

Games Application in Improving Children of Numeracy Skill

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Abstract

This paper presented a game application in learning addition, subtraction, division, and multiplication as basic numeracy skills through a fun learning process. The objective of this study is to develop a running math game application. This Game goal is to improving numeracy skills for children in 3rd grade of elementary school. A variety of software tools used include Photoshop, illustrator, and Unity. The result of this study is mobile game applications for android as a learning media for children practicing numbers.

Keywords: numeracy skill, mathematics, game application

1. Introduction

Numeracy skills refer to using mathematic knowledge, skills, behaviors, and dispositions in a wide range of situations. Mathematics is an indispensable subject of study. It plays a vital role in forming the basis of all other sciences that deal with space and time's material substance. In research from Vazquez (n.d.), mathematics is an autonomous intellectual discipline, one of the clearest exponents of the creative power of the human mind. Learning mathematics presents various challenges for many children due to the subject's complicated and often tedious nature. Based on the interview with the 474 teachers and 971 students from 169 schools, the result found that students got difficulties when they learned mathematics. They are not preferred in thinking and lack problem-solving skills. They are not frequently practicing in a mathematical subject.

Moreover, the teacher does not use learning media to help students' understanding (Somwong & Chanya, 2557). In the research topic Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs by Gafoor & kurukkan (2015) found that Mathematics is the most liked subject for only 3(6%) students and it is the hated one for 45 (88%) students. Their main reasons for hating mathematics were difficulty understanding the subject, poor instruction, and demand for more time to grasp, but they quickly forget what they learned. Furthermore, submission of material in the learning process sometimes experiences some obstacles. Some of the constraints teachers face are boring learning methods, and the media used is less attractive. (Puspitarini, Hanif, 2019) Using one-way learning media made students got bored. Students became less active because the method used was teacher-centered learning (Yuniasih & Dwi, 2018). Multimedia, Game, and instruction learning media have the potential to address these challenges and positively impact mathematics learning and attitudes. Using interactive media in learning activities can boost student's motivation.

A game is any activity that is executed only for pleasure and without conscious purpose. In this definition, every activity that brings pleasure is a game. (Wolfgang, 2000). In most games, the rules are more significant than the components. Whether commercial or non-commercial, all games have several standard features such as high interactivity, fun, rules that the player must follow, and, in many cases, a competitive element. However, serious games are aimed not only at providing entertainment or competitiveness but also at exploiting these to improve training in education, public policy, health, or communication strategies. Some criteria apply to all games. These criteria are the game rule, goal, The course of the game is never the same chance, and competition. (Zyda, 2005) & (Connolly, et al., 2012).

This paper focuses on gaming in the field of education. It attempts to create a new educational tool that combines a mobile application for counting numbers, including addition, subtraction, division, and multiplication, with game technique. This game application presents new and exciting ways to get children involved in learning calculations. This application can change the way children learn calculations with the game applications.

The paper organizes in the following manner: section II explains related works, section III briefly explains the methodology, the procedure for creating an app based on gaming, the hardware and software requirements, section IV discuss the result, and conclusion for the entire application and section V presents the future works to modify and enhance the application for education and other related areas.

2. Related Work

Learning with the multimedia game is an achievement of learners in an understanding of various complex phenomena. The research conducted by Porntip (2552) showed that multimedia was effective in learning about computer components (Ngeinphairot,2552), so the teachers needed to develop the multimedia application as a learning medium. Similarly, Yien et al. (2011) developed a game-based learning approach to improving student's learning achievements in a nutrition course. Sushada and Jirapan (2557) developed an interactive education game on tablet PC for Mathematics of the first Primary class (Tongmak and Srisomphan, 2552) Amornrat Thongdee and Siwanit Autthawattikul (2558) used multimedia for the problem-solving in first class primary school at Ban Nong Song Hong school in Ratchaburi Province. Moreover, Sirirat krajadtog (2012) developed computer-assisted instruction with game type for fundamentals of computer subject for a student in a secondary school in the second level of Sriprachan "Methipramuk" school, Suphanburi Province.

