

Design of the Learning Module for Math Quest: A Role Playing Game for Learning Numbers

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Abstract. Math Quest is a role playing game that could be used as a tool to learn numbers and basic mathematic operations. The Math Quest package consists of two main modules; learning and game modules that can be executed separately. The use of the learning module as a tool in learning will allow for a highly individualized and interactive environment. This paper presents the design of the learning module for numbers and their mathematics operation. Due to its interactive and stimulating nature, the module is suitable for school children age 9 to 12 years old to learn the subject. The development takes into consideration of constructivism learning theories where learning is based on students' active participation in problem solving and critical thinking regarding activity that they are involved in. The framework for each of module is as follows: objectives, concept, examples, exercises, quizzes. A heuristic evaluation on the design was conducted and positive feedback was obtained.

Keywords-role-playing game, learning module, numbers, mathematics

1. Introduction

Computer games are today an important part of most children's leisure. Computer games, formerly referred to as PC-based games are software artifacts that combine multimedia and other computing technologies such as networking to enable the game player to experience goal directed play in a virtual environment [1]. Games that encompass educational objectives and subject matter are believed to hold potential to render learning academic subjects more learner-centered, easier, more enjoyable more interesting, and thus, more effective [2]. Specifically, games constitute powerful learning environments for a number of reasons [3]; (i) they can support active, experiential, problem-based learning, (ii) they provide immediate and contextualize feedback and learn from their actions and (iii) they allow opportunities for self-assessment through the mechanisms of scoring and reaching different levels.

Game-based learning can be used as a teaching tool in the classroom to facilitate learning mathematics. According to [4], the use of game-based learning can stimulate the enjoyment, motivation and engagement of users, aiding recall and information retrieval, and can also encourage the development of various social and cognitive skills. As students play, they can look at the nature of the action they are following and the results yielded by the actions. Hence, learning mathematics can be more enjoyable. According to [5], mathematical games can also improve young children's number knowledge. Research projects such as the E-GEMS project demonstrated that games increased children's motivation and academic achievement within mathematics and science education in grades 4 – 8 [6]. A study by [7] found that the use of games on portable devices led to improved motivation and learning outcomes compared to traditional teaching within primary school mathematics and reading.

However, studies on how mainstream games could be used in school found that the most frequent obstacles encountered are: i) it was difficult for teachers to identify quickly how a particular game is relevant to some of the curriculum, as well as the accuracy and appropriateness of the content within the game; ii) the difficulty in persuading other school stakeholders as to the potential/actual educational benefits of computer games; iii) the lack of time available to teachers to familiarize themselves with the game, and methods of producing the best results from its use; iv) the amount of irrelevant content or functionality in a game which could not be removed or ignored, thus wasting valuable lesson time [8]. A study discussed in [9] had recommended that game designers design games that mimic closely specific contents of the curriculum.

A mathematics classroom in primary school is typically driven by formal assessment and mostly consists of chalk and board together with practices and drills. In addition, due to a class size of about 40 students in a typical class, it is a challenge to the teachers to engage student centered learning. Also, this environment does not offer greater flexibility where students can control their own pace of learning. Motivated by this fact, Math Quest, a role-playing game (RPG) is developed as a tool for primary school children to learn about numbers and basic mathematics operations. This topic forms part of the Mathematics curriculum for the primary schools in Malaysia. Math Quest consists of a game and a learning module, which may be executed separately, or together, depending on the player.

The objective of this paper is to present the design and heuristics evaluation of the learning module that can be used in the classroom and also for individual learning.

2. Overview of Math Quest

Math Quest is developed as a means of introducing a supplementary material in teaching Mathematics to kids between the ages of 9-12 years old primary school children. In this game, a player is accidentally transported to the Viking civilization, which is part of world of Mathedonia. In order to return to his world, the player needs to find his way back in these civilizations that depends highly on the ability to perform mathematics. This is because, in this world, mathematics is widely used in their everyday lives. During this journey, the player will meet some characters, encounter challenges and fight the enemies. All these activities require mathematical skills. As the story unfolds, the player will assist the people and face the challenges in Mathedonia before finally getting back to his present world. The game is best described as a linear game where there is only one possible ending, yet the player still has a great deal of freedom inside each of the “pearls” that make up the backbone of the story. In the full version, the game will incorporate seven civilizations and the Math concepts at each of the civilizations form part of the Mathematics curriculum for the primary schools in Malaysia. The design and heuristics evaluation of the game aspect of Math Quest has been discussed in [10] and [11].

3. Design of Learning Module

The design of the learning module has taken into considerations pedagogical issues and instructional design. The development of the module is adapted from the star model of Hix and Hartson [12] in Figure 1.

