Development of a Mathematics courseware: Fractions

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Abstract *Misconceptions associated with numbers can be found along the way since mathematics exists. Students find it difficult to understand fractions when the mathematics curriculum is taught in English especially in Malaysia. Students have difficulties to tally with what they had learned in English when their native language is Bahasa Malaysia. Meanwhile teachers find it difficult to treat students' misconceptions in the classrooms. A multimedia courseware has been developed on the topic of fractions in order to assist students in understanding fractions. The objective of this paper is to report on the development of a multimedia courseware for primary school students on the topic of fractions. The development has also adopted a game-based learning method. The ADDIE Instructional Design Model is used in the development and tools used are VB.Net, Game Maker, Adobe Photoshop and Windows XP. An evaluation has been conducted. The evaluation was based on the usability criterion that is screen design, satisfaction and learnability. The result shows that students are satisfied with the design and find that the courseware is easy to learn. It is hoped that the courseware can improve learning by providing fun and out-of-classroom environment to the students at their own time and pace.*

1. Introduction

Mathematics has always been one of the core subjects in the school syllabus around the world. It is not only applied in the learning process but also commonly used in daily life. With the advancement of information technology, the opportunity to integrate an alternative learning technique into the traditional teaching in Mathematics can be possible. Hence, various studies on the use of computer courseware and software have been conducted in teaching and learning mathematics [1].

Fractions is one of the topics introduced in the primary education. According to Charalambous and Pantazi [2], fractions is the most complex concept among children in primary education. Other scholars also agreed that students have problems in learning fractions and the problems persist into their adulthood [3][4][5]. Meanwhile as Sadi [6] pointed that misconceptions associated with numbers are found throughout the mathematics curriculum. This is one of the reasons why students are unable to fully understand fractions taught in class. Sadi [6] also indicated that in general, students are able to cope well with multiplication of fractions. However, students could not visualize the problem or understand the solution and the equivalent fractions of division of fractions. The problem with equivalent fractions is that students sometimes do not know how to find the equivalent fractions and sometimes they could not find the connection between the equivalence and size of the two fractions given. As for addition and subtraction in fractions, students who do not understand the solution tend to answer these types of questions with the same formula as multiplying the fractions. Charalambous and Pantazi [2] also highlighted that the obstacles that students encounter are due to the instructional approaches in teaching fractions.

Meanwhile, National Council of Teachers of Mathematics (NCTM) clearly point out that students in secondary school need to acquire a deep understanding of fractions and to be able to use them proficiently in problem solving such as algebra. Hence, it is apparent that students need to understand fractions during their primary school. Since then, many efforts have been made to explore the alternative ways of teaching fractions by creating curricula and didactic material which

incorporate new tools, pedagogical approaches, and methods. Monteo and Lopez [7] highlighted that the use of computers in education can be utilized to support the visualization of abstract concepts.

Therefore, educators need to find ways of teaching fraction that would not only make students understand fraction but at the same time can catch their attention to the lessons that is being taught. This paper presents a development of multimedia courseware in fractions which focus for primary school students aged 10 years old. The development also includes the game-based learning which aims to improve on the students' learning.

2. Theoretical Framework

The teaching on the topic of fractions starts as early as primary two at the age of 8 years old in most of the countries. In the lower grades of school system, students are required to learn mainly on acquiring the meaning of fractions and to describe its purposes. As they go to the higher grade, serious learning of fractions will take place. Sazali et al. [8] have developed an interactive multimedia courseware using Collaborative Learning (CDiCL) principles for the pre-engineering students in a polytechnic, Malaysia. They also indicated that even pre-university students have some misunderstanding of basic concepts in fractions. This is of concerned to most of educators as fractions is crucial for the learning of algebra. Hence, new approach in teaching needs to be identified to ensure that students have obtained the understanding of fraction.

In recent years, computer games are getting so much attention from kids and teenagers. A number of researchers [9][10] have conducted studies on the use of computer games as an instructional tool. Furthermore, NCTM *(*2000) also agrees with this by stating that, "Technology is essential in teaching and learning of mathematics; it influences the mathematics that is thought and enhances students' learning" (p.24). Computer games can be divided into 8 "genres" that are Action, Adventure, Fighting, Puzzle, Role Playing, Simulations, Sports and Strategy [11].

According to Heid and Blume [12], technological approaches in mathematics have not as yet been widely adopted largely due to a general impression by both practitioners and researchers that technology-intensive mathematics education is untested. Ke and Grabowski [9] have conducted a study to investigate the effects of mathematics performance and attitudes using game-based learning among fifth-graders. The results have indicated that the game-based learning was more effective than drills in promoting mathematics performance. The students also have shown positive attitudes towards the use of game-based learning in mathematics.

