Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

DESIGNING EDUCATIONAL GAME TO INCREASE MATHEMATICAL KNOWLEDGE

Joshua Putra [1], Johanes Fernandes Andry [2]

[1,2]Faculty Technology and Design, Information System Department, University of Bunda Mulia

Lodan Raya Street No. 2 Ancol, North Jakarta 14430, Indonesia
[1]joshuaputrajps@gmail.com, [2]jandry@bundamulia.ac.id

Abstract

Mathematics is one of the most difficult subjects to learn in school, mostly because there is a lot to be memorized especially with multiplication, resulting in math as the subject hated by students in school. One of the challenges in learning mathematics is students' laziness in the subject. To make learning in mathematics more interesting and interactable an educational game to increase knowledge of multiplication was developed in this study using the Game Development Life Cycle (GDLC) method which consists of six phases: initiation, pre-production, production, testing, beta, and release. The beta testing involved 30 students, from 2nd grade primary school. The results of the beta testing showed that 93.33% of the elementary school student respondents gained multiplication knowledge after playing the game. Based on the knowledge gained from this study, an educational game was created that may be used to teach Indonesian primary school students about multiplication.

Keywords : *Mathematics, Knowledge, GDLC,Multiplication, Game*

Abstrak

Matematika merupakan mata pelajaran yang sulit bagi banyak siswa, terutama ketika membahas perkalian. Hal ini dapat membuat siswa tidak menyukai mata pelajaran tersebut dan menghindarinya. Untuk membuat matematika lebih menarik dan interaktif, sebuah permainan pendidikan dikembangkan untuk meningkatkan pengetahuan siswa tentang perkalian. Permainan ini dikembangkan menggunakan metode *Game Development Life Cycle* (GDLC), yang merupakan proses enam fase yang memastikan pengembangan permainan dilakukan secara sistematis. Sebuah permainan pendidikan diuji coba beta dengan 30 siswa sekolah dasar kelas dua. Setelah memainkan permainan tersebut, 93,33% siswa memperoleh pengetahuan tentang perkalian. Hal ini menunjukkan bahwa permainan tersebut adalah cara yang efektif untuk mengajarkan perkalian kepada siswa sekolah dasar di Indonesia.

Kata Kunci : Matematika, Pengetahuan, GDLC,Perkalian, Permainan

1. INTRODUCTION

Education is the foundation for students to develop skill and ability. One part of education is learning mathematics [1]. Mathematics is a basic knowledge that is important to learn at every level of education, from kindergarten to high school and even university [2]. Learning mathematics involves more than just numbers. It also fosters a variety of skills that are applicable to daily life. These cognitive skills include logical, analytical, creative, and critical thinking [3], [4]. Mathematics is a difficult subject for most of the students. This is because there are many mathematical formulas that they have to remember and this addition lesson requires students memory to memorize beyond reason [5]. One of the challenges in learning mathematics is students' laziness in the subject.

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

Given that mathematics is a fundamental aspect of life, it might result in the loss of the country's next generation. Another barrier to studying mathematics is the lack of teaching resources. To date, students have only studied using printed or digital books. Students begin to get bored as they begin using the text continually. Because it might be challenging to visualize how mathematical equations will be used, students can have trouble comprehending the formulas they are studying. Alternative teaching approaches are now possible because of advancements in technology that help students comprehend and perform better in the field of study [6].

Technological developments from age have progress very rapidly every year. The development of this technology is very influential in various fields of life, one of which is developments in the field of entertainment such as playing games. In everyday life, playing games is felt to be good enough to help relieve fatigue or pressure after carrying out various activities [7], [8]. Ussualy, video games prioritizing elements of entertainment and providing interaction with its users, or commonly referred to as players. The game itself can be interpreted as a structured or semi-structured activity which is usually intended for entertainment, but can also be used as a learning medium [9], [10]. Learning here can be interpreted as 2 meaning, learning educationally and learning cognitively. Educational learning video games proven to increase the interest in learning also in concentration [11–13].

