

Designing a Mobile Game Application for Student with Learning Disabilities

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Abstract— Learning disabilities are a problem that influences the brain's capacity to receive, process, analyze and store information. These processing issues can interfere with learning fundamental abilities, especially for learning mathematics. Fortunately, different approaches and methods in teaching and learning can improve students with learning disabilities to understand and know to count basic mathematic operations. This study focuses on the designing of mobile game applications based on the Speedline method to help students with learning disabilities to understand basic mathematical operational especially the addition and subtraction problem. Based on the findings, Speedline game was design using the puzzle game concept and the game design is fully discussed in this paper.

Keywords— mobile game application; learning difficulties; speedline method; game-based learning; addition; subtraction.

I. INTRODUCTION

Learning Disabilities are neurologically-based processing problems. These situations can involve learning basic skills such as reading, writing or math. This disability can affect an individual's life beyond academics and can impact the relationship with family, friends and in the workplace. The sign and symptoms of learning disabilities usually recognize during the school years, but some individuals do not receive an evaluation until they are in post-secondary education or adult in the workforce.

There are many types of learning disabilities and the most common is Dyslexia, ADHD, Dyscalculia, and Dysgraphia. Dyslexia is a disorder that involves difficulty in learning to read or interpret words, letters and other symbols. ADHD which is attention deficit hyperactivity disorder is a person that has difficulty at paying attention and staying on task. Dyscalculia is a disorder that affects a person's ability to understand the number and learn math facts. Dysgraphia is a learning disability that affects a person's handwriting ability and fine motor skills.

As mentioned in Vijayalakshmi and Swaminathan [1] there are four types of learning disabilities as shown in figure 1. Due to the enhancement of the learning environment, the conventional way of learning does not satisfy the students with learning disabilities to understand the four basic operational especially addition and subtraction operation. Peltenburg [2] proofed that special education students experience many difficulties in solving addition and subtraction operation. Normally, students with learning disabilities show weaknesses in memory and have a problem with information processing. Al-Hmouz [3] mentioned that children will experience difficulty when adding numbers greater than 10 using their fingers.

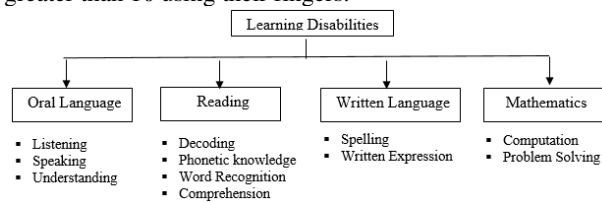


Fig. 1 Type Of Learning Disabilities

One of the strategies of teaching special students to learn mathematics is taking the time and let them understand and figure out how to use basic mathematical concepts [4]. Pressuring them to perform at a standard time beyond their abilities will only reduce their confidence and making them more difficult to learn. Besides, try to introduce to the student a new mathematical concept or a new method that is easier to understand than the standard math concept. Furthermore, learner tends to have low confidence levels, so it is very important to reward the student performance by giving a special treat for improving on their performance in class or finishing an assignment on time.

Mohd et al [5] highlighted that students with learning difficulties, most of them have difficulties in processing information. Therefore, the instructional design needs to be prepared in a correct way. Ahmad [6] stresses that technology needs to be embedded in instructional design to ensure students easy to understand and learn from easier to more challenging skills. The author also mentioned that previous study proves that multimedia is an effective way to help children with learning disabilities to learn and improve their skills.

To help students to understand the basic mathematic operation, game design is an important aspect and cannot be taken lightly. It deals with the overall story, game assets, interface design, mechanics as well as game rules. Although the game design can be started with sketching, it must be translated into the working game using suitable development tools. All the team members need to work together since designing a game requires consideration of all aspects of the game. Ahmad and Shafinah [7] highlighted that to get a good quality digital game is to understand how to elicit user emotion which can be derived from the game.

II. GAME DESIGN

A. Speedline Method

Speedline is a new method that uses lines to improve understanding of addition and subtraction operation. Speedline method is designed to allow students to calculate easily, quickly and accurately. In other words, it is a new initiative by Subject Matter Expert to enhance student understanding on how to perform basic mathematical operational especially addition and subtraction operation for students with learning disabilities.

The Speedline method is based on line. At first, students need to know or master on how to count from zero to nine in ascending order as well as count from nine to zero in descending order. Then the student will put the line under the number as shown in figure 2. After drawing a line, students will start counting for each line.

For an answer that involves two decimal points or more than that, students need to understand a new skill. If the number zero appears, a new line must be placed on the left side as shown in figure 3.

