended on adding more features to the system including developing web portal for e-Learning, or adding dynamics learner profiles to keep track of learning records by using web mining of user behavior which can be done to analyse the pattern of web usage. This will be helpful in designing web sites corresponding to user characteristics.

6. References


