ACCEPTABILITY OF ADAPTIVE E-LEARNING SYSTEM BASED ON KNOWLEDGE-LEVEL

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SCHOOL OF INFORMATICS SCIENCE LABUAN
UNIVERSITI MALAYSIA SABAH
2009

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THESIS SUBMITTED IN PARTIAL FULFILLMENT FOR THE DEGREE OF MASTER OF SCIENCE

SCHOOL OF INFORMATICS SCIENCE LABUAN
UNIVERSITI MALAYSIA SABAH
2009

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS THESIS

JUDUL : ACCEPTABILITY OF ADAPTIVE E-LEARNING SYSTEM BASED ON KNOWLEDGE - LEVEL

IJAZAH : SARJANA SAINS (TEKNOLOGI MULTIMEDIA)

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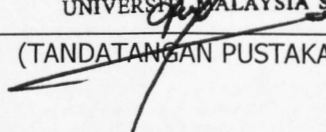
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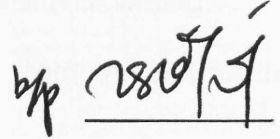
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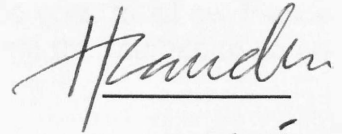
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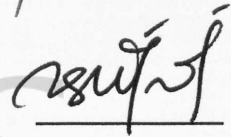VIVA DATE   : **8th MAY 2009**

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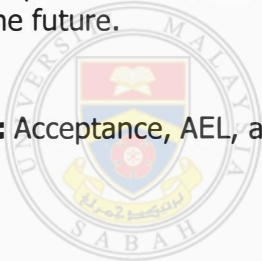
ABSTRACT

ACCEPTABILITY OF ADAPTIVE E-LEARNING SYSTEM BASED ON KNOWLEDGE-LEVEL

Adaptive E-Learning (AEL) based on students' knowledge-level contributes many benefits to its users. The study on such system is vital as currently, most AEL only consider student's preferences, interest, and navigation behaviour when investigating student's behaviour for personalized services. Further, compared to previous studies on AEL system, user's acceptance towards this type of system, however, has not been assessed and understood thoroughly. In order to get more experience about the acceptance of AEL system that tailored learning content based on students' knowledge-level, a survey consisting of 314 students have been conducted. Based on the Technology Acceptance Model (TAM), this study proposed a conceptual model of AEL system acceptance. The result of regression analysis shows a positive indication on the acceptance of AEL system among students with adaptability feature within the system affect student's intention to use the system. The study provides insight into the usefulness of an AEL system based on students' knowledge-level and gives more intensive view of the AEL system users. It is an important step towards a better understanding of the user's intention on using the system in the future.

Keywords: Acceptance, AEL, adaptability, benefits, TAM

ABSTRAK

AEL berdasarkan tahap pengetahuan pelajar menyumbang pelbagai manfaat kepada penggunanya. Penyelidikan terhadap sistem tersebut amat penting kerana pada masa kini, kebanyakan sistem AEL hanya mengambil-kira aspek kecenderungan pelajar, minat, serta kelakuan navigasi apabila menyiasat tentang kelakuan pelajar dalam perihal servis peribadi. Tambahan lagi, jika dibandingkan dengan penyelidikan yang telah dilakukan sebelum ini, penerimaan pengguna terhadap sistem seperti ini belum pernah dinilai dan difahami sebaiknya. Bagi mendapatkan lebih pengetahuan mengenai penerimaan sistem AEL yang menyediakan kandungan pelajaran berdasarkan tahap pengetahuan pelajar, suatu tinjauan penyelidikan yang terdiri daripada 314 pelajar telah dijalankan. Berdasarkan TAM, suatu model konseptual mengenai penerimaan sistem AEL telah dihasilkan. Keputusan penyelidikan menggunakan analisis regrasi menunjukkan petanda positif pada penerimaan sistem AEL di kalangan pelajar dengan ciri penyesuaian pada sistem tersebut memberi kesan terhadap niat pelajar untuk menggunakan sistem AEL. Penyelidikan in menyediakan pemahaman tentang keperluan sistem AEL yang berdasarkan tahap pengetahuan pelajar. Tambahan pula, penyelidikan ini memberikan pandangan yang intensif mengenai pengguna sistem AEL serta langkah penting ke arah pemahaman yang lebih baik tentang niat pengguna dalam menggunakan sistem tersebut di masa hadapan.

