Empirical Evaluation of Mixed Approach in Adaptive Hypermedia Learning System

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Abstract

Research on learning has shown that student learn more effectively when taught with methods that suits to their learning style. Regarding to the problem, an adaptive hypermedia learning system that exploit a mixed approach has been developed. The mixed approach comprise of 2 approaches; computer intelligence (fuzzy logic approach) and personality factor (MBTI approach) that use to individualize the learning material structure. It aims to utilize the learning characteristics and provide a personalized learning environment that exploit pedagogical model and fuzzy logic techniques. The learning material consists of 4 structures; 1) theory, 2) examples 3) exercises and 4) activities. The pedagogical model and learning characteristics are based on the student's personality factor (Myers-Briggs Type Indicator (MBTI)), whilst the fuzzy logic techniques are used to classify the structure of learning material which is based on student's personality factors. This paper tends to exemplify the evaluation process for mixed approach. The evaluation is comprised of two methods; usability and utility which is both of the methods are referring to the learnability factor, efficiency factor, satisfaction factor and accuracy factor. The system has been tested by 44 students from Faculty of Computer Science. Most of the participants give good response and the results from the evaluation have been very satisfactory.

Keywords: Adaptive hypermedia learning system, evaluation, usability, utility, learning style approach, fuzzy logic .approach.

1. Introduction

The adaptive hypermedia learning system (AHLS) is a computer based learning system in which interactive and dynamic learning module is customized to each student. In spite of the great amount of AHLS research, there is a lack of literature about the attempts to incorporate learning styles in adaptive web-based system. Several systems adapting different learning styles have been developed to date. However, it is not clear which aspects of learning characteristics are worth modeling, how the modeling can take place and what can be done differently for users with different learning style [1]. These problems may lead to students facing difficulties to understand what is being taught and decrease of students' interest to continue their study in the subject time taken to finish a particular lesson session [2].

Due to the problem above, an AHLS has been developed which is provide a personalized learning environment that exploit computation intelligent techniques (fuzzy logic approach) and personality factor (Myers Briggs Type Indictor – MBTI approach). This mixed approach is used to produce a dynamic course adaptation which will present the appropriate structure of learning material to the student [3].

In this AHLS, the architecture for the learning strategy used only 4 from 8 personality types in MBTI personality factor and selected based on the competence in online distance learning education or web based system [4, 5]. The four MBTI personality types used in this research are; Extrovert (E); Introvert (I); Sensing (S) and Intuitive (N). Whilst, the fuzzy logic approach used Mamdani-style inference to capture the

appropriate learning structure that suit to each student [6]. Mamdani-style inference is chosen after several testing have been done using Matlab finding the most similar result that fulfill expert's expectation [7].

Researchers have pointed out [8,9] the need for the evaluation of Intelligent Tutoring Systems (ITS). Among the advantage of evaluation is that it provides an opportunity to learn from mistakes and is capable of improving the life-span ITSs as well as their usability [9].

This paper describes an empirical study that examines the accuracy of learning experience preference judged by students and several usability testing. The paper is structured as follows: Section 2 discusses the mixed learning style (MBTI) and fuzzy logic approach. Section 3 illustrates on importance of evaluation for adaptive hypermedia learning system. Section 4 illustrates the method and processes for evaluation. Section 5 illustrates the detail on result and discussion, followed by summary in section 6.

2. Mixed learning style and fuzzy approach

Currently, several systems providing adaptation to users' learning styles have been created [3] and most of the adaptation of student's learning style to learning is totally based on the dominant student learning style (see [4] and [5]). The dominant results in [4] and [5], are mainly stated as one particular student's preferable learning material, ignoring other learning styles that a student may also posses. In reality, a student's learning style can be of mixed traits, each with a certain percentage of membership to the student's overall style.

Our AHLS used to model the fuzziness in student's learning style and the appropriate learning material method suitable for student's fuzzy learning styles membership. It aims to utilize the learning characteristics and provide a personalized learning environment, that exploit learning style and fuzzy logic techniques as shown in Figure 1. The pedagogical model and learning style refer to student's personality factor based on the Myers-Briggs Type Indicator (MBTI) [10, 11]. Based on the MBTI theory, fuzzy logic techniques are then used to classify learning material (structure of learning material).