Moreover, Tomic and Divjak (2011) discussed that using mathematical computer games for teaching contributes to a more efficient and quicker realization of educational goals at all levels of education. Using computer games for teaching creates pupils' positive attitudes toward mathematics. Their active participation is more significant than regular study, and the acquisition of mathematical knowledge, skills, and routines is more efficient, resulting in a better quality of the teaching process. The target learning outcome was mathematics achievement. Results indicate that video games contribute to higher learning gains compared with traditional instruction. (Tokaca, et al., 2019)

3. Methodology

This research paper uses the multimedia development life cycle method. This method consists of six steps: defining the system, system design, tools selection, authoring/rendering, testing, and product.

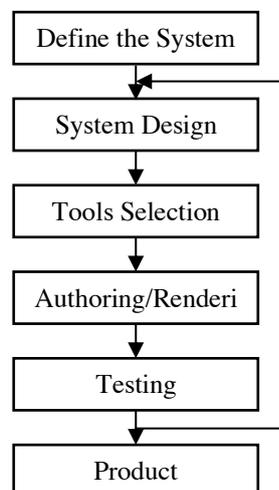


Figure 1: multimedia development life cycle

3.1 defining the system

The development started by first finding a mathematics reference book for a limit of boundary mathematics questions that will exit in the game. These questions refer to the mathematic book's name funny with mathematics questions of 1-3 primary school PBC (Ministry of Education, Basic Education Curriculum 2008, 2551). It covered subtraction, addition, multiplication, and division skill.

3.2 system design

The architecture of game-based learning for improving children's numeracy skills involves developing an interactive game containing text, audio, images, and animation. This game-based learning was performed using various multimedia tools and plugins such as photoshop, illustrator, and unity. The basic system design and flow is illustrated in figure 2

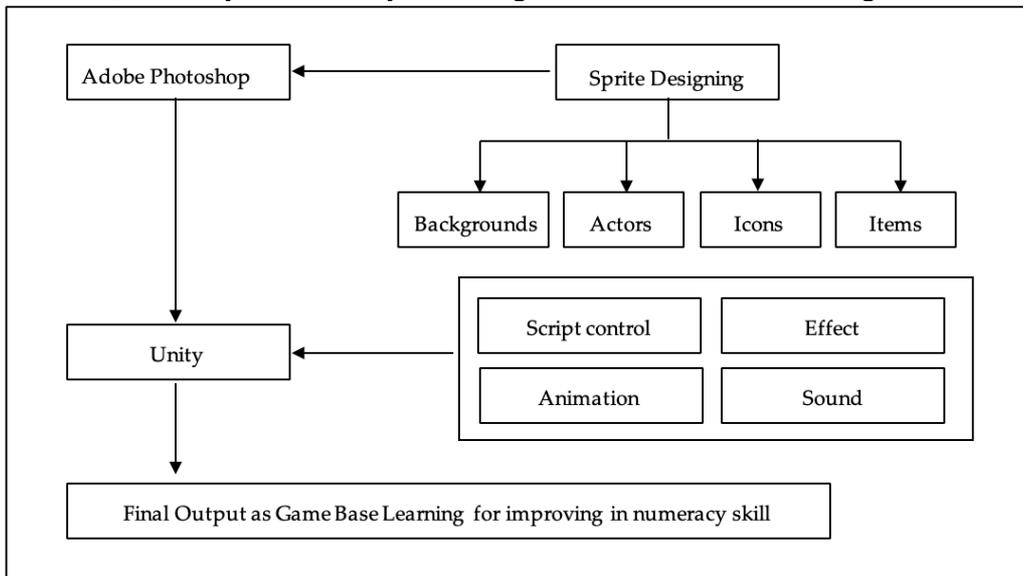


Figure 2: System Design

The flow chart of this game is shown in figure 3 below.