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LIST OF SYMBOLS AND SHORT-FORMS

Σ	Total
A	Adaptability
ATRC	Adaptive Technology Resource Center
AEL	Adaptive E-Learning
b_0	Intercept of Regression Model
b_1	Slope of Regression Model
c	Percentage = 100%
COFALE	Flexibility in Adaptive Learning Environments
EX-COFALE	Extension of Flexibility in Adaptive Learning Environments
H	Hypothesis
ICT	Information and Communication Technology
IS	Information System
IU	Intention to Use
KMO	Kaiser-Meyer-Olkin
M	Student Mark in Percentage (%)
n	Question Number
p	Probability
PCA	Principal Component Analysis
PEOU	Perceived Ease of Use
PU	Perceived Usefulness
R	Multiple Correlation Coefficients
r	Pearson Correlation Coefficient
R^2	Variability in the Outcome
SA	System Adaptability
SDLC	System Development Life Cycle
Sig.	Significance
SPSS	Statistical Package of Social Science
SRS	Sample Random Sampling
SSIL	Labuan School of Science Informatics
SS_M	Model Sum of Squares
SS_R	Residual Sum of Squares
SS_T	Sum of Squared Differences
TAM	Technology Acceptance Model
UMS-KAL	Universiti Malaysia Sabah – Labuan International Campus
UNITAR	Universiti Tunku Abdul Rahman
VIF	Variance Inflation Factor
x	Total Mark for Question Answered by the Student
X_i	i-th Participant's Score on Predictor Variable
Y_i	Predicted Outcome
a	Cronbach's Alpha
β	Standardized Regression Weight
ε_i	Residual
θ_i	Answer for Question i

1.1   Research Background

Today we are in the midst of one of the most transformative technological periods in educational history which is Information and Communication Technology (ICT) based education. ICT has leapfrogging the development of digital and network technologies in enhancing the quality of human life in many aspects including education. Adaptive e-learning (AEL) system is part of this revolution and has become an increasingly useful tool to improve the quality of education in our evolving society. AEL is defined as the ability of an e-learning system to adapt its learning contents whether to the learning style, preference, cognitive style, or even to the knowledge-level of a student (Mosston & Ashworth, 1990; Srisethanil & Baker, 1995; Beaumont & Brusilovsky, 1995; Brusilovsky, 1996; Brusilovsky, 2001).

What drives AEL system that tailored learning content according to the students' knowledge-level? What are the benefits offered by the AEL system? At the bottom line, the heterogeneity of knowledge-level that exists among students has led to the proposal of the AEL system. This is true as Brusilovsky (1996) claimed that AEL could accommodate the variation of students' profile whereby one of the profiles is knowledge-level. The adaptability of a learning content towards students' knowledge-level is essential because it could increase students' learning activities, provides for a better understanding on subject learned, and give an opportunity for the students to achieve their learning goal more efficiently (Jih, 1996; Cantoni *et al.*, 2004; Brkovic *et al.*, 2006; Waite *et al.*, 2007; Mooij, 2007). Specifically, adaptability feature has enlarges the functionality of a non-AEL system. Note here that throughout the study, the researcher will use the term of non-AEL as well e-learning interchangeably to address an e-learning application.

Despite the benefits offered by AEL system which tailored it learning content according to students' knowledge-level, the acceptance of the system among students has not been tested. The study focused on the acceptance of the

AEL system among student due to the fact that user acceptance is an important primary measures of system success as said by DeLone & McLean (1992). Adaptability feature is predicted as the external stimulus that affects students' acceptance on AEL system because of the feature is claimed to be the added value for the learning system and in fact, the feature is the main factor that create adaptability characteristic on a non-AEL system. Herewith, the adaptability feature within an AEL system will be assessed to justify whether the feature really contributes in the acceptance of such system. The examination of the system acceptance among users is a vital issue for the researcher in order to predict the system future usage and to assist the system future development.

1.2 Research Motivations

There are two main factors that drive this research. The first reason is due to the conscious on the importance of adapting learning content to students' knowledge-level. Studies have justified that a learning content which does not adapt according to the students' knowledge-level will affect student comprehension on subject learned (Donaldson & Knupfer, 2002; Cantoni *et al.*, 2004; Waite *et al.*, 2007), their learning effectiveness (Rockart & Flannery, 1983; Mackay & Elam, 1992), learning performance (Boyle & Encarnacion, 1994; Emurian *et al.*, 2003; Chen *et al.*, 2006), and learning motivation (Mooij, 2007). Besides that, there is also a lack in the study of AEL system which focused on adapting its learning content according to students' knowledge-level. This has been supported by Chen *et al.* (2006) where according to them most of AEL system nowadays only considering on adapting the system towards students' preferences, interest, and browsing behaviour, and neglect the importance of students' knowledge when implementing personalized mechanisms. Thus, this has motivates the researcher in studying on such system.