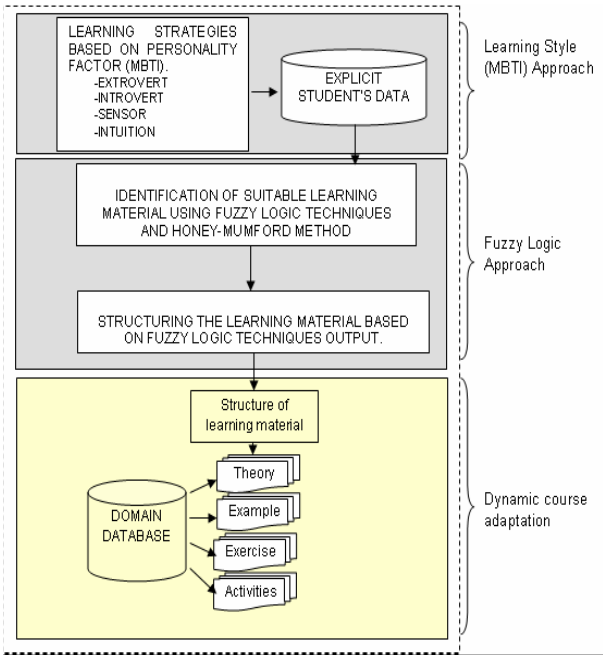

Figure 1. The framework of mixed approach

As shown in Figure 1, the framework of mixed approach are comprise of three division; learning style (MBTI) approach, fuzzy logic approach and dynamic course adaptation.

In learning style approach, explicit students' data are retrieved from MBTI's questionnaire, which given to student before the student could enter and explore the module that provided in the system. The student data consist of 4 data; introvert score, extrovert score, sensor score and intuition score. The fuzzy logic techniques are then used the students' data to personalize learning material according to the fuzziness in student's learning style. The personalization indicate the structures of learning material (theory, example, exercise and activity) that suits student's personality, taking into account the most preferred learning material and the least preferred learning material. As a result, student will obtain a structure of learning material that is most suited to their learning styles. Figure 2 show detail about the fuzzy logic approach.

Fuzzy logic is computationally undemanding and is most suitable for processing imprecise input data, as it supports natural description of knowledge and reasoning in the form of imprecise concepts, operators and rules [12]. In AHLS, fuzzy logic techniques have been used

due to their ability to handle imprecise information, such as student's knowledge and their cognitive abilities [13].

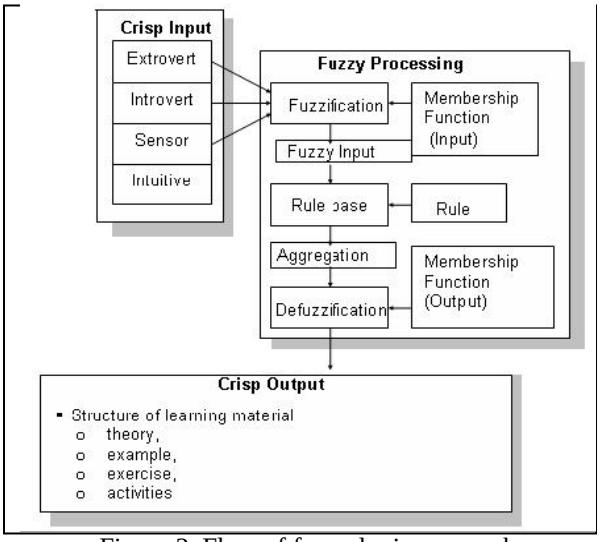

Figure 2. Flow of fuzzy logic approach

3. Importance of Evaluation in AHLS.

Evaluation of intelligent tutoring system (ITS) is very important. AHLS is one of the intelligent tutoring systems. Several researches stated the advantages of evaluation [8] and one of the advantages of evaluation is it could provide an opportunity to learn from mistakes and improving the usability of the system.

