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Personalized Learning Website for Fractions

Norazrena Abu Samah, Noraffandy Yahaya, Mohamad Bilal Ali
Department of Educational Multimedia
Faculty of Education, Universiti Teknologi Malaysia
Skudai, Johor, Malaysia
nore_azrena@yahoo.com, fandymcl@gmail.com, mba@utm.my

The need has arises towards the consideration of individual difference includes their learning styles, learning orientations, preferences and needs in learning to let learners engage in and responsible for their own learning, retain information longer, apply the knowledge more effectively, have positive attitudes towards the subject, have more interest in learning materials, score higher and have high intrinsic motivation level. As regard to the importance of individual differences, Martinez [8] has grounded Intentional Learning Theory that covered individual aspects of cognitive, intention, social and emotion. Therefore, a personalized learning website will be developed by referring to the theory in order to overcome problems in the topic of Fractions for thirteen years old students. Learners' interactions on the website will be investigated to identify the features of the website that affect learners' achievements and motivation, and help in overcoming problems in Fractions. One-group pre-test – post-test design of pre-experimental research design will be used in this research. In addition, ADDIE Model is the model that will be referred to conduct this research. Data analysis methods that will be involved are pattern of interaction analysis, motivation factors analysis, observation, interviews and database analysis.

Personalized Learning Environment; Fractions; Mathematics, Mistakes; Misconceptions; Individual Differences; Learning Orientations

I. INTRODUCTION

The rapid growth of individual difference research since early 19th centuries has brought improvements and solutions in education field. The need has arises towards the consideration of individual difference includes their learning styles, learning orientations, abilities, talents, preferences and needs in learning to let learners engage in and responsible for their own learning, retain information longer, apply the knowledge more effectively, have positive attitudes towards the subject, have more interest in learning materials, score higher and have high intrinsic motivation level [1]-[7]. Weber, Martin and Cayanus found that necessary challenges and opportunities for learning, and self-development will be provided if learners' differences are considered in learning [7]. In addition, the emphasize of individual difference in learning increase learners' satisfaction that increase their motivation towards learning and followed by better grade in the subject [1],[4].

As regard to the importance of individual differences, Martinez has grounded a new theory that combined Individual Difference Theory and Neuroscience aspects, which is Intentional Learning Theory [8]. This theory covered individual aspects of cognitive, intention, social and emotion. These aspects are integrated in Learning Orientation Model that categorized students based on how they choose to plan, set, perform and attain goals, intend to commit and expend effort and also, experience learning and achievement [9]-[16]. Learning Orientations Questionnaire is the instrument used to categorized learners into four learning orientations profiles, which are Transforming, Performing, Conforming and Resistant Learners. This questionnaire has been proved as the new way to assess individual differences [13],[15].

Moreover, studies found that Learning Orientation Model is best applied in Personalized Learning Environment [9]-[13],[16]. This new trend of learning environment has individualized approach and is suitable for adapting individual differences and needs in learning [3],[9],[17]-[19]. This learning environment provides more than one system to be used synchronously by different learners based on their preferences. For that reason, this learning environment is best applied in online learning or specifically by using website [9]-[14],[16]. Website is found by Martinez to be perfect for individualized learning [12],[16].

In addition, there are many advantages of online learning [9],[12],[17],[20]. Martinez and Bunderson found that website enables instructors to monitor students' progress easily, present content specifically, identify learners' difference easily, provide Personalized Learning Environment and encourage students to become independent or self-direct [9]. Martinez also found that website made students' progress easily monitored, content can be specifically presented and learner can be uniquely identified [12]. Besides, online learning also led to innovations in education [17]. What is more, website has capability to increase students' satisfaction that would make them become more motivated [4]. For that reasons, other researchers have suggested and used Design Guidelines for Personalized Learning Website to implement Learning Orientation Model in learning [9],[11],[13],[16].