The second factor that drives to this research is due to the limited study pertaining to the acceptance assessment of an AEL system which tailored its learning content according to the students' knowledge-level. Although studies have been done in the field of AEL to increase the functionality of non-AEL system and despite the benefits offered by AEL system, however, user's acceptance towards this type of system has not been assessed and understood thoroughly. As far as concern, there is a scarce research that examines the system acceptance by

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extending adaptability feature as the external stimulus which affects students' acceptance towards the system. Indeed, the researcher believes that benefits alone could not be used as the assumption that AEL system will be accepted by its users. Hence, this has motivates the researcher to overcome the shortcoming by examining the system acceptance among students with the used of adaptability feature as the external determinant (stimulus) that affect such system acceptance. Furthermore, it was said that user acceptance is an important primary measure of system success (DeLone & McLean, 1992). This statement has encouraged and even increased the researcher's interest to gauge the acceptance of AEL system in which it is claimed as a beneficial learning system and to predict the system future usage among students.

Generally, this study attempts to answer and expound three distinct questions which are: (1) why does adapting learning content according to students' knowledge-level is important?, (2) if the system is being applied within our education system as another means of learning method, does it being accepted by its target user?, and (3) does the adaptability feature really affect users' acceptance or users' intention in using the AEL system in the future?

1.3 Research Objectives

Based on the research motivation, four research objectives have been developed for the research.

i)   To examine the initial acceptance of AEL system which tailored its learning content according to the students' knowledge-level as an alternative learning method by using adaptability as the external stimulus.

ii) To examine whether adaptability feature influence the acceptance of an AEL system.

iii) To develop an acceptance model for AEL system which provides learning based on students' knowledge-level.

iv) To outline a recommended guideline for developing an electronic-based learning system

1.4   Research Hypotheses

There are five hypotheses identified in this research resulted from the developed Technology Acceptance Model (TAM) - based model which can be read as follows:

i)   H1: System adaptability has a significant positive relationship with perceived usefulness.

ii)   H2: System adaptability has a significant positive relationship with perceived ease of use.

iii)   H3: Perceived ease of use has a significant positive relationship with perceived usefulness.

iv)   H4: Perceived usefulness has a significant positive relationship with intention to use AEL system.

v)   H5: Perceived ease of use has a significant positive relationship with intention to use AEL system.

1.5   Research Scope

The scope of the adaptability feature in AEL system is on the ability of the system in providing learning content based on students' knowledge-level. Knowledge-level is used as the source of adaptation because it is the most important factor that enables students to understand more on a new learning topic (Donaldson & Knupfer, 2002).

The sources of the data in this research are collected from primary data and as well as secondary data. Primary data is gathered through questionnaires distribution among the respondents, whereas, secondary data is gathered through literatures survey.

The scope of this research is undergraduate students from the Labuan School of Informatics Science (SSIL) of Universiti Malaysia Sabah – Labuan International Campus (UMS-KAL) who has no priori experience in using an AEL system. The main reason of selecting this student as the scope is because the developed prototype which is used as the tool in acceptance assessment, is in a Differentiation domain. Differentiation is part of the topic included in Basic Mathematic (IT1113) subject, one of the major subjects taken by SSIL students. Therefore, the scope selection is relevance. Moreover, among the SSIL students,

only those who never experience in using AEL system will be selected, while those with experience will be eliminated. This is to ensure that the data gather is an initial exposure data.

Initial exposure data is essential for two distinct reasons. Firstly is to avoid bias during the investigation of AEL system acceptance. According to Straub *et al.* (1995) and Szajna (1996), efficacy of 'perceive ease of use' component in TAM may decline with user experience on particular system. Secondly, the data is needed so that it could provide a priori information on system acceptance which is important for the system future development.

1.6   Research Significance

This research has a several significances which are listed as follows:

i)   Theoretically and empirically investigates the benefits and usefulness of adaptability feature within an AEL system which further could provide insight into the need for AEL system that based on students' knowledge-level as an alternative learning method to the class-based lecture.

ii)   Empirically measures the acceptance of AEL system that provides learning content based on students' knowledge-level. This result of the acceptance assessment could provides more intensive view of the AEL system users and also an important step towards a better understanding on the user's intention in using the system in the future. Hence, this insight could be used as a reference for education institutions and educationist in implementing AEL in their education system such as avoiding any non-profitable investment since the investigation of initial acceptance of the system has been done through this present study.

iii)   Further, it is hoped that a list of potential guidelines of system development can be outlined from the result gathered through the acceptance assessment. This guideline can be use as a reference when developing an e-learning system in the future. It is essential so that anyone, especially in education area, could develop a learning system which could induce users' acceptance toward the system by considering factors that affect learning system acceptance and thus ensure that the system will be continually use by the students, if not to increase it

usage. This is true as claimed by Deng *et al.* (2004) the determination of initial acceptance during pre-assessment of system acceptance is important so that the results obtained is applicable as a reference for the system future development.