There are two types of evaluation for ITS, formative and summative evaluation [8,9]. Formative evaluation mainly occurs during design and early development of a project. It frequently addresses the question of relationship between the architecture of ITS and its behavior. While, summative evaluation is concerned with the evaluation of completed system and the making of formal claims about those systems. It answers the question regarding the educational impact of an ITS on students. However, these types of classification are still too broad where a lot of methods can fall in either one of these classes.

Another research has been done on evaluation solely on the usefulness of computer system [9]. The usefulness can be analyzed further within two sections: usability and utility [14]. Usability is one part of the overall acceptability of a computer system. Software of any type should meet the basic standards for usability. Usability evaluation is important of the overall evaluation of web-based learning environments. The user interface of web-based application must be easy and effective to use so the user can concentrate on the information content and learning instead of interface. For the utility part the research consider in educational context the concept of utility can be broken down into pedagogical utility and added value of web-based learning and teaching.

Usability is a quantitative and qualitative measurement of the design of user interface grouped into five key factors: learnability, efficiency, memorability, errors and satisfaction [15]. In this paper, three out of the five key factors will be studied in detail learnability, efficiency and satisfaction of the students. While the utility part, is more concern on the effectiveness of mixed approach based on the accuracy of learning experience preference judged by the students.

Learnability of the students is based on the ease of use of the students when working towards completing the task specified for them. Efficiency looks at how productive the students once having learned the software and the last attribute satisfaction is to study the students level of pleasure using the system.

Result for evaluation; usability and utility part are based on the questionnaires' answers received from the student and from data retrieved from databases.

4. Method and Processes

The evaluation process was done in a controlled environment where the students are required to complete their learning in lab. There are 44 students participate in this tested where all the students are divided into 2 session. This 2 session consists of 2 parts the morning session and the evening session.

During the evaluation process, the students are given a simple user manual to guide student while learn using the system and 2 set of questionnaires; questionnaire to gather information on student learning satisfaction and questionnaire to gather information on the usability of the system. Students also allowed to study freely whether to follow the suggested sequences of learning material captured from mixed approach or based on their own

preference. Each of students is required to finish the assessment part before they could leave the system. At the end of the session, students are allowed to give feedback regarding the system.

5. Result and discussion

Based on section 3, this testing mainly focused on four key factors; the learnability factors, the efficiency factors, satisfaction factors and accuracy factors. The results on each factor are discussed in the following sections.

5.1 Learnability Factor

The learnability factor is measured quantitatively based on participants' ease of using the system by incorporating MBTI learning style to suite the students' personality factor. Based on the questionnaire, 95.7% of the students agreed on the effectiveness in learning based on MBTI learning style. Figure 3 shows the percentage of students agreed on the effectiveness in learning based on MBTI learning style.

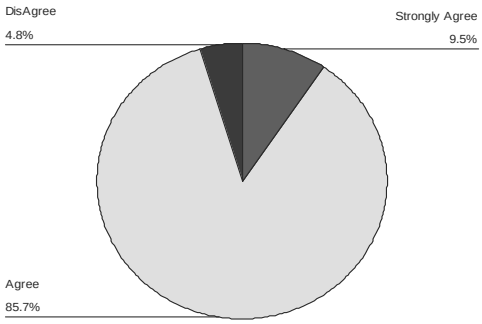

Figure 3: Effectiveness of learning based on MBTI learning style

We also test the ease of adaptive navigational paths provided by the system. The paths showed to each student will be annotated with different colors such as yellow, red and green to signify the material that the student have already learned, forbidden because of prerequisite is not fulfilled and ready to be learned. The annotation can help prevent the students from disorientation while navigating through the system. Figure 4 shows 13.6% of the respondents strongly agree and another 68.2% respondents agree that the navigational paths provide ease of using the system. Only 18.2% of the respondents disagree with the use of navigational paths for ease of usage.