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II. BACKGROUND OF THE PROBLEM

There are believes that Mathematics is a difficult subject to learn and has no connection with the real-world. These result to low motivation in learning Mathematics that cause high mathematics anxiety, low value in Mathematics and low self-concept of ability among students [20]-[23]. Apart from that, Sadi found that misconceptions in Mathematics occurred because of inherent to the subject [24]. Therefore, in other to tackle Mathematics' issues, motivation level of students in Mathematics need to be increased and misconceptions in Mathematics must be overcome.

In specific, Fractions has many important especially in Mathematics and also in other fields. In Mathematics itself, Fractions is the basic of learning Algebra and also is the continuity of learning Proportionality [25]. In the topic of Fractions, students learned operations involving proper and improper fractions with same or different numerator or denominator, equivalent fractions that involved simplification and sequential of fractions, and interpretation of fractions using graphical method or set notation. However, some students misbelieve that Fractions has no meaning in life. They cannot understand the reason of learning Fractions and its applications in the real world. Because of that, their informal knowledge is disconnected from the symbolic of fraction [26].

Thus, many mistakes in Fractions among students are found by researchers which are (a) mistake in operations of additions, subtractions, multiplications and division involving fractions [27]-[29], (b) mistake in equivalent fractions that includes comparing fractions and line interval [27],[29],[30], (c) mistake in interpretation of fractions [29],[31], and (d) mistake in reasoning [32]. Besides that, Kerslake in [33] found that misconceptions occurred in operations of additions, subtractions, multiplications and division involving fractions, equivalent fractions, simplification of fractions, whole number in fractions and concept of sequential in Fractions.

III. STATEMENT OF THE PROBLEM

Learners' unique differences include their emotional states of mind, learning rates, learning styles, stages of development, abilities, talents, feelings of efficacy, attributes and needs must be attended to and taken into account if learners are to engage in and take responsibility for their own learning [1]-[3],[5],[7]. Learners also will be provided with the necessary challenges and opportunities for learning and self-development if their differences are considered in learning [7]. Students tend to retain information longer, apply it more effectively, have more effective post course attitudes towards the subject, assimilate text messages more completely, improves attention and retrieval processes, acquisition of knowledge and effort expenditure, increase persistence, more interested in the material and scored higher if the teaching and learning match with their learning styles, interest, attitudes and abilities.

Therefore, in considering users' unique differences in learning environment, a personalized learning website will be developed on the topic of Fraction for Form One students by referring Activity Theory. Pre-test, post-test and interview output will be analyzed to determine users' needs and their relationship with students' achievements.

IV. RESEARCH QUESTIONS

This research is conducted with corresponding questions which are to:

A. Develop personalized learning website for Form One topic of Fractions:

Q1 How to develop personalized learning website for Form One topic of Fractions?

B. Investigate learners' interactions on the developed personalized learning website:

Q2 What are the most and the least interaction functions of the developed personalized learning website used by each learner?

Q3 What are the most and the least interaction functions of the developed personalized learning website used by Transforming, Performing, Conforming and Resistant Learners?

C. Investigate whether there are relationships between achievement, misconceptions, mistakes, and motivation level for the topic of Fraction, and learners' interactions on the developed personalized learning website:

Q4 Were there any relationships between students' achievement and their motivation level for the topic of Fraction?

Q5 Were there any relationships between students' misconceptions and their motivation level for the topic of Fraction?

Q6 Were there any relationships between students' mistakes and their motivation level for the topic of Fraction?

D. Qualitative data to probe performance in the topic of Fraction after exposure to developed personalized learning website:

Q7 How did students with different learning orientations profiles view the learning through the developed personalized learning website?

Q8 Were the developed personalized learning website overcome students' misconceptions and mistakes in the topic of Fraction?

Q9 What were the features of the developed personalized learning website that contributed to overcome students' misconceptions and mistakes in the topic of Fraction?

Q10 What were the features of the developed personalized learning website that contributed to

improve students' achievement in the topic of Fraction?