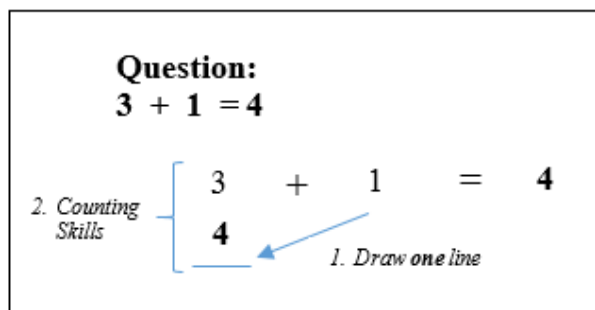


Fig. 2 Draw and Count Skills

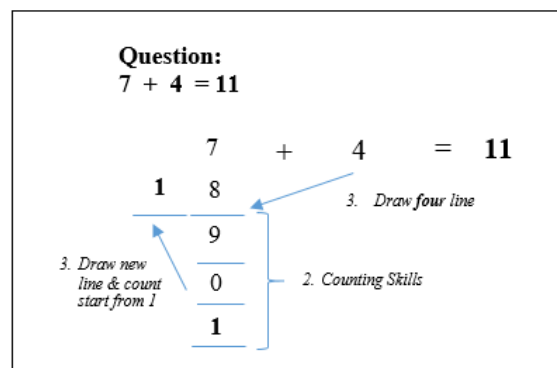


Fig. 3 Basic Addition Operation

For subtraction operation, students need to know how to count a number from nine to zero in descending order. The basic instructions or step are as follows:

Step for Addition:

- (i) Student should place the line under the number according to the given question number
- (ii) Student needs to know how to count and write from number 0 to number 9.
- (iii) When the number 0 or zero is written on the line, the student must provide an additional line under the next number.
- (iv) Step for Subtraction:
- (v) Student should place the line under the number according to the given question number
- (vi) Student needs to know how to count and write from number 9 to number 0.
- (vii) When the number 9 or nine is written on the line, the student must provide an additional line under the next number.

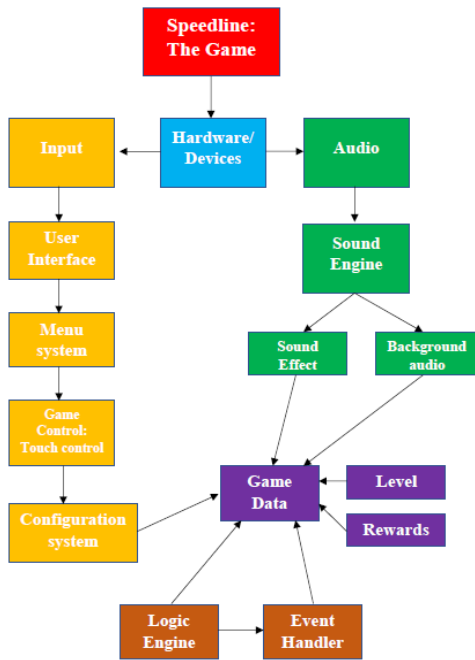


Fig. 4 Game Architecture of Speedline

B. Game Architecture

There is a sound engine, logic engine, event handler, touch handler for the Speedline game architecture. The game architecture focuses on the game features of making the event trigger work and smooth player control. The system also gathered data from players every time it starts to ensure that the game level is automatically saved after levels unlocked or locked. Figure 4 shows the game architecture of Speedline mobile game application

C. Storyboard

In storyboard design, rough sketches of interfaces and game objects are presented. The interface is created based on the target audience that is the children in pre-school as shown in figure 5.

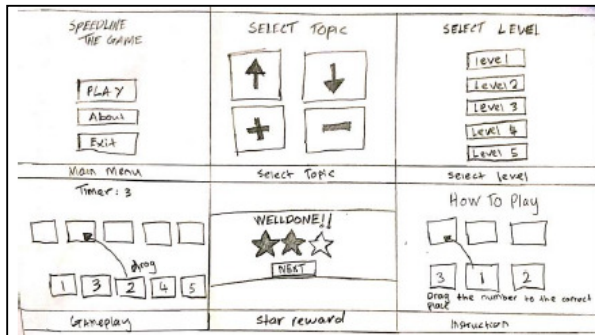


Fig. 5 Game Storyboard

D. Navigation Design

Player is needed to understand the navigation design for them to not get lost in navigating around the system. Therefore, an effective navigation design is very crucial as it may affect the player's user experience. Figure 6 shows the navigation flow of the game designed.

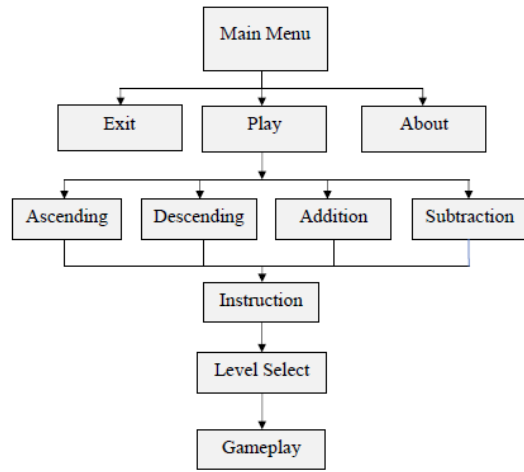


Fig. 6 Navigation Flow of the Game

E. Input Design

Input design focuses on the entry of raw data provided by a player which will be converted into a computer-based system. The system is required to receive input from the player to be processed to produce the output. Since the game is played on an android device, the input will be from the touch-based system. For example, player will touch the button to move to another scene and touch drag the game object to move it to the right place.

