

Designing Role-Playing Games to learn Numbers

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Abstract: *This paper discusses on the design of a role playing game that could be used as a tool to learn numbers and basic mathematic operations. A simple prototype consisting of 3 mini games is being developed for 10 year old children. Each of the mini games is grouped according to subtopics of numbers and has three levels of difficulty, basic, intermediate and advanced. This prototype is built with a storyline, challenges and a reward system just like any other ordinary games. Positive feedback on the appeal of the game is obtained from the evaluation.*

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.

According to [4], people learn best when they have a strong and immediate motivation to acquire new knowledge, and when they are having fun. Game based learning is able to create a fun, motivating, and interactive virtual learning environment. Initial research findings on educational gaming suggest that it has a place in classroom instruction, and can be used to facilitate learning in a couple of ways. Research projects such as TEEM and CGE in [5] have revealed positive benefits mainly regarding skills development and motivation. Data analyses in [5] showed that the gaming approach is both more effective in promoting students' knowledge of computer memory concepts and more motivational than the non-gaming approach. The E-GEMS project demonstrated that games increased children's motivation and academic achievement within mathematics and science education in grades 4 – 8 (see [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 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. Furthermore, for today’s kids, raised on computers and video games, presenting concepts in a form they are predisposed to love is a great formula for success [10].

This paper describes the design of a role-playing game prototype, Math Quest, to teach 10-12 year old children about numbers and basic mathematics operations. This topic forms part of the Mathematics curriculum for the primary schools in Malaysia. Role-playing games (RPG’s) is a game in which the player assumes the role of a character in the game world and pretends to live, fight and act as the character. The character, on screen, becomes the player’s avatar (fictional characters) in the imaginary world of the game. Characters in RPG game can be divided into two categories: the player characters and non-player characters (NPC). Player characters, are played and controlled by real players, through roaming or adventures helped the development of game plot; NPC cannot be controlled by players, but they played indispensable supporting role in guiding or obstructing game players, such as providing games mission to them, helping them or just as the enemy [11].

2. Overview of Math Quest

Math Quest has been designed as an on-line role playing game and is the improved version of the game developed by [12]. Just like the earlier version, spiral model together with the pedagogical and game design components are employed in the designing of the improved prototype. 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 this activities require mathematical skills. As the story goes, the player will assist the people and face the challenges in Mathedonia before finally getting back to his present world. Gradually the people are able to apply the knowledge of mathematics and can fend off the attacks of their enemies. 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 levels of the game structure are shown in Figure 2.1. Math Quest is developed using Adobe Flash 8, Adobe Photoshop CS2 and Macromedia FreeHand and Sound Forge & Audacity.

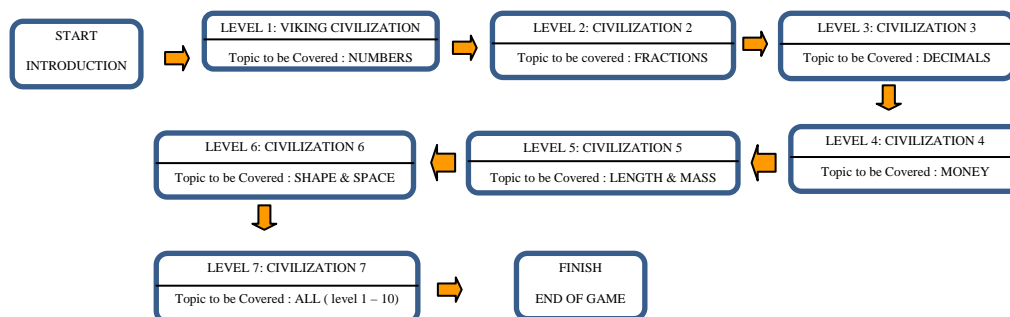


Figure 2.1 Math Quest Level of Structure

Figure 2.2 shows the math quest homepage. Each of the topics available in the game is characterized by the civilizations that are shown in Figure 2.3. This screenshot is the main page of the game. Users have the choice to learn the topics by visiting each of the civilizations. Players are expected to click on the highlighted civilizations (in the complete full version) to proceed with the game. Together with this screen is the narration of the story.