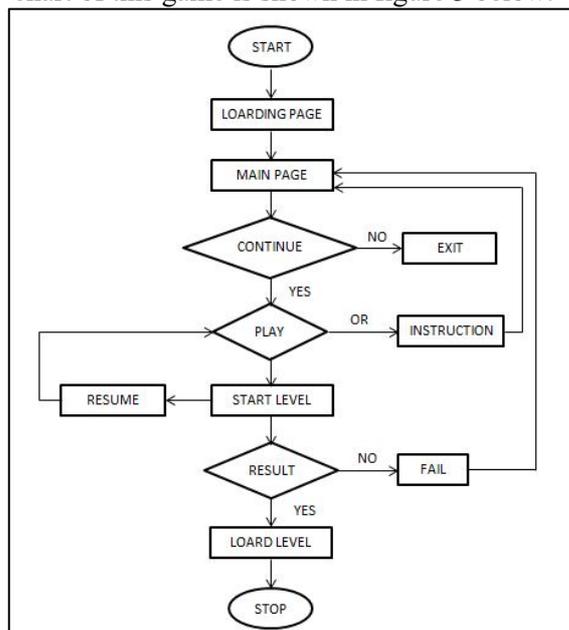


Figure 3: Flowchart of Game

3.3 Tools Selection

The development started by first preparing all sprites used in the game, as shown in Figures 4-7. There are actors, icons, items, and backgrounds. Designing of all sprites was created in adobe photoshop.

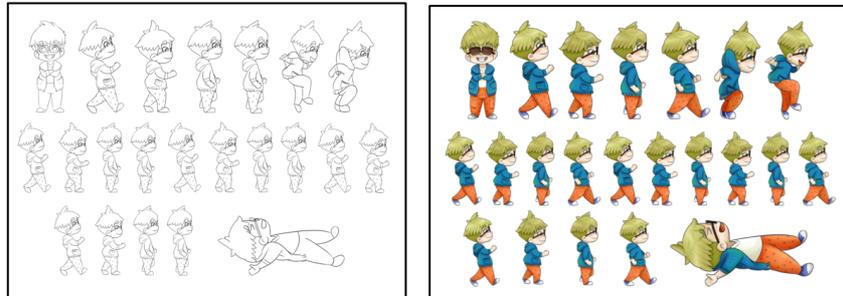


Figure 4: Sprite of Actor

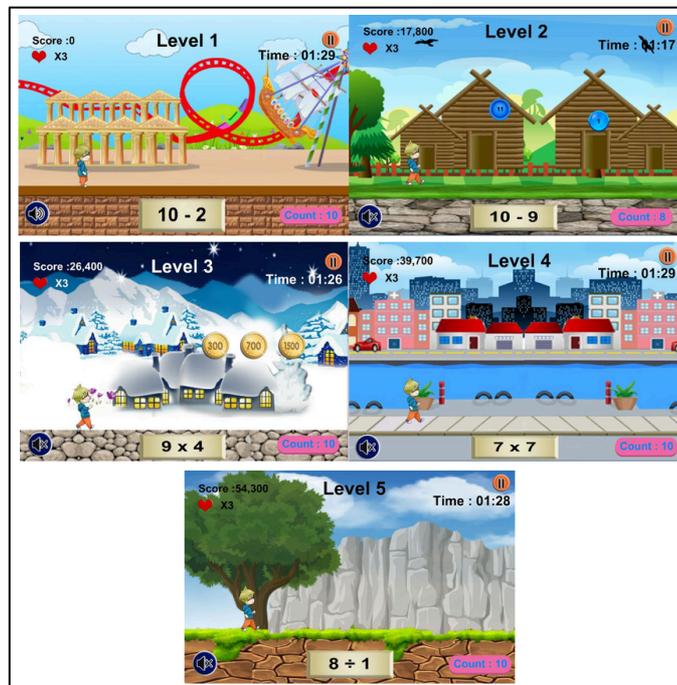


Figure 5: Background Designing



Figure 6: Game Icons



Figure 7: Game Items

3.4 Authoring/Rendering

3.4.1 Using Rigidbody 2D and Box Collider 2D Component in Unity

Rigidbody 2D and Box Collider 2D components are the most crucial part of gravity and physics objects. Through Rigidbody, an object will put its motion under the control of unity's physics engine. Box Collider 2D is an invisible shape that is used to handle physical collisions for an object. A collider does not need to be precisely the same shape as the object's mesh, and a rough approximation is often more efficient and indistinguishable in gameplay (unity3d, 2021). Every object that should interact with gravity and other physics objects requires a BoxCollider 2D component and a Rigidbody 2D component (Mackinnon, 2021). For this purpose, Rigidbody 2D and Box Collider components are used in the game, as shown in figure 8.