V. Research Methodology

The research will be conducted via qualitative and quantitative methods. One-group pre-test – post-test design of pre-experimental research design will be used in the research. This research design suggested the subjects to be pre-tested, exposed to a treatment, and then post-tested. The design will be used to compare achievement, and misconceptions and mistakes identified before and after exposure to the system. The qualitative methods that will be involved are document analysis, interviews, user interaction analysis and observations. Qualitative method was used to gain new perspectives on learners' differences and also to gain more in-depth information and understanding of learners' differences and the effect of a system that was developed to cater students' misconceptions on Fractions. As well, quantitative method will be used to categorize learners based on their learning orientations and to ascertain statistically significant differences between pre-test and post-test, between scores of four learning orientations profiles, between learning orientations factors and between motivation factors. The quantitative method will be used to probe data obtained from the qualitative method. ADDIE Model is referred to conduct the research as follows:

A. Phase 1: Analysis Phase

In analysis phase, mistakes and misconceptions in Fractions are analyzed from previous studies and students' answer scripts in schools. 24 Form One students from a smart school in Johor will be chosen as the sample for the study from the population of all Form One students who learn Mathematics in all smart schools in Johor. Based on the analysis of previous studies, mistakes and misconceptions in Mathematics, specifically in the topic of Fractions could be overcome if learners' differences are taken into account [1]-[7]. Therefore, Learning Orientations Model [10]-[12],[16] will be referred to categorize students based on affective, conative and social as prior aspects, and cognitive aspect as secondary but still an important aspect in the model. Students will be categorized to four learning orientations profiles – Transforming, Performing, Conforming and Resistant Learners. In addition, based on the analysis in this phase, the most suitable medium of learning for Learning Orientations Model is personalized learning website [9]-[14],[16]. Therefore, an interview of students' preferences in an educational website will be administered to 20 students from the population, where the sample of the study is excluded.

B. Phase 2A: Design Phase

In this phase, research instruments will be constructed and tested their validity and reliability. First, an interview to probe the effectiveness of the system is constructed. Second, instruments for pre-test and post-test will be developed by referring to the topic of Fractions in Curriculum Specifications of Mathematics for Form One students that is developed by Curriculum Development Centre (*Pusat Perkembangan Kurikulum*). Lastly, observation checklist will be constructed to analyze students' behavior during learning using the system. Treatment instruments of the study also will be constructed in this phase to storyboard the system. First, learning contents and activities, and online quizzes and tests are constructed by referring to the topic of Fractions in Curriculum Specifications of Mathematics for Form One students that is developed by Curriculum Development Centre (*Pusat Perkembangan Kurikulum*). Second, interactions and social elements will be construction based on Type of Interactions Document. Lastly, Database Document will be developed for systematic development of the system's database. The database will be used to record students' activities during learning using the system.

C. Phase 3B: Developmental Phase

Alpha testing will be done in this phase. The testing is used to inspect the suitability of the learning contents, structural design and user interface of the prototype. The testing will be done by 20 students from the population, where the sample is excluded, three instructional design experts and three content experts. Besides that, the prototype will be modified based on the results of alpha testing. Error testing will be done to check the connectivity and linkage in the modified prototype. After that, the modified prototype will be completed to a complete system of personalized learning website with database for Form One's topic of Fractions. A minimum System's Requirement Document will be constructed for user's reference.

D. Phase 4: Implementation Phase

In the implementation phase, pre-test, Learning Orientations Questionnaires (LOQ) and Motivation Questionnaires (MQ) will be first administered to the sample. There will be three different websites, which are developed for each learning orientations profiles, which are Transforming Learners, Performing Learners and Conforming Learners. Based on the results obtained from the LOQ, students are enrolled to the website that synchronous with their learning orientations profiles. Resistant Learners will be given an opportunity to choose their preferred website to learn through with. Students will be learned through the system during school hour for four weeks. At the end of each week, another LOQ and Motivation Questionnaires will be administered to students. Students will change the website if their learning orientations profiles are changed based on the LOQ. The process will be repeated weekly till the end of the fourth week together with the post-test on the last week of the implementation of the system. Conversational interviews will be held informally along the implementation phase

while a structured interview will be held formally a week after the end of the fourth week of implementation. The interviews will be used to probe performance in the topic of Fraction after exposure to the system.