Figure 2.2 Math Quest home page



Figure 2.3 Seven Civilizations

In the prototype, the player is automatically transferred to the Viking civilization. His mission throughout the game is to find the missing orb. This orb will allow the people in the respective civilizations to use mathematics in their everyday lives. Users will be shown a series of animation, text, images, NPCs and sound to immerse players into the game's storyline together with the tutorials on how to play the game on the main screen shown in Figure 2.4. Table 1 shows the components on the screen that relate to the game play.



Figure 2.4 Main interface

Table 1 Main Interface Components

NO.	COMPONENT	DESCRIPTION
1	Character Status	Displays the hero's current status and health points. The player will lose the game if health point is reduced to zero.
2	Gold and Star Collection	Displays hero's current possession of stars and gold.
3	Minimap	Shows the miniature version of current position that will indicate his location (blue dot) and where he needs to go (blinking yellow).
4	Help	When this button is clicked, a new pop-up will appear to display the tutorials on how to play the game.
5	Announcement Panel	When this button is clicked, a new pop-up will appear to display the Event, Hint and Chat tab.
6	Quest Log	Showing current quest or mission that the player needs to accomplish.
7	Inventory	When this button is clicked, a new pop-up will appear to display all items that the player possessed during the game.
8	Globe of Knowledge	It contains the source of knowledge. When this button is clicked, a new pop – up will appear to display the topics for the KBSR mathematics
9	Magic	When this button is clicked, a new pop-up will appear to display all the magic that the player possessed during the game.
10	Award	When this button is clicked, a new pop-up will appear to display all the awards that the player possessed during the game.
11	Blackboard	When this button is clicked, a new pop-up will appear to display a calculator for the player to use.
12	Game option	It displays the options such as load the game, Adjust graphics, Volume, Music and Sound effect,

Currently, the prototype consists of 3 mini games. These mini games are the tasks that a player needs to undertake in order to progress. The mini games are Emma the Innkeeper, Briggs the Builder and Farlene the Storekeeper. Each game represents the sub topic on numbers. A player will have to complete these games in this sequence, since this represents the flow of how these sub topics are being taught in school. As an educational game, every mini game is preceded with the learning objective of the game. At the same time, tutorials are provided at the beginning of the games since all the scenarios in the game are different.



Figure 2.5 Emma the Innkeeper Game



Figure 2.6 Briggs the Builder Game

Figure 2.5 provides a glance of the Emma the Innkeeper's game. In this game, the player is supposed to help Emma find the corresponding mailbox by clicking on the corresponding squares. This game is intended to help players understand the sequence of numbers reinforce the player's counting ability. The numbers are generated based on a sequence of numbers and is represented in terms arrays in the mailbox. The player is given 60 seconds to correctly identify the respective mail boxes. Random numbers will be generated and there are six levels in the game. A player finds the mailbox by identifying the correct sequence of numbers. The first level involves an array of numbers from 1 to 25. As the player moves to a higher level, the size of the arrays will increased correspondingly. Level 6 involves an array of size 8 by 8. The player must complete level 3 in order to progress the game. Besides number sequence, some players may also employ the concept

of multiples of the numbers to find the mailbox. Upon successful completion of the game, the player is rewarded with the mail order that needs to be given to Briggs and hence start the second mini game.

Figure 2.6 shows the screen shot for the Briggs the Builder's game. This mini game is designed to help the player understand the concepts of place value and addition. In this game, the players are given a blue print of a design of a building. There are 6 types of shapes, each representing the digit values of a number. At different levels, the players are presented with a different blueprint in which they are required to calculate the number of nails needed for constructing the solid. In this game, the player is required to match the shapes in the blue print with the required number of nails that is needed for the construction. Each of the shape represents values from 1 to 100 thousands. The player will then calculate the total number of nails required and input this answer in the nails dispensing machine. Since each shape represents different values, this activity helps the learner to reinforce his/her understanding on this topic. Once the player has collected his rewards from Briggs, he is required to visit Farlene's store and uses the rewards to buy some weapons or food that he may need during his quest.