Figure 8. Rigidbody 2D and Box Collider 2D Component

3.4.2 Create Animation in Unity

Games are meant to be interactive. When the user plays a game, the user will have complete control of the character and the camera. Animation is one technique for movement to give life to game characters and creatures. In this game, the workflow of an animation system is used. The animation system consists of animation clips and animator controllers. The concept of animation clips is the step to change actor position, rotation, or their properties over time. Animation Clips of this game are walk and jump. as shown in figure 9.

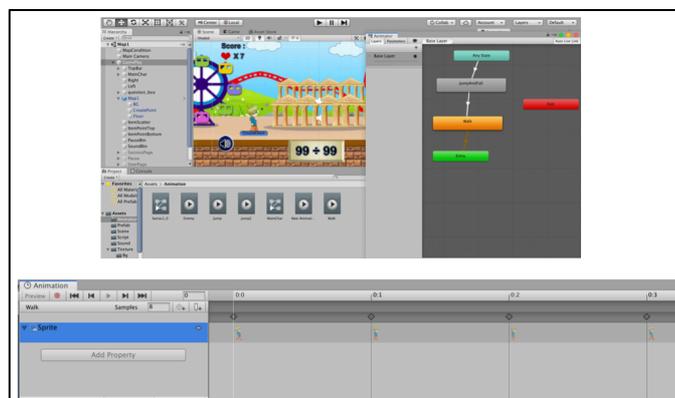


Figure 9. Animation System

The animation clips of this game used internal sources by importing multiple pictures are called "picture frames" to Unity tools. Whereas, Animation clips from external sources are created by artists or animators with third-party tools such as Autodesk® 3ds Max® or Autodesk® Maya®,

or come from motion capture studios or other sources. Animator controllers arrange and maintaining a set of animations of a character or other animated game object (unity3d, 2021). The controller references the animation clips used within it and manages the various animation states and the transitions between them using a so-called State Machine, which could be thought of as a kind of flowchart or a simple program written in a visual programming language within Unity.

3.4.3 Creating Scripts

Scripts are an essential part of gaming in unity. It is implemented game logic and behavior by merely applying to the game objects. Unity supported scripting with C#. Script components will allow many things to trigger game events, check for collisions, apply physics, and respond to user input. This game script is used as a controlling button, loading page, controlling the player, generating the question, controlling for sound, and controlling the character to move forward, backward, jump, and dodge. This game uses four mathematics operators: addition, subtraction, division, and multiplication—this paper uses a switch case to generate a question. The question is random from 0 to 9, the number of questions in probability to be three of numbers. Below is the script used to generate a question.