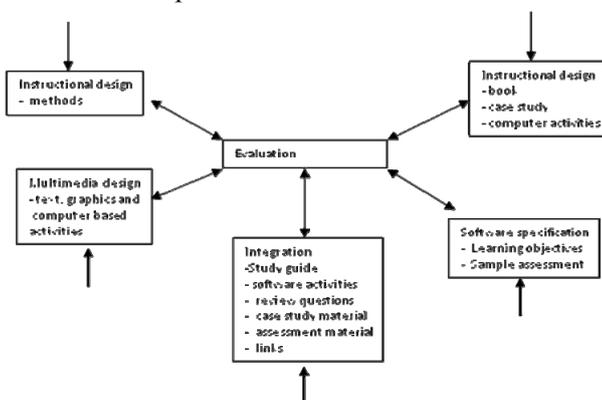


Figure 1 Star life cycle model

Six main processes of module production were identified; module specification, instructional design, multimedia design, integration and evaluation as shown in Figure1. Evaluation is the central to the approach to multimedia courseware development. Module specification is the process of identifying the aims and objectives of the material, determining the previous knowledge and describing the detailed syllabus. Instructional design is concerned with the pedagogic approach and structuring of the course material, the media to be used to deliver the material. In this development, constructivism learning theories were taken into consideration where learning is based on students' active participation in problem solving and critical thinking regarding a learning activity that they are involved in.

Multimedia development is concerned with selecting, designing, and producing components of the module. Among the few things that should be considered, are number of related features of presentation material, the channel used for communication, the sequencing of display components and the coordination of the overall display. The process of integration focuses on achieving a seamless and aesthetic combination of structure and presentation. The whole course has to be consistent and the navigation through the course material is intuitive and sensible in terms of modules, and the instructional design. Implementation concerns with the material on one or more platform. All components need to be evaluated besides the specification, use of multimedia, implementation, and instructional design.

The learning module for the number topic was developed using Flash. It consists of five sub-topics. There are three levels for each subtopic: basic, intermediate and advanced. The framework for each of the level is as follows: objectives, concept, examples, exercises and quizzes. The courseware is able to give prompts to the students' answers and feedback regarding scores obtained by them.

The Math Quest homepage together with the main interface is shown in Figure 2 and 3 respectively.



Figure 2 Homepage of Math Quest

The blue globe icon in Figure 3 represents the learning module for the game. When the player clicks on the button,



Figure 3 Main interface of Math Quest

a new pop up window will appear to display the topics as shown in Figure 4. The player may choose to go through the book of knowledge to revise, learn, or do exercises before playing the game or anytime he or she

prefers. The topics and subtopics will be displayed on this screen and group into three levels of difficulties, basic, intermediate and advanced.

Learning mathematics on the topics of numbers would be more systematic since the content is based on the syllabus. Students will be guided throughout the module. Figure 4 shows the icons that have been designed in the courseware. The subtopics can be viewed on the left, while on the right side the users can view the icons for exercise, puzzles & games, assessment and online modules.



Figure 4 Main Interface of Learning Module

Icons for lessons, quizzes and grades are displayed on the screen for easy navigation. Animation will be used to further explain each of the topics. Table 1 shows the navigation buttons on the screen that relate to the learning module. The player will return to the game environment upon clicking the save and close button. The player may also redeem the points earned in the learning module for rewards while playing the game.

TABLE 1 NAVIGATION ICONS FOR THE LEARNING MODULE

NO	COMPONENT	DESCRIPTION
1	View Lesson	Allow player to browse the topics that are available.
2	Quiz	Displays all available tests and quizzes for player to answer for a particular topic. Player will be given grades, as well as other rewards which are in the form of stars and scores upon completion of the quiz.
3	Fun	Displays a collection of games or puzzles that player may choose to answer.
4	Topics	Allow the player to choose the topics that he would like to learn or revise.
5	Progress	Allows the player to keep track on the subtopics and the levels, either basic, intermediate or advance that has been covered. 'Tick' green shows that the level has been completed. A red 'cross' indicates otherwise.

Each module starts with the definition of the topic. Figure 5 shows the interface of the definition module on numbers. Here students are introduced to the concepts of whole numbers and place values. The step by step animation to introduce the concept of numbers is carried out by Avanus, who is one of the main characters in the game. Students can always repeat the animation if they want to see it again.