2.1 Available Games in Fractions

There are three examples of the games that are available online. The games are: Fraction Frenzy, Cookies for Grampy, and Action Fraction.

2.1.1 Fraction Frenzy

Fraction Frenzy is copyrighted to Planet Interactive, Inc. and published in the LearningPlanet.com. User can play this game online for free at the website. In this game, user will have to find a matching fraction to be coupled-up and clear the stage. It provides a few rounds where each round will have 10 levels. The difficulties will increase in each level.

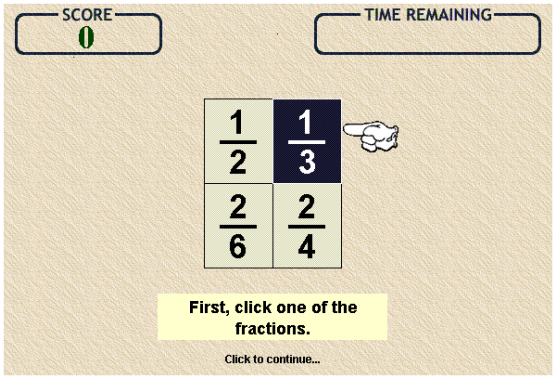

Figure 2.1 Fraction Frenzy
Source: LearningPlanet.com

2.1.2 Cookies for Grampy

The objective of this game is to make a whole cookie using given fractional pieces. At the end of the game session, it is hoped that user can learn and practice addition, subtraction and multiplication of fractions. The game is played by dragging the pieces on the right side onto the circle on the left side to make a complete cookie. This game is copyrighted to Richard E. R. and and can be played on visualfractions.com website.

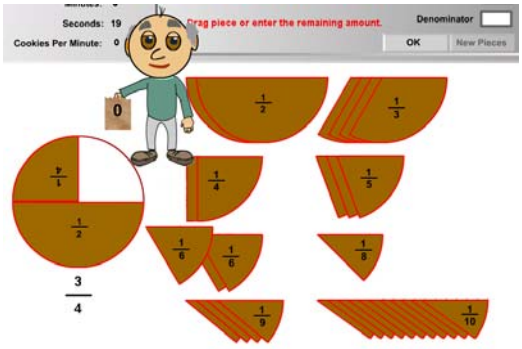

Figure 2.2 Cookies for Grampy
Source: http://www.visualfractions.com

2.1.3 Action Fraction

Action Fraction can be categorized as a strategy game where user needs to race the opponents to the finishing line. During the race, user will be shown a question on fractions and all user needs to do is to click on the correct answer. The quicker the user answers the question, the car will move further. However, if the answer is not correct or user did not answer that question, the car's speed will run out and the car will stall. After each question, the opponent will get to move forward.

Among the examples, Action Fraction can be categorized as an interactive, able to sustain players' interests in playing the game. This is because of the use of colors and the interesting storyline of the game. However, all the four games have similar drawbacks. All the games do not have a tutorial in it and all of them are in English.

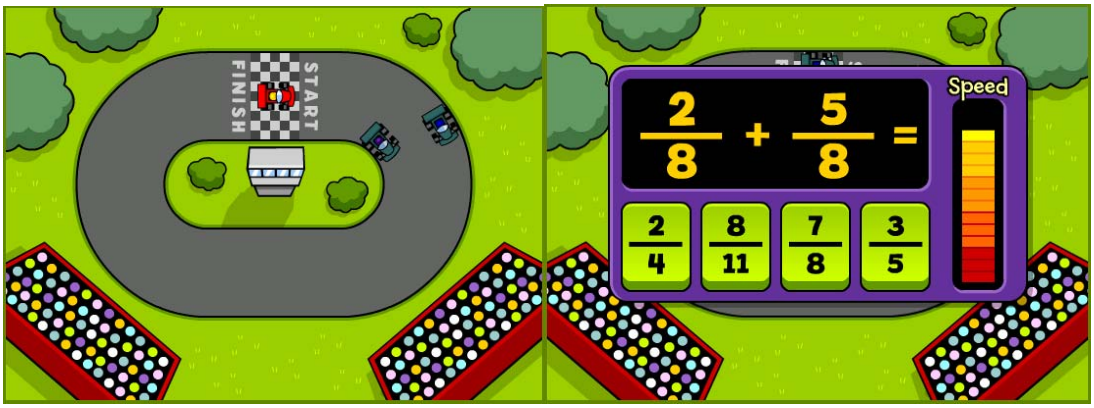

Figure 2.3 Action Fraction
Source: http://www.funschool.kaboose.com

3. Methodology

ADDIE Instructional Design Model is used in this project development methodology. The ADDIE model for instructional system design (ISD) is a basic model that can be applied to any kind of learning solution. The tools used in the development are VB.Net, Game Maker 7.0 Lite and Adobe Photoshop CS2. The courseware has also adopted game-based learning in order to enhance the students' learning in fractions. An evaluation was conducted to test on some of the usability aspects such as learnability, satisfaction and screen design. The questions are based on Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Eight primary four students are involved in this evaluation. Students are asked to go through the courseware and they are also interviewed after the session ends.