1.7   Chapters Organization

Chapter 1 introduce the topic studied by stating the motivation that drives the present study, research objectives, research hypotheses, the research scope, and the significance of the research.

Chapter 2 involve extensive study on the previous literature pertaining to e-learning, AEL, and TAM. The data obtained from this literature survey is useful to understand research background and to have an insight on the environmental context of research problems. Besides that, the information gathered is useful in developing the proposed model which developed based on TAM model, prototype of AEL, and the research questionnaire. All these developed products will be used as the supportive tools for the acceptance assessment during the quantitative survey.

Chapter 3 present and explain the methods used in this research in order to complete the study.

Chapter 4 discuss the overview of the AEL prototype which is developed as the supportive tool for the acceptance assessment conducted during the quantitative survey among respondents.

Chapter 5 show the results attained through the analyses using Statistical Package of Social Science (SPSS) application. The analyses involved are frequency analysis, factor analysis, reliability analysis, and regression analysis.

Chapter 6 discuss and conclude the findings of the study. Identification and explanation pertaining both the research objectives and hypotheses has been met or not is presented within this chapter.

Chapter 7 state the research contributions, implications, and limitations. Besides that, this chapter also provides suggestions for future research. These suggestions are proposed based on any shortcoming found in this research.

LITERATURE REVIEW

2.1   Definition of Adaptation

'Adaptation' is defined as "*the state or process of changing to suit a new situation*", whereby the 'situation' is defined as "*the things happening at particular time*" (Oxford Dictionary, 2007). In this research, the 'situation' posits as student's knowledge-level. Therefore, adaptation in this research context is defined as the process of changing to suit student's knowledge-level.

2.2   Definition of Adaptation in E-Learning

Adaptability feature enlarges the functionality of a non-AEL system. Researchers have generally defined AEL as an e-learning system that can adapt e-learning content to meet the characteristic(s) of individual users (Vu Minh Chieu *et al.*, 2006; Gu & Sumner, 2006). While, Brusilovsky (1996) has specifically defined an AEL system as a hypermedia system which reflects some features of the user in the user model and apply this model to adapt visible aspect of the system to the user. User model is a collection of individual user's information (Xiao *et al.*, 2004) or user record which keeps in a user database (Alotaiby *et al.*, 2005). In other words, according to Brusilovsky (1996) again, the system should satisfy three criteria:

1. It should be hypertext or hypermedia. Hypermedia means 'pages' or nodes connected by links (Brusilovsky, 1997).
2. It should have user record.
3. It should be able to adapt the hypermedia using the record of a user.

Basically, learning content can be adapted whether to student learning style, preferences, cognitive style, or knowledge-level (Mosston & Ashworth, 1990; Srisethanil & Baker, 1995; Beaumont & Brusilovsky, 1995; Brusilovsky, 1996; Brusilovsky, 2001). As for this research, the focus is in accommodating the learning content based on student's current knowledge-level in the subject being learned. This adaptation works by providing the student with the most appropriate learning content, which has been customized into distinguished learning modules, according

to their knowledge-level. Therefore, based on the above definition of adaptation and by taking into account the general and specific definition of an AEL system, the adaptation of e-learning in this research context is defined as the process of changing or providing an e-learning content that suits to the student's knowledge-level. Garcia-Barrios (2006) said that AEL system can be a supportive solution in a variety of application scenarios such as in the education perspective because it could supplies a personalized learning material to an individual learner. There are many AEL system that implement adaptive mechanism based on the student's knowledge-level and these systems are successfully achieved the need of providing a conductively learning environment to the student.