The third mini game is called Farlene the Storekeeper as shown in Figure 2.7. In this game, the player is required to lend a hand at rearranging 8 types of items either in the cupboard or on the shelf in the in the store before he make any purchases. Players are required to match the items and drag these items onto the correct shelf. Furthermore the number of items that can be accommodated by each shelf or cupboard varies. In addition, not all shelves are empty. In this game, the player needs to determine the number of items that can be arranged on each shelf. Only 1 item can be drag at one time. Each item may be of different values. The player needs to identify the correct combination of numbers that are possible. This game is intended to help players understand and practice arithmetic operations especially multiplication and division. The player will successfully pass the stage after completing level 3. Once this level is achieved, the player will be rewarded with stars or weapons for defense during combat. All the mini games are equipped with supporting characters (NPC) that helps players by giving tips to solve the problem. A player will be able to know his performance in the game from the rewards received after each game. For novices, this feature will highlight on the areas that need to be improved.



Figure 2.7 Farlene the Storekeeper



Figure 2.8 Combat Interface

Besides the tasks, the game is also designed with combat screens. Combat occurs where the player needs to deal with enemies they have encountered. When this happens, the player will be transferred into a new combat screen where the player will decide whether to attack the enemy, defends himself/herself. The player may attack using the weapons earned throughout the game or choose to answer a random Mathematics question that will be loaded onto the main screen in

objective format. Since this is civilization is on numbers, the questions in the combat require simple arithmetic calculations as the answer. By choosing to answer the question and getting it correct, the player will earn double hits and able to do damage to the enemy much faster than just to attack with the weapon. Once the enemy's life reaches zero, combat mode will end, and the player will be returned to their previous screen. In this combat, students can test their theories and strategies along with providing practice in multi-steps problem solving. Figure 2.8 shows the interface of Combat.

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. A new pop-up will be displayed. The topics and subtopics will be displayed on this screen and group into three levels of difficulty, basic, intermediate and advanced. Icons for practice, grades and assessment will be displayed on the screen for easy navigation. Animation will be used to further explain each of the topics. The contents and animations of each of the topic are currently under development.

The game also supports the Load and Save game feature. In this way, all the accomplishment and achievement of the player throughout the game are kept inside the memory and will be loaded when the player wants to play again.

3. Heuristic Evaluation of Math Quest

The prototype was played by 10 (5 boys and 5 girls) pupils of mixed abilities aged between 10 to 11 years old. Two of the students were from the lower ability, while three were of average ability and the rest are from the higher ability group. An interview session that lasted about 15 minutes was conducted with each of the pupils upon completion of playing the prototype. The evaluation (demonstration and interview) is focus on the appeal of the game. The results obtained are summarized in Table 2. On the whole, positive comments were received about the game. Almost all of the respondents has expressed that the game is fun and would like to play the game again. Furthermore, all of them expressed that they would like the game to be used in the classroom while learning mathematics since they feel that they would enjoy the lessons more. However, most of the respondents (especially the girls) do not like the combat component of Math Quest. Some of them suggested that the combat should include other form of activities besides fighting. The three students who dislike the tasks in mini games were from the lower ability group. One of the reasons given was there were too many questions to be answered before the game is complete.

Table 2. Evaluation of Math Quest

Questions	% Agreed or Strongly Agreed
Do you think that Math Quest is fun?	100%
Would you want to play Math Quest again?	90%
Do you think that you will enjoy a math class conducted using Math Quest?	100%
What do you like about Math Quest?	
- Scenery	10%
- story	80%
- characters	80%
- Colour	90%
- Combat	40%
- Tasks in mini games	70%
What do you dislike about Math Quest?	
- combat	60%
- tasks in mini games	30%

4. Conclusion

This paper has discussed the design and development of a prototype of a role playing game, Math Quest in learning numbers and basic mathematics operations. The game consists of 3 mini games, each is based on the sub topics of numbers. On the whole, positive feedback has been obtained from the evaluation on the appeal of the game carried out to 10 pupils. This feedback will be used to further improve the game.

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