The development of an adaptive e-learning toward the learning style diversity of visual-auditory-kinesthetic

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Abstract

The purpose of this research is to develop an adaptive e-learning model in order to solve the problems of student's learning styles diversity. In the long run, the adaptive e-learning system is supposed to solve the problems of traditional e-learning systems which provide only the same plain hypertext pages to all students regardless of individual learning styles.

The development process consisting of requirements analysis, design and implementation follows an engineering approach that has advantages in terms of separating content, navigation and presentation design. The final product of this research would be a model of adaptive e-learning system toward the student's learning styles diversity. The system will identify the student's learning styles tendency through a set of questionnaire. The questionnaire scores will be used by the system as a basis to provide the student a presentation of learning materials differently. The three possibilities of learning mode are visual, auditory, and kinesthetic**.**

Keyword: e-learning, adaptive, learning styles, visual, auditory, kinesthetic

I. Introduction

Information technology can not be denied has contributed a large part in improving the quality of education both in the field of academic, administrative and management. In the early development of computers, educators have used it to help deliver learning materials in the form of CAI (computer assisted instruction) or to help manage education in the form of CMI.

Internet technology advances provide great benefits for education. Utilizing the Internet in education, among others, is to convey materials or web-based learning

which is often referred to as e-learning systems. E-learning system has been developed by various educational institutions and now becomes a backbone for the implementation of distance education.

E-learning systems are now generally give the same presentation of learning materials for each user because it assumes that the characteristics of all users are homogeneous. In fact, every user has different characteristics in terms of ability levels, learning styles, backgrounds or anything else. Therefore, a user's e-learning is not necessarily getting the appropriate learning materials and consequently the effectiveness of learning is not optimal.

An e-learning system should provide the level of difficulty of learning materials in accordance with the user's ability, and learning how to present the material in accordance with the user's learning style. In other words e-learning system should be able to adapt the appearance of a wide variety of user characteristics, thus having high learning effectiveness.

The problem can be overcome because the e-learning adaptive systems: (1) displays an alternative web page according to individual characteristics, (2) oriented to a wider user group, (3) provide navigation to limit the range of users in finding information. To be able to function as such, then the adaptive e-learning system has major components include domain model, user model and adaptation model (Brusilovsky, 2001; Cannataro, Cuzzocrea, Mastroianni, Ortale, & Pugliese, 2002).

This paper will discuss the process of developing adaptive e-learning to the diversity of learning styles of students starting from the stage of the analysis, design, implementation and evaluation. At the stage of evaluation, it will be conducted formative evaluation of a non-formally called on going formal evauation and commonly known as the Alpha testing.

II.   E-learning Adaptif

E-learning system called adaptive if the system is able to adjust automatically to users based on assumptions about the user's (Oppermann, Rashev, & Kinshuk, 1997). According to Cristea and De Bra (2002), the ability of adaptive e-learning

system to be able to adjust automatically to the user's condition is obtained from the user model. In addition to be adaptive, adaptive e-learning system should also be adaptable, ie, provide an opportunity for users to modify system behavior in accordance with the wishes of the user (Papanikolaou, et.al., 2003).

Adaptive e-learning technology (hypermedia) basically combines the hypermedia technology and the adaptive system (Brusilovsky, 2001). Adaptive e-learning system needs to accommodate the conditions or characteristics of users and store all this information in the user model and then the system will use this information as a basis for delivering learning materials. According to De Bra (2002), the user model obtains information about users by monitoring the interaction, browsing behavior, and testing.

Adaptive e-learning system is developed on the assumption that the individual learning model is able to give better results than other learning models (Invernizzi, Rosemary, Juel, & Richards, 1997; Wasik, 1998; Hock, Pulvers, Deshler, & Schumaker, 2001) . What is meant by this individual learning is the provision of learning materials appropriate to the characteristics of learners. Because the individual learning can not be implemented in a traditional classroom, it is necessary to develop web-based learning programs that are adaptive.

Adaptive a-learning can display learning materials in accordance with the characteristics of the user. This will solve the problems in WBI (web-based instruction) or conventional e-learning such as: (1) displays the same web page to all users regardless of the existence of individual differences, (2) traditional classroom-oriented material that is intended to a specific user, so that other user groups will be difficult to understand the material, (3) are at risk of "lost in space" in learning the material. These problems will reduce the level of learning effectiveness of conventional e-learning.

Meanwhile, because it is a web-based, then the adaptive e-learning will have the same advantages as in the WBI, which is not limited to a particular classroom (accessible from anywhere), not limited to a certain time (can be accessed at any time), and not limited to a particular platform (accessible from any operating system). In

addition, learning materials in WBI (compared to CAI or other instructional media) faster and easier to update, faster in distribution to users, more users can access.