2.3   Review of Existing AEL System

In order to implement adaptability, Brusilovsky (1999) presents five main techniques concerning the learning components and one-technique concerning problem-solving, as follows:

1. Adaptive presentation of learning content – At any given time during the learning process, the learner is provided with learning contents that are appropriate to their present competence.
2. Adaptive use of pedagogical device – At any given time during the learning process, the learner is encouraged to do learning activities that are appropriate to their learning competence.
3. Adaptive communication support – For any learning discussion, the learner is suggested with peers who are appropriate to help him of her overcome their own difficulty in learning a particular subject.
4. Adaptive assessment – At any given time during the learning process, the learner is provided with assessment problems and methods that are appropriate to their present competence.
5. Adaptive problem solving support – For any problem-solving session, the learner is supported with appropriate feedback such as hints to solve the learning problem effectively.

Brusilovsky (1999) further stated that the above five operational criteria support adaptation within an adaptive system and should be applied to show the adaptive mechanism. However some AEL system does not adopt all of the

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operational criteria yet it still known as an adaptive system. According to Tetiwat & Igbaria (2000), this kind of system still be called as an AEL system because the system support a number of criteria which offer the user an adaptability experience. An example of such systems is SimQuest, COFALE, and EX-COFALE.

SimQuest is one of the AEL systems that do not support all of the operational criteria suggested by Brusilovsky (1999). It developed by De Jong, Van Joolingen and Van Der Meij. The design of SimQuest learning system is based on computer-based simulations and scientific discovery learning, a self-directed and constructivist form of learning (Von Joolingen & De Jong, 1997). It is claimed that students need to possess a certain number of scientific discovery skills in order for the discovery of learning to be successful. These skills include hypothesis generation, experiment design, prediction, and data analysis. Lack of these skills can lead to an ineffective discovery behavior such as drawing incorrect conclusions from collected data. Therefore, the authors support a number of adaptability features and guidelines which allowing as well assisting learners to carry out scientific experiments, thus learn by themselves easily. Instead of five adaptability operational criteria suggested by Brusilovsky (1999), SimQuest only supports two components of the adaptive criteria which are adaptive presentation of learning contents and adaptive pedagogical devices. The first criterion (adaptive presentation of learning contents) is shown by the system using a multiple model of learning where the system provides a combination of texts, graphs, simulations, audios, and videos. The authors believe that the multiple mode of presentation would assist the student to grasp diverse aspect in learning a particular subject and directly meet the concept of acceleration or speed in learning process. Other than that, SimQuest also apply multiple perspectives of learning in order to support the adaptive presentation of learning content where SimQuest prepared many kind of learning materials with each materials is differentiate by the complexity of the learning topic. The multiple perspective of learning concept is used because according to Von Joolingen and De Jong (1997), each learner possess a mental model such as a mental representation or knowledge structure about a concept or a situation at any point in time. It is said by Tauber and Ackermann (1991) that through personal experience, the learner may undergo a certain number cognitive changes and then develop a higher mental model. For instance, a beginner could

start with a "novice" model on a given subject and gradually evolve toward an "expert" model through his or her learning process. Furthermore, SimQuest support adaptive use of pedagogical devices by encouraging the student to study the same concept in different contexts, at different times, and by different methods through experimenting with different kind of simulations. In every simulation, students are always stimulated to examine a number of interrelated concepts systematically. The idea of creating a multiple simulation is to assure that the best simulation concept is used to an appropriate student (Von Joolingen & De Jong, 1997).

Other then SimQuest, there is another AEL system that adapts its content based on the student's knowledge-level which is Cognitive Flexibility in Adaptive Learning Environments or in short COFALE. It is an adaptive system that creates a learning environment by supporting constructivism. According to Vu Minh Chieu (2007), constructivism is a learning theory which stated that people learn by actively constructing their own knowledge, based on prior knowledge. Therefore, COFALE is build to adapt to the user's knowledge-level. The design and use of COFALE system is based on pedagogical principles which is cognitive flexibility, an important facet of constructivism. Compared to contemporary adaptive learning systems, COFALE seems to fulfill all the needed criteria for cognitive flexibility (Gu & Sumner, 2006). According to Spiro & Jehng (1990), cognitive flexibility is "*the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situation demands*". COFALE is based on ATutor, an open-source, web-based learning content management system (LCMS) designed and maintained by Adaptive Technology Resource Center (ATRC, 2007). COFALE gives the tutor the ability to implement various types of student models. For example, one can implement two types of student model, 'novice' and 'expert'. Also, the learning content in COFALE can be decomposed into quite primitive content (or learning) units, so that the system can present each student with a different content unit. COFALE supports three adaptive operation criteria which are (1) adaptive presentation contents, (2) adaptive use of pedagogical device, and (3) adaptive communication support. In order to provide the first adaptive criteria, the system systematically presents students with learning contents in a web-based platform using a multiple mode of presentation. This mean that the system will display the same content to the student but each student will have their option to

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