F. Output Design

Output design is the design that focuses on the retrieval and presentation of the information as requested by the user. Table I shows the list of output design of the game.

III. RESULTS AND DISCUSSION

A. Game Genre

Based on a preliminary study about the game genre as shown in table 2, results show that the top game genre was a puzzle game with a score of 28.6%. Follow by Action and Strategy game with a score of 17.3%. Simulation is in rank four with the score 13.5% and Platform 9.6%. Puzzle Games means that game has few levels to be completed and higher difficulties of solving the game missions. Based on this finding, the Speedline game is design using the puzzle game concept.

TABLE I
OUTPUT DESIGN

| Touch Button | Output |
|--------------|--------------------------------|
| PLAY | Start the game |
| ABOUT | Move to scene about |
| EXIT | Exit application |
| → | Next slide |
| ← | Previous slide |
| CONTINUE | Continue to level select scene |
| ↶ | Move to the previous scene |




| | |
|---|---|
|  | Move to Ascending, Descending |
|  | Addition and Subtraction topic respectively |
|  | Start a level |

TABLE II
GAME GENRE

| Game Genre | Percentage (%) |
|--------------|----------------|
| Puzzle | 28.85 |
| Action | 17.31 |
| Strategy | 17.31 |
| Simulation | 13.46 |
| Platform | 9.62 |
| Adventure | 7.69 |
| Role-Playing | 5.77 |

At the early stage, the inspiration is from the Chinese Dragon Game and Brain Workouts Game. Both are from the popular puzzle game genre that involves a mathematic operation. Table 3 shows the difference between these games.

B. Game Art Creation

Production of text, graphics, audio, and animation are the elements of game art creation. For the production of text, texts are focusing on simplicity and suitability for children between the ages of 6 – 12 years old. It also uses the font type, size, and color that is appealing and easy for them to read. The background design as shown in figure 7, uses shape and color. For the background in the menu interface, the pen tool is used to create a certain shape or object such as the mountain and tree. The number character in the menu interface was from vecteezy.com and the color is changed to suit the theme of the background. All the background was designed using Adobe Illustrator and import in to Unity engine.

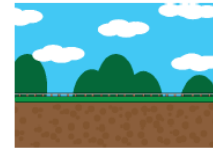
TABLE III
COMPARISON OF PUZZLE GAME

| | Chinese Dragon Game | Brain workouts | Speed Line Game |
|----------|---|---|--|
| Platform | Standalone PC | Standalone PC | Mobile – Android |
| Genre | Puzzle Game | Puzzle Game | Puzzle Game |
| Level | Player chooses the level of ordering number ascending or descending | The player needs to drag and drop the correct number at the right place to create the right answer. | Player can choose a topic and the next level will automatically unlock to a new level once they finish the task. |

| | | | |
|------------|---|--|--|
| Rules | Player will get a new set of number after completing the first round. | New question will be set when pressing a reset button. | Drag and drop the line and fill the correct number to the right place. |
| Challenges | The number can start from 1 to 100 include a decimal point. | The number is limited to create the right answer. | The player will receive a reward based on a certain time. |



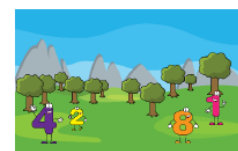
Ascending Level



Descending Level



Add and Subtract Level



Menu interface

Fig. 7 Background Design

A game object is an object the player interacts with it and help to complete the level. The design was made with shape and color using Adobe Illustrator and also import to the Unity engine (Figure 8).



Fig. 8. Game Object

IV. CONCLUSION

To conclude, the SpeedLine method helps students with learning disabilities to solve addition and subtraction operation from one to seven digits. Using the line is not require the retrieval of stored facts from memory. However, because students are encouraged to do the exercise repeatedly using SpeedLine, it is expected it can be stored in a child's long-term memory. SpeedLine method also has the advantage that involves auditory, visual and kinesthetic. Also, help students with self-confidence without using a finger to count or tally counting.

V. FUTURE SCOPE

In the digital native era, SpeedLine method is a good alternative for special education students to solve the mathematical problem easily and accurately. To achieve this mission, game design and game architecture are an important part of this study. The design must be documented for future use and references and to make sure that it suits user requirements before the game is implemented. The next activities to be discussed are about game development, game testing, and game implementation.

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