Multiplication Jump is an educational platformer video game that being developed by researchers. Platformer video games is a video game genre where the gameplay was the player can move horizontaly through walking or running and verticaly through jumping, ussualy the goal of platromer video games are to reach a finish line from a certain map or level [14].The goal of Multiplication Jump is to combine the element of platformer video game and multiplication knowledge on the game.

The researchers will be assisted by The Game Development Life Cycle (GDLC) through out developmnet of Pixel Jump, the GDLC is a methodology for game based application development with an iterative approach consisting of 6 development phases strating in Initiation, Pre-production, Production, Testing, Beta, and Release [15]. The GDLC is aimed to help researcher developing Pixel Jump from start to finish, the GDLC is proven to help previous researcher to develop their games [16].

The researchers wants to develop a platforming video game targeted to 2nd grade primary school, where the game is designed to be entertaining and to be a mathemathic learning medium. Researchers believe that these factors will lead to better multiplication knowledge in students.

2. LITERATURE REVIEW

Previous research by [17]. Researcher using the GDLC method to create an RPG game that help better their arithmetic skills, the result show that their game called the Wizard of Math display math problem with RPG Elements, also the game doesn't have any negative effect and the game doesn't pressure their consumer too keep playing it.

On another previous research by [18]. Researchers created a game using the GDLC method to increase environmental awareness. The research shows that after playing the game the test subject gain environmental knowledge by 71.11%.

3. RESEARCH METHODS

Figure 1 are the 6 stages of the game development life cycle it includes initiation, pre-production, production, testing, and release.

3.1. Initiation

In the initiation stage, the researcher began to identify the initial idea and concept of the game such as

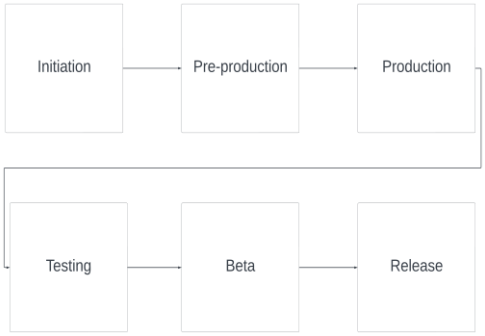

Figure 1. Game Development Life Cycle [19]

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

3.2. Pre-production

In the pre-production stage, the researcher going to put the idea from the initiation stage into unified modelling language like use case diagram and the activities diagram.

3.3. Production

In the production stage, the researcher is in the main phase executing the making of the video game, this stage associated with creating or searching game asset, writing program code into, designing stages into complete games.

3.4. Testing

In the testing stage, the researcher tested the functionality of the game using black box testing.

3.5. Beta

In the beta stage, the researcher is going to test the game to the target audience, the target audience consisting of 30 2nd grade elementary students from primary school.

3.6. Release

In the release stage, the researchers are going to release the game to the internet so the game can be accessed by students on the world.

4. RESULT & DISCUSSION

4.1. Initiation

Table 1. Game Design Document

Game Title	Multiplication Jump
Number of Player	One
Target Audience	2nd Grade Primary School Students
Objectives	Players need to collect fruits to go to the next level, to collect fruits player going to need to answer multiplication question
Game Mechanics	Players control their character by using keyboard as a control button, the control as follows: a to move to the left and d to move to the right and spacebar to jump. Player characters can die if they fall from a certain height on the ground or are hit by traps or enemies. If the player dies, they can retry the stage or return to the main menu. The player going to interacts with the box of fruits to go to the next stage, every interaction there is going to be a multiplication question on it.
Challenge	The challenge of the game is to control the player and not to die to traps and enemies, and lastly answer multiplication questions from the stages.
Conclusion	Multiplication Jump is an action-packed educational platformer game that can improve the knowledge of players about multiplication.

Table 1 is the game design document that shows what are the essential concepts of the game as shown on the table above.