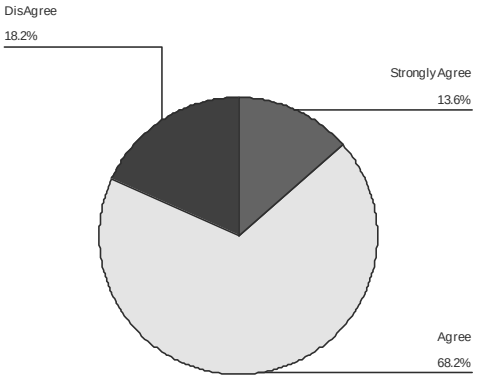

Figure 4: Learnability of adaptive navigation path

5.2 Efficiency Factor

The efficiency factor is measured based on the students assessment result retrieved from MySql database. This evaluation shows the performance of each student while using the system. From the students assessment answer's captured in the database, the percentage shows that 11.4% of the students manage to get marks between 80 to 100 percent, 63.6 % get marks between 40 to 79 percent and 25.0 % get marks between 0 to 39 percent. Figure 5 shows the percentage of students' assessment.

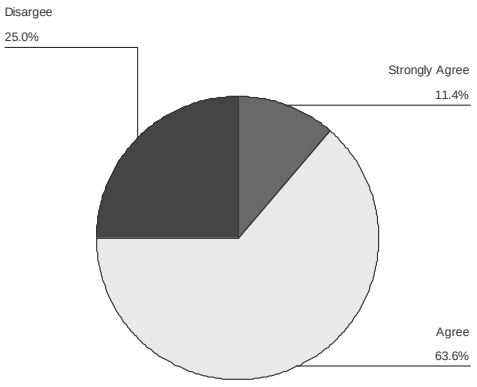

Figure 5: Percentages of students' assessment result.

5.3 Satisfaction Factor

The satisfaction are based on factors such as the terms is understandable and familiar to the participants, the understanding of the learning materials, the suitability of colors used in this system, the usefulness of the interactivity in the system and the overall satisfaction the user finds when they use the system. Figure 6 shows the satisfaction percentage of participants using the system.

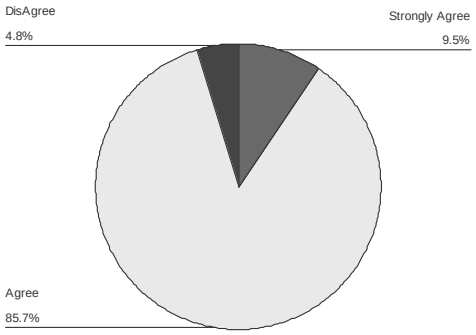

Figure 6: Participants' satisfaction in learning using this system

5.4 Accuracy Factor

The MBTI learning style effectiveness is further proved by the students preferable in using the learning structure based on learning sequences suggested by the system. 77.3% of the participants agreed to follow the suggested sequences while 22.7% disagreed to follow it. The percentage of students' preferred on using learning structure based on suggested learning sequences is as shown in Figure 7.

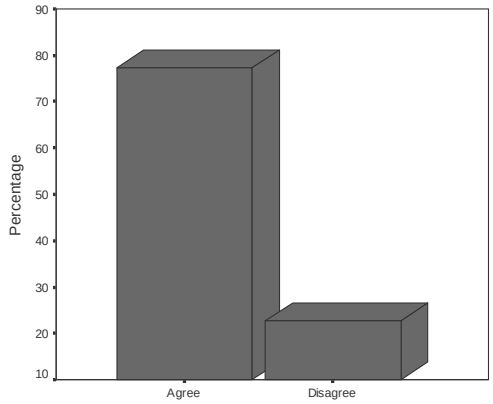

Figure 7: Participants preferable in using learning structure based on suggested learning sequences.

6. Conclusion and further work

In the proposed approach, the evaluation are more concern on the usability and the accuracy of learning experience preference judged by the students regards to the effectiveness of mixed approach model. Based on the result acquired from the students, we notice that the students satisfied with the system and most of the student learned based on the suggested sequence of learning material given by the mixed approach model. The results shows, there are high accuracy of learning experience between the mixed approaches learning material structure with students' preferable learning material structure. We are currently testing these mixed approach model by comparing to the INSPIRE's learning material sequence based on student's performance effectiveness.

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