III.   Learning Styles

There are many definitions of learning styles. According to James and Blank (1993), the learning style is defined as the habit of learning where one feels the most efficient and effective in receiving, processing, storing and removing something that is learned. McLoughlin (1999) concluded that the term learning style refers to the habit of acquiring knowledge. Honey and Mumford (1992) defines learning styles as attitudes and behaviors that demonstrate how someone has the most preferred learning.

Summary of some research on learning styles suggests that (1) some students have different learning habits with others, (2) some students learn more effectively when taught with the most preferred method, and (3) student achievement related to how to learn (Riding & Rayner, 1998). Learning styles affect the effectiveness of training, regardless of whether the training is done face to face or on-line (Benham, 2002; Surjono, 2006). This shows how important the role of learning styles in teaching and learning.

Learning styles is often measured using questionnaires or psychometric tests (McLoughlin, 1999). There are a variety of tools to measure learning styles, including:
- Honey and Mumford's Learning Styles Questionnaire (Honey & Mumford, 1992)
- Grasha-Riechmann Student Learning Style Scales (Hruska-Riechmann & Grasha, 1982)
- Felder's Index of Learning Styles (Felder & Silverman, 1988)

One learning style which is known by its simplicity is VAK. The VAK learning style use three main sensory receivers, namely visual, auditory and kinesthetic in determining a dominant learning style of learners (Rose, 1987). The VAK learning styles is based on the modality theory that although in each of the learning process of students receiving such information from three sensories, but there are one or two dominant sensories.

IV.   System Development

The development of the adaptive e-learning system is different in some respects form other software development in general. According to Koch (2000), this difference is mainly concerned with navigational facilities, the role of the user, and dynamic adaptation of learning materials and presentations as well as navigation. The model development is done through an engineering approach with the following stages:

IV. 1. Analysis

The analysis is the first stage in the development of an adaptive e-learning model. In the analysis phase, it is generated a description of system requirements, a description of system functions and the main features of the system which is expected. This adaptive e-learning system is expected to provide a presentation of learning materials which vary according to the tendency of the user's learning style. Thus the system must be able to identify the diversity of learning styles of users and take advantage of user data as considerations to deliver presentations.

The users of the adaptive e-learning system is expected to obtain learning materials according to learning styles, so that the learning process becomes more optimal. As described by James and Blank (1993) that learning style is the habit of learning where one feels the most efficient and effective in receiving, processing, storing and issuing something learned.

A set of questionnaires is used to identify trends in the user's learning style. The learning style model that was adopted in this e-learning system is Visual-Auditory-Kinesthetic (VAK). The VAK model is very popular but it is quite simple in its implementation. The VAK model will identify trends in student learning styles associated with the visual aspects (eg: pictures, diagrams, graphs, etc.), audio aspects (eg, narration, sound effects, etc.) and aspects of kinesthetic or movement (eg: holding, doing, etc.).

The function of the overall system are expected as follows:

- The system displays a front page where users should be able to login and get a preliminary information.
- If users log in as a student, the system provides a list of questions (questionnaire) to reveal the tendency of the user's learning style.
- The system determines the tendency of the user's learning style based on scores obtained in answering the questionnaire.
- Users who get majority scores of V aspects will be directed to the mode of learning that highlight the visual elements. In this mode the system will display the learning materials with accompanying illustrations in the form of drawings, diagrams, graphs, etc.
- Users who get majority scores of A aspects will be directed to the mode of learning that highlight the audio element. In this mode the system will display the learning materials in the form of illustrations, accompanied by an audio narration or verbal descriptions.
- Users who get majority scores of K aspects will be directed to the mode of learning that highlight the kinesthetic elements. In this mode the system will display the learning material, accompanied by illustrations that require hand movement (move, move, push, etc.).
- At the end of the learning materials, the system will display a test to evaluate the achievement of student understanding.
- If the test result is less than the minimum threshold, then the system gives the opportunity for users to fill out the questionnaires again. The student may possibly follow other learning modes.
- If users log in as a lecturer, the system displays an interface to edit and upload the learning materials.
- If users log in as an admin, the system displays an interface for managing the system.

IV. 2. Design

The results of the above analysis stage is used as an input in the next stage of design. The first phase of the design produce a system architecture which is based on a summary of the functional systems and features of adaptive e-learning systems.

The next stage of the design produce a system design which is implemented using Use Case diagrams. Use Case diagrams are used to demonstrate the functionality of an entity such as a system, sub-system or class by using actors, use cases and relationships between them (Alhir, 2002; Booch, Rumbaugh, & Jacobson, 1999).