E. Phase 5: Evaluation Phase

The quantitative methods of analysis that will be involved in the study are paired sample t-test and analysis of variance (ANOVA) to determine the statistically significant differences of variables. The qualitative methods of analysis that will be used are document analysis, interviews, observations and user modeling based on the database. Below is the summary of analysis methods that will be used in relations with research questions (Q) of the study:

Q1	Alpha testing and error testing.
Q2	Frequency of interaction functions used by each learner is recorded.
Q3	Frequency of interaction functions used by each learning orientations profiles identified from the fifth LOQ is recorded.
Q4	Three graphs depicting the means of students' achievements in pre-test and post-test against the means of each of motivation factors from the first and fifth motivation questionnaires.
Q5	Comparison between misconceptions overcame and the changes of each of motivation factors.
Q6	Comparison between mistakes overcame and the changes of each of motivation factors.
Q7-Q10	Structured interview will be held a week after implementation period, conversational interview will be done informally during daily conversations, database will be referred to identify user interactions on system and observation on students' behaviour during learning using the system.

F. Sampling

The research will be conducted to a purposive non-random sample that involves 24 Form One students in a smart school in Johor. Purposive sampling is the dominant method used in qualitative research since the information collected can be studied in depth. Maximum variation sampling is the strategy used in the research. This sampling emphasized that the criteria used to select respondents is more important than the number of respondent selected. For that reasons, Learning Orientations Questionnaires (LOQ) are administered to 100 Form One students of the populations from the smart school. Accordingly, 24 respondents are chosen randomly based on their learning orientations resulted from the LOQ - six Transforming Learners, six Performing Learners, six Conforming Learners and six Resistant Learners.

G. Research Instruments

Pre-test and post-test will be constructed by referring to the topic of Fractions in Curriculum Specifications of Mathematics for Form One students that is developed by Curriculum Development Centre (*Pusat Perkembangan Kurikulum*). The qualitative method of document analysis will be used to analyze each student mistakes and misconceptions from the pre-test and post-test answer scripts. Besides that, Learning Orientations Questionnaires (LOQ) [11] and Motivation Questionnaires [21] will be administered during the pre-test of post-test. The LOQ will be fully analyzed by the Training Place while means and standard deviations of each motivation factors will be calculated using SPSS Program. In addition, a webcam will be placed on each student's computer to record each student's behavior. Each student's activities using the computer will also be recorded using software called CamStudio. Also, there is a database document contains User Pattern of Interactions Document, log-in and log-out of users, and their mouse-click activities.

As well, two modules of interview are constructed for the research. Module I interview is constructed to analyze students' preferences in an educational website. The interview is a constructed interview that will be administered to 20 students from the population, where the sample is excluded. Analysis of the interview will be referred to develop the system in the developmental phase. Next, Module II interview is constructed to probe performance in Fractions after exposure to the system. The interview is a constructed interview that will be administered to the sample a week after the end of the last week of exposure to the system. Besides that, a conversational interview will be administered along the exposure period informally. The interviews will be recorded using sound recorder because data can be captured more faithfully than hurriedly written notes and easier for the researcher to focus on the interview. The interviews will be analyzed by referring the process stated by Schneider and Conrad (1983). The steps in analyzing the data are noticing, collecting and thinking.

VI. Conclusion

This study is based on pre-experimental research design with qualitative and quantitative method of data collection. The triangulation method will be used to strengthen the results of the research. The prototype will be upgraded based on testing results in formative evaluation phase. The completed system will then be implemented to students. Its effectiveness in catering misconceptions and mistakes in Fractions will be evaluated using the comparison of the pre-test and post-test, and an interview. Pattern of interaction analysis will be done based on the database of the website.

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