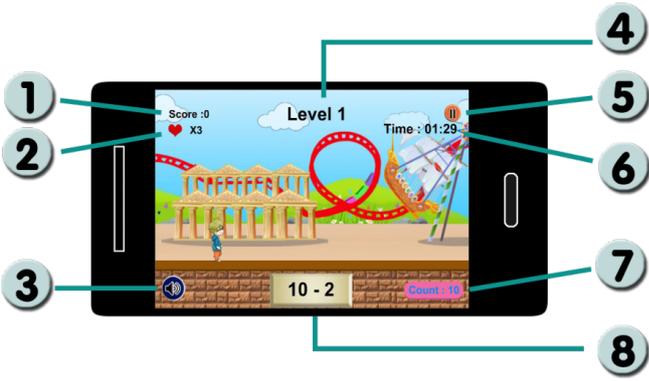
```
public string[] Generate(int countOperator,int max ,int min)
{
    List<int> Number = new List<int>();
    string[] data = new string[4];
    Number.Add(Random.Range(min,max));
    Number.Add(Random.Range(min, max));
    Number.Sort();
    int Operator = Random.Range(0, countOperator);
    switch (Operator)
    {
        case 0:
            data[0] = Number[1].ToString();
            data[1] = Number[0].ToString();
            data[2] = (Number[1] + Number[0]).ToString();
            data[3] = "+";
            return data;
        case 1:
            data[0] = Number[1].ToString();
            data[1] = Number[0].ToString();
            data[2] = (Number[1] - Number[0]).ToString();
            data[3] = "-";
            return data;
        case 2 :
            data[0] = Number[1].ToString();
            data[1] = Number[0].ToString();
            data[2] = (Number[1] * Number[0]).ToString();
            data[3] = "x";
            return data;
        case 3:
            while (Number[1] % Number[0] != 0)
            {
                Number.Clear();
                Number.Add(Random.Range(0, 100));
                Number.Add(Random.Range(0, 100));
                Number.Sort();
            }
    }
}
```

```

data[0] = Number[1].ToString();
data[1] = Number[0].ToString();
data[2] = (Number[1] / Number[0]).ToString();
data[3] = "÷";
return data;
default:
return data;
    
```

4. Results and Conclusion

This study aimed to design and develop a game application for improving children in numeracy skills. These skills of numeracy are addition, subtraction, division, and multiplication. This game is available for children to play with five levels by starting use addition questions at the first level and adding more challenging of next level using subtraction, multiplication, and division. Each level providing of 3 lives that can protect the player fail and 90 seconds in playing for each level. This paper tries to provide smart ways to improve student's learning in calculation. Thus, the results indicate that Learning mathematics through a game is increasing students' enthusiasm. It is transferring student attitude to be positive on the mathematics subject. While students are playing games and having fun, they are practicing numeracy skills at each level in the game. Games can supplement traditional learning but not replace it. The result of develop running map game as shown in figure 10 below.

	
<p style="text-align: center;">Loading Page Its loading game with three second before go to main menu page.</p>	<p style="text-align: center;">Main Menu Page It has 4 function buttons are about button, help button, play button, and exit button</p>
	
<p>Level game page (Level 1)</p> <ul style="list-style-type: none"> 1: The score of playing game. 2: The live in game. It set 3 times. 3: The sound button. Pressing the sound button to turn off or turn on the sound. 4: The level of game. 5: The pause button, pressing pause button the option page will pop up. It has 3 function buttons are resume button to continue the game, replay button to start new game, and home button to go back to main menu page. 6: Time can be playing game with 90 sec. 	

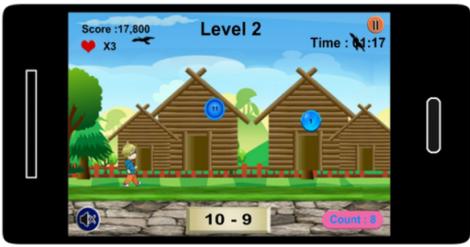
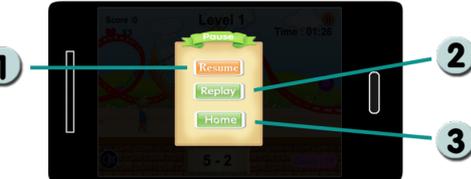
<p>7: number of questions in total 10 questions in each level. 8: The question box.</p>	
	
Level 2	Level 3
	
Level 4	Level 5
	
<p>Game Over Page</p> <p>1: The score of playing game. 2: The highest score in playing game. 3: The home button 4: The next button, to continue next level.</p>	<p>Option Pop up Page</p> <p>1: The resume button, to continue the game. 2: The replay button, to restart a new game. 3: The home button, to back main menu page.</p>
	
Congratulation Pop up Page	About Page to describe the RM game “What it’s about?”

Figure 10. Running map game

5. Future Work

Teaching with computer games involves a focus on the games as a starting point for subject-based learning processes within the school’s range of subjects, concentrating on the specific goals for each subject. It will be more beneficial for researchers to study the impact of games concerning achieving specific learning objectives. This game application is just a prototype; the researcher is not exploring how this game application can be an impact on children in improving mathematic skills; this study can be for future work.

