

Development of Multimedia Application for Learning Algebra

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Abstract

New technology and advancement in computer technology has attracted educators and researchers to develop educational computer applications. These learning applications help to enrich learning materials with the utilization of multimedia presentation. The objective of this study is to assess the undergraduate engineering students' understanding of algebra and to develop a multimedia application for learning algebra. The study was carried out in three stages. In the first stage, a set of questionnaire was distributed to 113 students and a set of test was given to 60 students. The second stage was the development of the application and the third stage, the evaluation of the developed application. The survey and test result show that most of the students have difficulties in understanding algebra especially in the subtopic of factorization. In turn, an Algebra Tutor was developed based on the survey information and the students' test result.

Keywords: Algebra, Multimedia Application, Factorization

1. Introduction

Educational technology has a major role in education (Ouyang & Stanley, 2014). The emerging needs for technology in education have increased the development of multimedia in education. A multimedia application must have a combination of text, graphic, animation and sound (Frey & Sutton, 2010; Karthikeyan, & Aravindh, 2012). When multimedia is incorporated in learning, a multimedia application must have the potential to connect learning activities with integrated media objects.

In mathematics education, multimedia is integrated into the learning process in order to improve learning and also, one's cognitive level (Milovanović, Obradović, Milajić, 2013). Learning mathematics using multimedia application can improve understanding of the theories and concepts that are hard to explain in traditional classrooms (Jasni & Zulikha, 2013). Multimedia application in mathematics provides active engagement because of its multiple presentational styles compared to traditional learning methods (Chuang, 2014).

Although mathematics is a core subject in education, most of the students find that the concepts in mathematics are abstract and difficult to understand. Mathematics requires students to memorize the formula and visualize the pictures in order to understand the concept. This results in a low perceived motivation level towards Mathematics (Jasni & Zulikha, 2013). Researchers also stated that most observed failures and substandard performance in mathematics are due to insufficient teaching-learning environment. Khalid *et al.* (2010) reveals that many students in tertiary education are still weak in mathematics even after eleven years of mathematics education.

Algebra is the foundation of mathematics and is considered the most important subject that must be mastered in order to proceed to a higher level of a mathematics course. Algebra provides a way to explore, analyze, and represent mathematical concepts and ideas. It can describe relationships that are purely mathematical or ones that arise in real-world phenomena and are modelled by Algebraic expressions (Stephens & Ribeiro, 2012; Lewis & Blunk, 2012). Algebra has been an entry requirement for many colleges and universities around the world when it became Harvard University's entry requirement in 1820 (Welder, 2006). This subject is highly needed in mathematics, science and engineering field. Kooij & Goddijn (2010) stated that Algebra is present in higher level vocational classroom where mathematics, science and engineering are highly applied.

As for polytechnics in Malaysia, Sijil Pelajaran Malaysia (SPM) leavers should at least have a credit in mathematics to enrol in any engineering class (Department of Polytechnic Education, 2013). SPM is equivalent to the O-Level. Although Algebra is not stated in the entry requirement, every SPM leavers that have credits in Mathematics should at least have knowledge of basic Algebra because it has been taught in secondary school (Ministry of Education, 2010). Algebra is included as one of the topics for the course BA101 (Engineering Mathematics 1) that is offered to all semester 1 engineering student for polytechnics across Malaysia. This course consists of Algebra, Indices and Logarithm, Geometry and Measurement, Coordinate Geometry and Graph as well as Trigonometry (Syllabus BA101 Engineering Mathematics 1, 2013). A passing grade for this subject is compulsory for students to continue to Engineering Mathematics 2 (BA201) in semester 2 (Syllabus BA201 Engineering Mathematics 2, 2013). Failing to do so will cause them to repeat the course for another semester. This will eventually lead to a low Cumulative Grade Point Average (CGPA) and delayed graduation. Thus, the development of Algebra Tutor is deemed the best solution to help low achievement students in learning algebra.

2. Research Methodology

2.1 Research Methodology

This research was carried out in three main stages. The first stage was the analysis of students' view of the current teaching and learning process as well as their understanding of algebra. In this stage, a set of questionnaire and a set of algebra test were given to the students. The questionnaire was given to 113 students to elicit their view of the current algebra learning in polytechnic. The algebra test was given to 60 students from two intact classrooms in order to assess their understanding of basic algebra concepts. The second stage of the research is where the algebra tutor is designed and developed based on results obtained from the first stage. The application is then developed using multimedia software. The resources for the application include website links, algebra tutorial video, step by step tutorial animation and quizzes. The last stage is the software evaluation.

2.2 Survey Findings

Table 1 shows the result of the survey carried out and table 2 shows the result of the algebra test. The survey shows that most of the students requested an additional tutor that can help with their mathematics learning outside of the class time. The test result in table 2 shows an analysis of students' understanding of basic algebra and factorization. From the test, most of the students have difficulties in solving questions related to factorization.

Table 1: Findings of the Algebra Learning Questionnaire

No	Item	Finding
1.	Students' view of the subject Engineering Mathematics 1	40% stated that the subject is difficult to understand
2.	Students' view of the topic Algebra	20% find that the topic is difficult to understand
3.	Students' view of the current teaching and learning process	69% agreed that the learning process do not cater students' learning differences.
4.	Students' need for additional learning material	29% requested additional learning material besides notes and module in the class.
5.	Students' need for additional tutor	92% requested additional tutor that can help them learn on their own.
6.	Students' readiness for computer related application	92% are ready to use any mathematics applications that are introduced to them.