An actor is a set of roles which the user can do activities when interacting with the entity. Actors can be either human users or other systems. A use case is a unit of behavior or functionality of an entity viewed from the users perspective. From the list of functional and features that have been obtained in the analysis stage, it can be determined actors and use cases as follows.

- Actor: Student, Lecturer, Admin and Sub-system
- Use Cases:
  - Students (students who have enrolled, the student who has not registered): register, login, logout, fill out the questionnaire, study the learning materials, do exercises, work on test questions, view profiles, repeat fill out the questionnaire.
  - Lecturer: login, logout, edit learning materials, upload learning materials, edit test questions, edit questionnaires.
  - Admin: login, logout, manage student and lecturer
  - Sub-system: create a profile, update profile, present the questionnaire, determine the score results of the questionnaire answers, direct students to a particular instructional mode, present learning materials with a particular mode, present the test questions, give students the opportunity to repeat the questionnaire.

IV. 3. Implementation

The results of the design phase is realized through a programming work. The adaptive e-learning system is implemented using an open source LMS (Learning

Management Systems) called Moodle. As the Moodle LMS basically does not have adaptivity features, it would require additional modules that can integrate functions of adaptivity into the Moodle LMS.

The reason why the adaptivity functions are implemented in the form of modules not immediately programming in the Moodle are its flexibility. In this way, this adaptivity module can be easily installed in a variety of elearning system that uses standard Moodle LMS.

The front page of the adaptive e-learning system is the entry for the user to the system (Figure 2). The function of this page is to provide login access to all users and provides general information about the adaptive e-learning. Categories of users in the adaptive e-learning system still follow the Moodle categories, namely: Admin, Course creator, Teacher, User, and Guest. The adaptive e-learning system can be accessed via: **http://elearningadaptive.com**
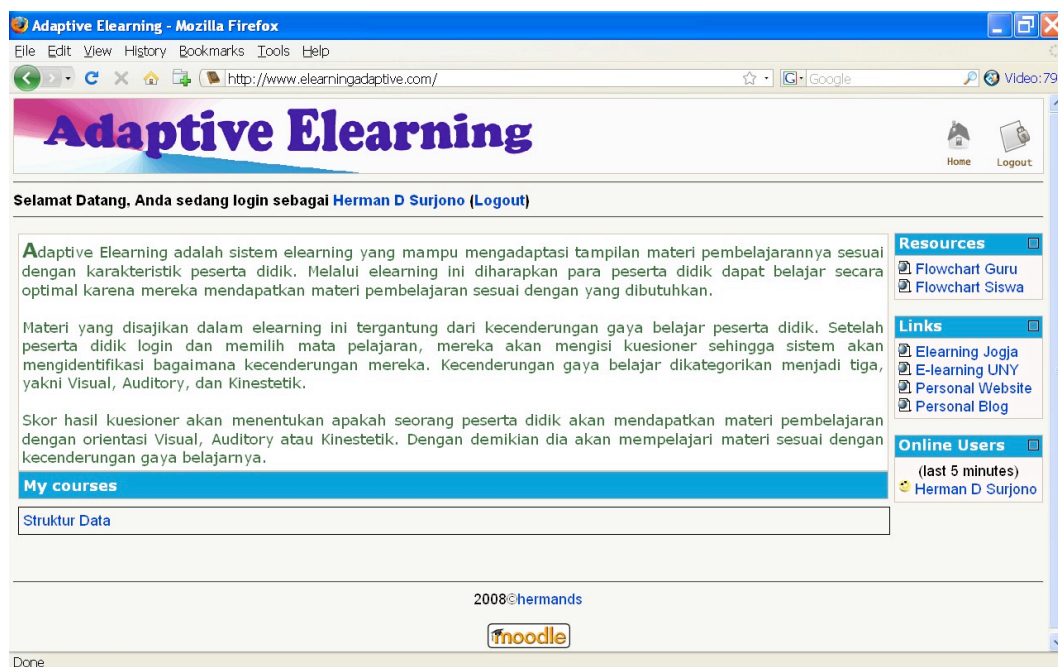

Figure 2. A front page of the adaptive e-learning system

IV. 4. Evaluation

Overall the evaluation stage for an e-learning system can be divided into two, namely formative evaluation and summative evaluation. The formative evaluation is carried out when the development process is still ongoing with the aim that a better system can be acheieved before the system is widely used by the user. While the summative evaluation is conducted when the system is done and is widely used by users in order to determine the effectiveness of e-learning systems in the learning activities.