4.2. Pre-production

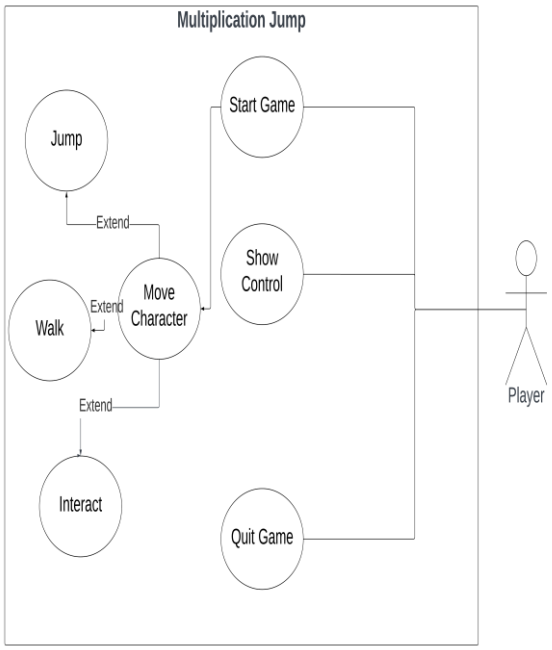

Figure 1. Use Case

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

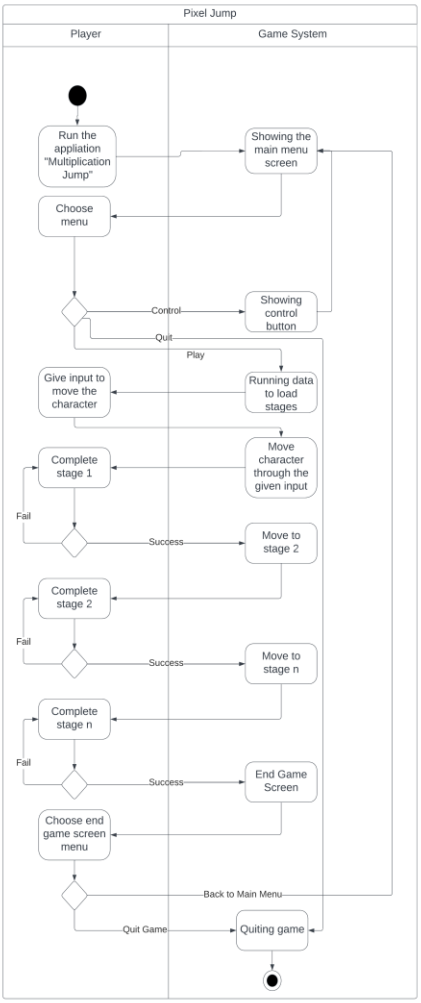

Figure 2. Activity Diagram

Figure 1 is a use case diagram that was used in the making of the "Multiplication Jump". Players can mainly make 3 choices: start the game, show control of the game, and quit the application. If the player starts the game, the player can control the character of the game such as walking, jumping, and interacting. The show control menu is going to show the player what buttons to be pressed to control the character of the game and the quit game menu is going to make the application closed.

Figure 2 shows the activity interaction between the player and the game system, which is designed to help the researchers map out what activities players can do within the game.

4.3. Production

Figure 3. Start Menu

Figure 3 is the main menu of the game, main menu is the first screen that shows to the player when they run the game to have choices to do in game the choices are as follow start, credit, control, and quit.

Figure 4 are the control menu of the game, control menu is the screen that teach the player what are the control of the character of the game, therefore the players can learn how to control their character before playing the game.

Figure 4. Control Menu

Figure 5. In Game

Figure 5 are the in game interface, the player can control their character in game in accordence with the control menu, the player need to pass through the obstacle then make it to the finish line to finish the stages.

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

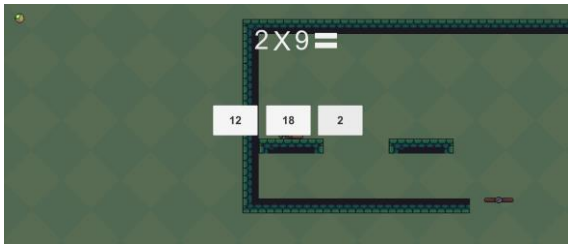

Figure 6. Math Question

Figure 6 is the game math question HUD when the player interact with a box of fruit this multiplication question appear, the player need to answer the question if the player get the answer correctly then they got the fruit, if the player answer incorrectly then the question reset until the player answer the question correctly.