4. Development of courseware

The developed courseware consists of 6 Tutorial topics: Basic Fraction, Addition, Subtraction, Multiplication, Division and Improper/Mixed Fractions. At the end of each topic, students are tested with questions using game-based method. This has been as indicated by Chuang and Chen [13] where computer-based multimedia, with its special characteristics, can easily create a motivating and flexible learning environment that leads students to actively involve in the learning process.

It was developed using both English and Bahasa Malaysia. According to [14], primary school students in Malaysia do not have many problems in understanding fractions as they only learn the simple addition, subtraction, multiplication and division of fractions in primary school. However, their biggest challenge is the language used in teaching and learning mathematics which is English. Malaysians used Malay language as their lingua franca while English is used as a second language. Students who are not used to English language find it difficult to understand fractions especially when application type of questions.

5. Results and Discussions

5.1 Interface

In the welcoming page, user is required to choose the language that they would like to use throughout the session. This is shown in Figure 4.1. From here, user will be linked to the main page based on the chosen language.

Figure 4.1 Welcome Page

The main page will display the options Tutorial and Quit**.** The main menu displays a brief description about the courseware. The Tutorial button will lead user to the tutorial page while Quit button will close the interface. This is shown in Figure 4.2.

Figure 4.2 Main Page

On the Tutorial page, user will be presented with a list of subtopics to choose from. Upon selecting the subtopic, user will be presented with tutorials concerning the subtopic. Basic tutorial page shows some pictures of fractions and what it was called. Its purpose is to familiarize user with the topic on fractions. The Interface is as shown in Figure 4.3.

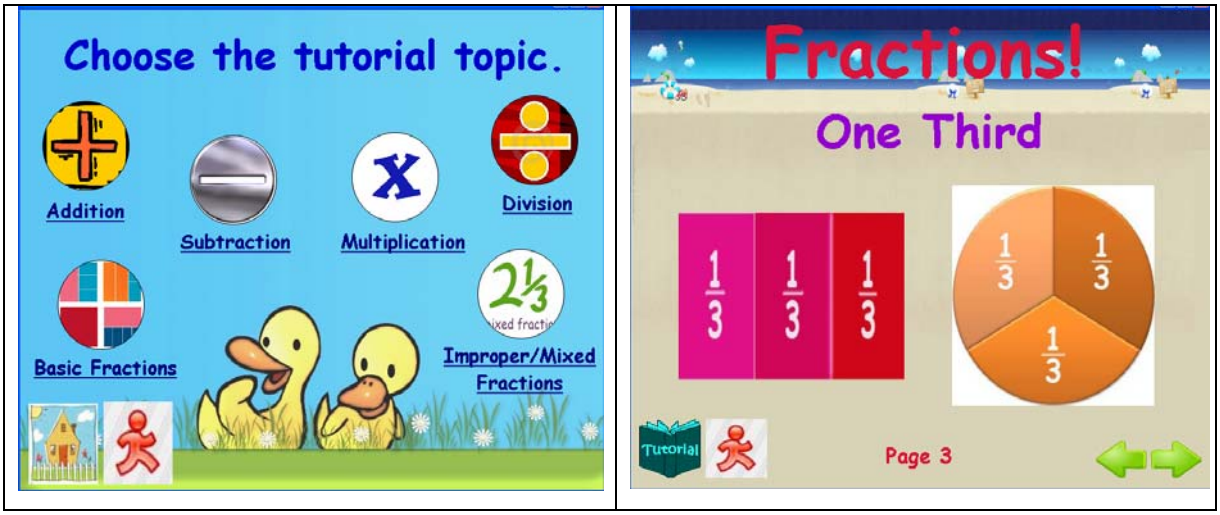

Figure 4.3. Tutorial pages

The picture of book with the 'Tutorial' word written on it is actually a button that will lead user back to the tutorial main page. While the red figure icon is the exit button. These buttons are standardized and used throughout all tutorial pages. Figure 4.4 shows one of the subtopic on improper and mixed fractions are and how to convert improper fractions to mixed fractions and vice versa.