Table 2: Test Result

Subtopic	Answered Correctly	Answered Incorrectly
Simplify Algebra Equation	51%	49%
Factorization	16%	84%
Substitution Method	62%	38%

Information from the survey and test has been used in the process of developing the Algebra Tutor. The analysis of the information helps to describe the design of the application. Analysis of the test result shows that most of the students have difficulties in understanding variables in Algebra. Usman (2012) stated that fundamental concept of variables and equation is important in developing basic Algebra operations. By understanding the concept of variables, students will be able to solve different types of problems. The concept of variables are defined and presented in the Algebra Tutor tutorials.

2.3 Algebra Tutor Architecture

The algebra tutor is divided into five main parts; student learning outcome, tutorials, resources, quizzes and assignments. The first part is the student learning outcome. For this prototype, students are expected to complete three learning outcomes. By the end of the tutorials, students need to understand two topics; basic algebra operation and factorization. These two topics are selected from the result of the questionnaire and test given to the students.

The second part is the tutorials section; basic algebra, factorization and factorization of quadratic equation. Each tutorial comes with questions and an animated answer. Students are shown step by step the method to solve every question given by the application. Students can independently go to any tutorial they want. These tutorials have an animated narrator that gives instructions and explanations throughout the tutorial.

The resources are the third part of this application and act as a library of references. In this part of the application, students can view videos, websites and internet tools. The websites which are linked to this resources panel are web algebra tutorials. This website will be automatically displayed on the resource panel. By enabling students to view all related material on the resources panel, students will have a wider access to the related material without having to search for it on the internet. The videos on this panel also can be viewed without an internet connection.

In the fourth part, students can assess individual quizzes. These quizzes consist of questions on basic algebra and

factorization. Students will be awarded 10 marks for each correct answer. The last part is where the class assignments are posted for the student. Figure 1 and Figure 2 show the screenshot of the application.

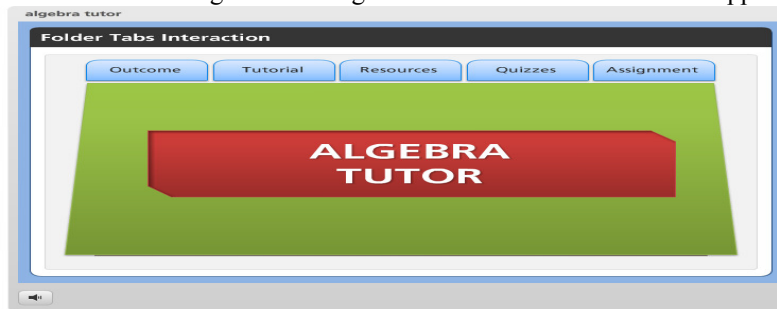


Fig. 1: The Main Page of the Algebra Tutor.

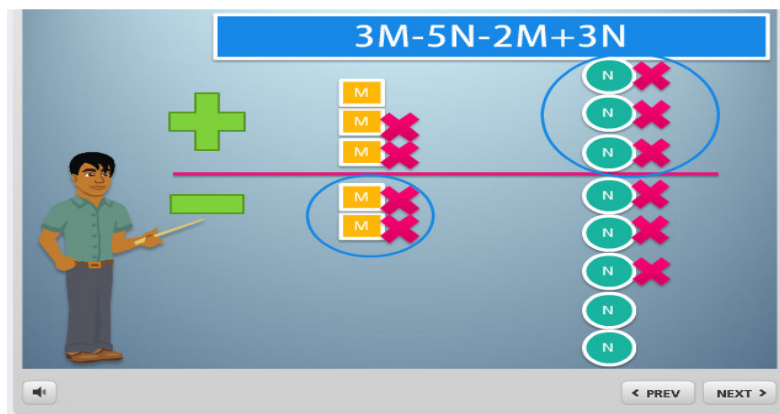


Fig. 2: Screenshot of the Tutorial Part.

2.4 Application Evaluation

A software evaluation was carried out as one of the compulsory part of any multimedia application development. For this application, the evaluation was done by two experts; a content expert and an instructional design expert. The content expert that has been selected is a polytechnic lecturer with six years of experience in teaching mathematics. The instructional design expert is a senior software engineer with seven years of experience in testing software. Table 3 shows the evaluation and comments given by the experts.

Table 3: Application Evaluation Finding

Item	Content Expert	Instructional Design Expert
Content	Students outcome are clarified, content are curriculum oriented and divided into suitable parts	Language and concept are suitable for specific user; objective of the learning is not appropriately explained.
Ease of use	The navigation button needs more explanation, no documentation or user manual for user	The application needs more improvement on ease of use.
Presentation/Visual Layout	The text, graphic, screen design and video are designed to meet the user needs	The consistency of the presentation still need more improvement but the overall presentation is good
Learning Activity	The learning content is suitable to increase students' thinking skill. The cognitive level are appropriate for the specific target student	The application successfully guides the student to process information systematically.

The evaluation given by the experts show that the application has been successfully developed to meet the required objective. The content, visual presentation and learning activities were designed and developed for the target user. The ease of use of the application on the other hand, needs more improvement.

3. Conclusion and future work

The objective of Algebra Tutor development is to help educator and student in learning Algebra. This application presents multimedia tutorials that consist of basic algebra learning material. The evaluations of the developed application show that the application has fulfil the objective of the research. Future work will deal with developing more materials on other subtopics in Algebra and provide additional activity modules. Furthermore,

the developed application has to be included as a class activity to improve the teaching and learning process.

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