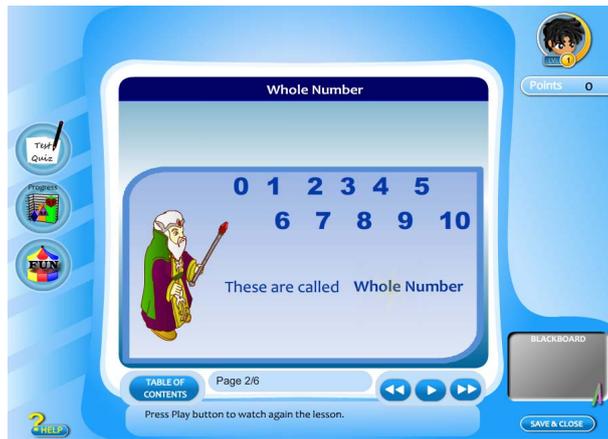


Figure 5 Definition

Three different examples are given for each level of the sub topics. Figure 6 shows an example for “place value of numbers”, i.e, ten thousands, thousands, hundreds, tens and ones.



Figure 6 Example

In order to check their understanding on the material, a set of exercises are given. An example of the given exercise is in Figure 7.

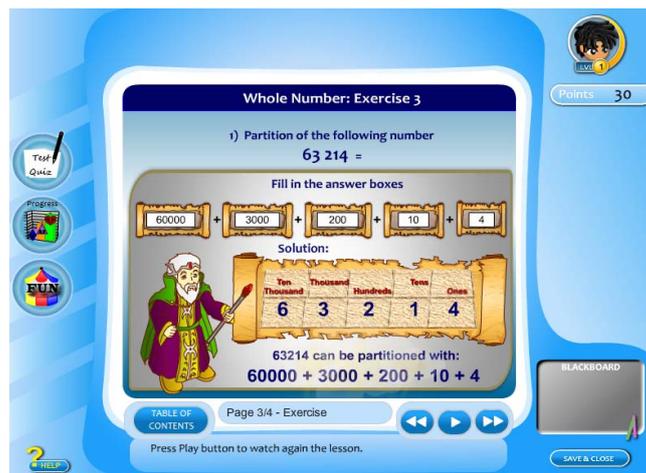


Figure 7 Exercise

Finally, the students are required to take a set of quiz that consists of 10 questions. The overall score will be given once the player has completed the set of quiz questions as shown in Figure 8. Students are allowed to proceed to the next level of the module if they score at least 70% in the quiz. This module has adapted the mastery learning approach where students need to study the material sub topic by sub topic until they master it [13]. The player will repeat these activities for all the sub topics.



Figure 8 Score and Marks for Quiz

Some of the games designed for this topic are Mailbox Mania, Baa BaaBad Sheep and Farlene’s Store.

4. Results and Discussion

A heuristic evaluation on the module was carried out to 20 students in Year 4 and Year 5 of one of the local primary school. [14] recommend that testing on three to six users are sufficient to identify most of the usability problems. Hence, the number of students involved in this evaluation is more than enough to identify the problems. The objective of this study was to get some constructive inputs on how to improve the development of the full learning module. The questionnaire consists of 13 questions on courseware design (Part 1) and 3 questions (Part 2) on their opinion of the module. A scale of 1 to 3 was used; 1 is for ‘agree’, 2 is ‘not sure’ and 3 is for ‘disagree’. Each respondent was given a hands-on on the module and at the end of the presentation, the respondents was given a survey form. The results are shown in Table 2 and Table 3.

TABLE 2 RESULTS OF SURVEY

Part 1: Courseware Design	% of respondents who agree
User Interface	80
Texts	80
Interactivity	85
Suitability	80

TABLE 3 WHAT THE RESPONDENTS LIKE AND DISLIKE ABOUT THE LEARNING MODULE

Items	% of respondents who like	% of respondents who dislike	% of respondents who do not respond
Animation	70	20	10
Colour	80	15	5
Graphics	70	10	20
Character	50	30	20
Examples	65	20	15
Exercises	75	10	15
Definition	85	10	5

The respondents are also required to give comments on the module. Some of the comments given were:

1. Requires audio.
2. Requires more examples.
3. No help button.
4. Some pages are too fast.

At the same time, the students are also required to list down some special features of the module that they like. The features are:

1. It is easy to learn because each step of the workings are shown.
2. The English is quite easy to understand.
3. The students can go back to the pages that they don’t understand and see the examples.

On the whole, more than 70% of the respondents have shown positive response towards the courseware design.

5. Conclusion

This paper has presented the design of a learning module for Math Quest, a role-playing game for learning numbers. A heuristic evaluation was carried out to 20 students to get some feedback on the module. The special features highlighted by the respondents are; the lesson is easy to learn because of the step by step workings, the language is easy to understand and the flexibility of the modules. However, some of the areas that were suggested for improvements include adding the help button, more examples and the full control of the learner over the module and to include audio. This feedback together with the suggestions will be used to further improve the module before finally integrating it with the whole game environment.

6. Acknowledgment

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7. References

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