Figure 4.4 Tutorial page

Addition tutorial page as depicted in Figure 4.5 shows how to add fractions with the same and different denominators. It guides user through step by step on how to solve the question. There are three examples available for user to refer to and learn how to add fractions with the same and different denominators. To view the steps, user need to click on the *Click* button and the steps will appear one at a time. With this, user will have interactions with the courseware and user will understand the steps better.

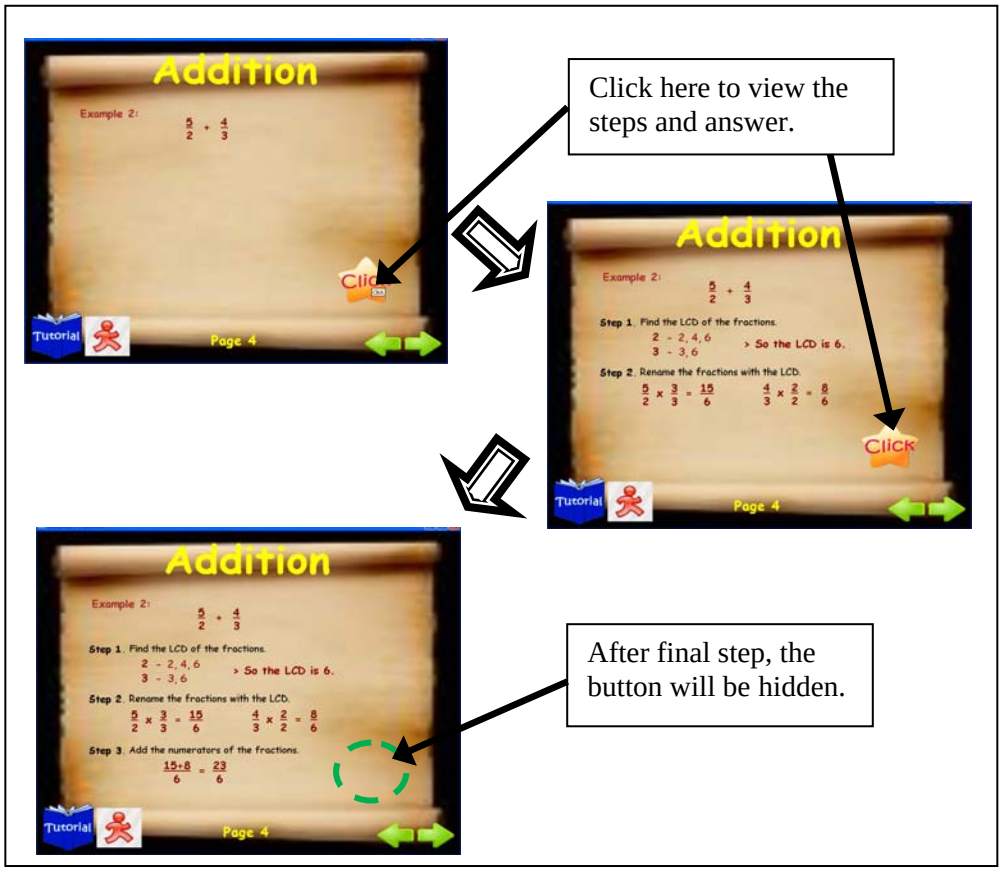

Figure 4.5 Addition Tutorial page

At the end of tutorials, user's understanding will be tested with several practice questions. To answer these questions, user needs to just simply click on the *Answer* button at the bottom of the page. This is shown in Figure 4.6. From there, the user will be linked to a game. User will have to identify the right answer for the question in the game. However, these practice questions are available in the addition, subtraction, multiplication and division only. At the end of addition, subtraction, multiplication and division fractions, there will be a practice session where user will answer through games. The games are divided into three levels. Level 1 is easy, level 2 is moderate and level 3 is hard. This is depicted in Figure 4.7. Students will start with Level 1 first before he/she can proceed to the next level. Level 1 is a simple maze game where user needs to navigate the character through a maze to find the right answer. There are few answers given and the user needs to get to the right answer while avoiding two monsters. The game will end once user gets to the right answer.