In future work, it should add levels of the game, game items, and mathematic contents related to the game. The same game can develop for various subjects or any of the contents that tedious subject. However, the game application can develop for online video games that allow multiple users to play simultaneously.

References

- Amornrat, T. and Siwanit, A. (2558). The effect of using multimedia for the problem-solving in addition of Prathom 1 students at Ban Nong Song Hong school in photharam, Ratchaburi Province. *Veridian E-Journal, Slipakorn University*, pp. 2321-2335.
- Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., and Boyle, J. M. (2012). *A systematic literature review of empirical evidence on computer games and serious games*, *Computers & Education*, 59 (2), pp. 661–686.
- Duagntod,S. (2554). *Development of computer games for teaching computer courses integrate mathematics*. Thai Lirary Intergrated System.
- Gafoor, K.A. and Kurukkan, A.(2015, August 18-19). Why High School Students Feel Mathematics Difficult? An Exploration of Affective Beliefs. *UGC Sponsored National Seminar on Pedagogy of Teacher Education- Trends and Challenges at Farook Training College, Kozhikode, Kerala, pp1-6*. Retrieved from <https://files.eric.ed.gov/fulltext/ED560266.pdf>
- Mackinnon, B. (2021, July 7). *Introduction to Unity 2D*. Retrieved from <https://www.raywenderlich.com/707-introduction-to-unity-2d>.
- Ministry of Education, Basic Education Curriculum 2008. (2551). *Calculation," in Funny with Mathematic question of 1-3 primary school PBC*.Bangkok.
- Ngeinphairot,P.(2552). *Game development, multimedia teaching computer components and Working of computers for the second level of primary school*. in Computer Technology King Mongkut's University of Technology North Bangkok.
- Puspitarini, Y.D. & Hanif, M. (2019). *Using Learning Media to Increase Learning Motivation in Elementary School, Vol.4, No.2,53-60*. DOI:10.29333/aje.2019.426a
- Somwong, P. & Chanya, P (2557, November 30). *survey on problem Why are students afraid of mathematics*. Retrieved from http://suppawethwilair.blogspot.com/2014/11/blog-post_83.html
- Sirirat, K. (2012). The development of computer assisted instruction : game type subject basic of computer on component of computer for mathayomsuksa 2 students of Sriprachan “Methipramuk” school, Suphanburi Provice. *Veridian E-Journal*, vol. 5, no. 2, pp. 193-210.
- Tomic, D. and Divjak, B. (2011). The Impact of Game-Based Learning on the Achievement of Learning Goals and Motivation for Learning Mathematics - Literature Review. *Journal of information and organizational sciences*, vol. 35, no. 1, pp. 15-30.
- Tokaca,U., Novakb,E., and Thompson, C.G. (2019). Effects of Game-Based Learning on Students’ Mathematics Achievement: A Meta-analysis. *Journal of Computer Assisted Learning*.
- unity3d.(2021, September 10).*Unity Manual*. Retrieved from <https://docs.unity3d.com/Manual/CollidersOverview.html>.
- Vazquez, J. L. (n.d.). *the importance of mathematics in the development of science and technology*. Retrieved from <https://verso.mat.uam.es/~juanluis.vazquez/reptmath.pdf>
- Wolfgang, K. (2000, December 1). *What is a Game*. Retrieved from <http://www.thegamesjournal.com/articles/WhatIsaGame.shtml>
- Yuniasih, S.R & Dwi, M.I.(2018). "Need Assessment of Interactive Multimedia Based on Game in Elementary School: A Challenge into Learning in 21st Century," *International Journal of Educational Research Review*.
- Yien, J.M., Hung,C.M., Hwang, G.J. and Lin, Y.C. (2011). A game-based learning approach to improving students' learning achievements in a nutrition course. *The turkish online journal of educational technology*, pp. 1-10.
- Zyda, M. (2005). *From visual simulation to virtual reality to games*. *Computer*, 38(9), 25-32.