Figure 7. Game Complete

Figure 7 is the game complete of the game, game complete menu is the screen that player player achive when they finish all the stages of the game congrating them for their work, then there is two button to get the player to main menu or for the player to quit the game.

4.4. Testing

Table 2. Black Box Testing

Test Case	Display as expected	Running Button Function	Gameplay Testing
Main menu	✓	✓	-
Control Menu	✓	✓	-
Stage 1-3	✓	-	✓
Stage 4-6	✓	-	✓
Stage 7-8	✓	-	✓
End Game Menu	✓	✓	-

Table 2 displays the result of the black box testing method. It appears that all the menu screens (Main menu, and Control menu) are displaying as expected and have functioning control button. Additionally, the gameplay for each of the eight stages is functioning correctly. Finally, the end game menu is displaying as expected and has a functioning control button.

4.5. Beta

The beta testing involved 30 students, from 2nd grade of primary school. The pre-test post-test methodology is used throughout the beta testing.

To determine whether the game can raise a user's knowledge of multiplication, the game was tested using pre-test and post-test procedures. The question related to multiplication and the goal was to assess game influence by contrasting player's prior and post-game knowledge. As shown in Table 3, the test was created using a one group pre-test and post-test design.

$$x = posttest\ score - pretest\ score\ maximum / score - pretest\ score$$

Table 3. Test Design

Pre-test Measurement	Treatment	Post-test Measurement
To assess a student's multiplication knowledge Students were given a pre-test of 10 multiple-choice questions to assess their knowledge of multiplication before playing the game. For every correct	Students played the game "Multiplication Jump" to practice their multiplication skills.	After playing the game, the students' multiplication knowledge was evaluated using a 10-question multiple-choice quiz. For every correct answer, the student received 10 points and there was no

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

answer, the student received 10 points and there was no penalty for incorrect answers. The maximum possible score was 100.		penalty for incorrect answers. The maximum possible score was 100.

Table 4 Question Table

Number	Question
1-10	Y1 * Y2

The test results were utilized to determine each respondent's knowledge gain using the method presented in Equation 1.

Table 4, The knowledge gain table to show the interval and the meaning of each interval for the knowledge gain after playing the game. The knowledge gain result is shown in Figure 7. A total of 2 respondents didn't gain any knowledge of multiplication after playing the game, their pre-test and post-test game came in no different prior to playing the game and after playing the game, one of the respondents that had no increase have a pre-test score and post-test of 100 so this one respondent already have a good knowledge of multiplication before playing the game.

The random numbers Y1 and Y2 are chosen between 2 and 9. The researcher excluded 1 and 10 as variables in the question because the multiplication involving these numbers is considered too simple and students are usually already familiar with them. The following questions were used in the testing process.

A total of 3 respondents gains a small knowledge of multiplication after playing the game. A total of 4 respondents gained significant knowledge after playing the game, one of the high gain respondents got score of 100 after playing the game.

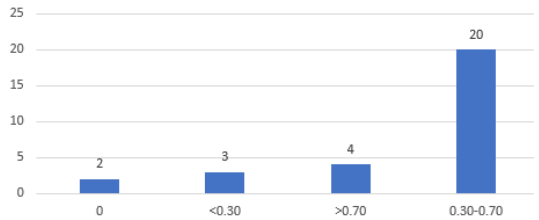

Figure 7. Knowledge Gain Result

Table 5 Knowledge Gain Table

Gain Interval (x)	Knowledge Gain
$x \geq 0.70$	Significant
$0.30 > x < 0.70$	Moderate
$0.01 > x \leq 0.30$	Small
$x = 0$	No Increase

A total of 20 respondents gained a moderate knowledge of multiplication, the moderate knowledge gainer respondent their post-test score is between 60 to 80 and the average score are 70, so the medium knowledge gainer a having somewhat of a good score. Based on the result of the beta test, it was found that 93.33% of the students gained knowledge of multiplication after playing the game.

5. CONCLUSION

The beta testing of the game involved 30 students from second grade primary school. The results of the beta testing showed that 93.33% of the students gained multiplication knowledge after playing the game. Overall, the study found that the educational game is a promising tool for teaching multiplication to Indonesian primary school students.