Figure 4.6 Practice Page

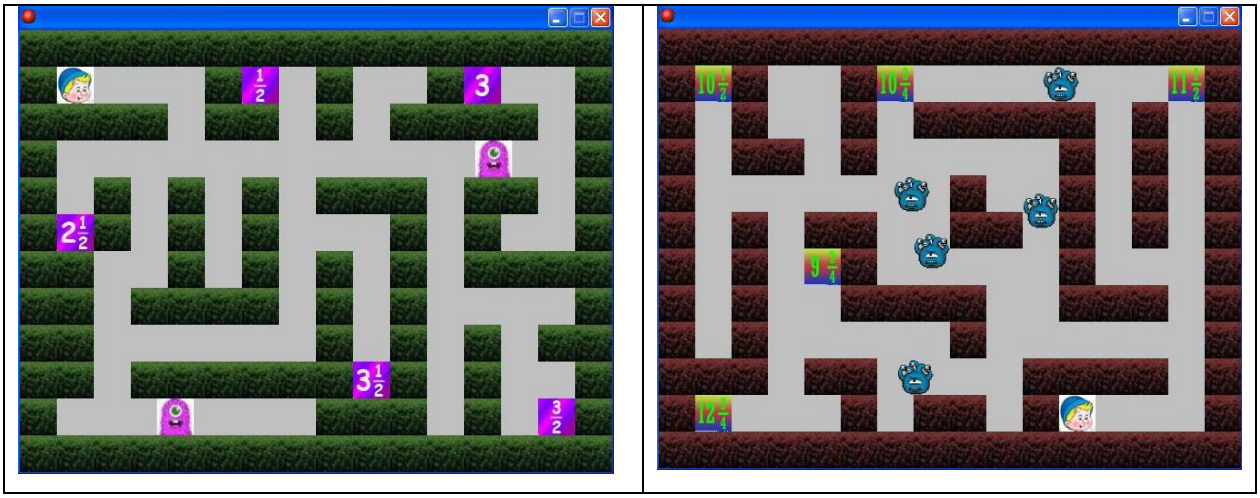

Figure 4.7 Maze Game interfaces

5.2 Evaluation

An evaluation has been conducted with students from Sekolah Kebangsaan Pendang, Kedah. The purpose of the evaluation is to gather feedbacks regarding the usability of the courseware. The questions asked are based on the aspects such as learnability, satisfaction, and screen design. The questions in the learnability include the content of the topic, how easy to learn and control the whole lessons. In the satisfaction, the users are asked if the lessons help them to understand the topic and meet the objectives. While in the screen design, the users are asked on the interactivity, design and layout of the screen. In general, the results are as shown in Figure 5.1.

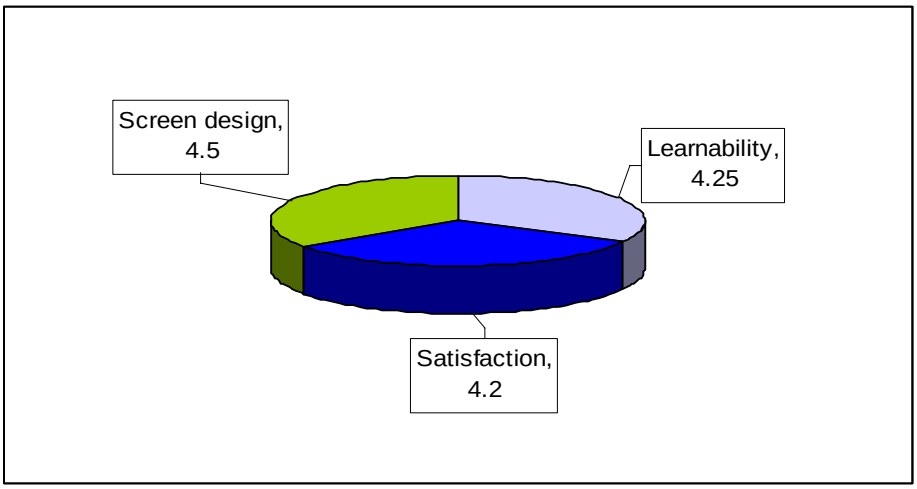

Figure 5.1 Results

80% of the students are satisfied with the design and find that the courseware is easy to learn. Based on the findings also, it can be concluded that the students like to learn fractions using the developed courseware and they would like to play more of the educational courseware like this. The colorful interfaces catch their attention and the tutorial given is simple and clear. The tutorial is good for revision; however it is not suitable for first time learning session. The 2nd level maze game is quite hard for them because there are lot monsters and they move very fast. Therefore, it is hard to get to the right answer. They also would like to see more variations in the games. Further testing should be conducted with more users to validate the effectiveness of the developed courseware.

6. Conclusion

The paper describes the development of a courseware on the topic of fractions for primary students. The courseware has adopted learning theories and game-based learning in the development. The games have been developed as interactive and colorful to suit primary school students. The games developed can improve learning by giving students an alternative way of study that is more fun and relax. Therefore, students can enjoy what they are learning. By learning fractions through games also take students out of classroom environment and able to study at their own pace and time.

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