According to Allessi and Trollip (2001), the formative evaluation can be regarded as Alpha Testing. In the software development process, in addition to always be evaluated in a continuous or ongoing evaluation, at least after the program finishes it needs two kinds of evaluation, namely Alpha Testing and Beta Testing. In the Alpha testing, some personnel such as staff developers, instructional designers, content experts, media experts were asked to run the program from beginning to end in order to evaluate the program and material feasibilities. The goal is to identify as many problems as possible in the program in order to revise the program.

The results of this evaluation can be described as follows.

- The ongoing evaluation was conducted by researchers at every stage of the system development, i.e. ranging from analysis, design to implementation. The ongoing evaluation at the design and implementation stage is done by way of comparing whether the work is done in line with the functional system. In the event of non-compliance, then the job must be immediately corrected. With this ongoing evaluation, the final result will meet the expected criteria.

- The final performance of the adaptive elearning is that the system is working in accordance with the expected functionality, which is capable of displaying learning materials in accordance with the trends of student learning styles. The system can identify the trends of students' learning styles through a questionnaire.

V. Summary

The adaptive e-learning model was developed on the basis of the fact that a conventional e-learning has limitations which is only capable of delivering the same presentation of learning materials for all users. The development of the adaptive e-

learning model to the diversity of learning styles was carried out following an engineering approach: analysis, design, implementation and evaluation. At the evaluation stage it was conducted an ongoing evaluation and Alpha testing. To determine the learning effectiveness of the adaptive e-learning system, it needs further experiment study involving real users.

VI.   DAFTAR PUSTAKA

Alessi and Trolip. (2001). *Multimedia for learning: Methods and development.* Boston Allyn and Bacon

Benham, H. C. (2002). *Training effectiveness, online delivery and the influence of learning style.* Paper presented at the 2002 ACM SIGCPR Conference on Computing Personal Research, Kristiansand, Norway.

Brusilovsky, P. (2001). Adaptive hypermedia. *User Modeling and User Adapted Interaction, 11*, 87-110

Cannataro, M., Cuzzocrea, A., Mastroianni, C., Ortale, R., & Pugliese, A. (2002). *Modeling adaptive hypermedia with an object-oriented approach and XML.* Paper presented at the 2nd International Workshop on Web Dynamics (WebDyn 2002) in conjunction with the 11th International World Wide Web Conference (WWW 2002), Honolulu, Hawaii.

Cristea, A., & De Bra, P. (2002). *ODL education environments based on adaptivity and adaptability.* Paper presented at the World Conference on E-Learning in Corp., Govt., Health., & Higher Ed. (ELEARN).

De Bra, P. (2002). Adaptive educational hypermedia on the web. *Communication of the ACM, 45*(5), 60-61.

Hock, M. F., Pulvers, K. A., Deshler, D. D., & Schumaker, J. B. (2001). The effects of an after-school tutoring program on the academic performance of at-risk students and students with LD. *Remedial and Special Education, 22*(3), 172-186.

Honey, P., & Mumford, A. (1992). *The Manual of Learning Styles* (3rd ed.). Maidenhead, UK: Peters Honey.

Invernizzi, M., Rosemary, C., Juel, C., & Richards, H. (1997). At-risk readers and community volunteers: A three-year perspective. *Journal of Scientific Studies in Reading, 1*, 277-300.

James, W. B., & Blank, W. E. (1993). Review and critique of available learning-style instruments for adults. In D. Flannery (Ed.), *Applying cognitive learning styles* (pp. 47-58). San Francisco: Jossey-Bass.

McLoughlin, C. (1999). The implications of research literature on learning styles for the design of instructional material. *Australian Journal of Educational Technology, 15*(3), 222-241

Oppermann, R., Rashev, R., & Kinshuk. (1997, July 14-16). *Adaptability and adaptivity in learning system.* Paper presented at the Knowledge Transfer, London, UK.

Papanikolaou, Grigoriadou, M., Kornilakis, H., & Magoulas, G. D. (2003). Personalizing the interaction in a web-based educational hypermedia system: The case of INSPIRE. *User Modeling and User Adapted Interaction, 13*(3), 213-267.

Riding, R., & Rayner, S. (1998). *Cognitive styles and learning strategies*. London: David Fulton Publisher

Rose, Colin, (1987). Accelerated Learning. New York: Bantam Dell Pub Group

Surjono, H.D. (2006). *Development and Evaluation of an Adaptive Hypermedia System Based on Multiple Student Characteristics*. Unpublished doctoral dissertation, Southern Cross University, Lismore NSW Australia.

Wasik, B. (1998). Volunteer tutoring programs: A review of research. *Reading Research Quarterly, 33*(3), 266–293.