REFRENCES

[1] E. K. Yuda, "Sifat-Sifat Operasi Hitung Perkalian Bilangan Bulat Dalam Pembelajaran Matematika Di Sekolah Dasar," *Semin. Nas. Pendidik. Dasar*, Vol. 5, No. 1, Pp. 294–301, 2020.

[2] P. S. Dewi And H. W. Septa, "Peningkatan Kemampuan Pemecahan Masalah Dan Disposisi Matematis Siswa Dengan Pembelajaran Berbasis Masalah," *Mathema J.*, Vol. 1, No. 1, Pp. 31–39, 2019, [Online]. Available: Https://Ejurnal.Teknokrat.Ac.Id/Index.Php/Jurnalmathema/Article/View/352.

[3] S. N. Afifah And A. B. Kusuma,

Jurnal Manajemen Informatika & Sistem Informasi (MISI)
Volume 6, Nomor 2, Juni 2023.
ISSN 2614-1701 (media cetak)
ISSN 2614-3739 (media online)
DOI : 10.36595/misi.v5i2
http://e-journal.stmiklombok.ac.id/index.php/misi

"Pentingnya Kemampuan Self-Efficacy Matematis Serta Berpikir Kritis Pada Pembelajaran Daring Matematika," *J. Mathedu (Mathematic Educ. Journal)*, Vol. 4, No. 2, Pp. 313–320, 2021, Doi: 10.37081/Mathedu.V4i2.2642.

[4] Y. P. Utami And D. A. D. Cahyono, "Study At Home: Analisis Kesulitan Belajar Matematika Pada Proses Pembelajaran Daring," *J. Ilm. Mat. Realis.*, Vol. 1, No. 1, Pp. 20–26, 2020, Doi: 10.33365/Ji-Mr.V1i1.252.

[5] N. Yulianty, "Kemampuan Pemahaman Konsep Matematika Siswa Dengan Pendekatan Pembelajaran Matematika Realistik," *J. Pendidik. Mat. Raflesia*, Vol. 4, No. 1, Pp. 60–65, 2019, Doi: 10.33449/Jpmr.V4i1.7530.

[6] Y. Y. Setiawan, M. M. I. B. Bsy, And N. L. Fajriyah, "Metode Maternal Reflektif Dan Media Visual Sebagai Alternatif Pembelajaran Salat Pada Siswa Tunarungu," *J. Pendidik. Islam*, Vol. 5, No. 2, 2020.

[7] M. Mustofa, S. Sidiq, And E. Rahmawati, "Penerapan Finite State Machine Untuk Pengendalian Animasi Pada Video Game Rpg Nusantara Legacy," *J. Sist. Komput. Musirawas*, Vol. 3, No. 1, 2018, Doi: 10.32767/Jusikom.V3i1.251.

[8] M. Adam And I. F. Anshori, "Perancangan Game Puzzle Platformer Ploop Menggunakan Model Game Development Life Cycle," Vol. 6, No. 1, Pp. 34–48, 2023.

[9] R. A. Krisdiawan, "Implementasi Model Pengembangan Sistem Gdlc Dan Algoritma Linear Congruential Generator Pada Game Puzzle," *Nuansa Inform.*, Vol. 12, No. 2, Pp. 1–9, 2018, [Online]. Available: Https://Journal.Uniku.Ac.Id/Index.Php/Ilkom/Article/View/1634/1211.

[10] S. A. Fauzan, S. R. Pradana, M. Hikal, M. B. Ashfiya, Y. I. Kurniawan, And B. Wijayanto, "Implementasi Game Development Life Cycle Model Pengembangan Arnold Hendrick's Dalam Pembuatan Game Puzzle-Rpg Enigma's Dungeon," *J. Ilmu Komput. Dan Inform.*, Vol. 2, No. 2, Pp. 113–126, 2022, Doi: 10.54082/Jiki.26.

[11] K. Permatasari, Y. Setiawan, P. Guru, S. Dasar, U. Kristen, And S. Wacana,"Meningkatkan Minat Dan Berpikir Kritis Siswa Kelas 6 Sd Melalui Pengembangan Game The Rotation," *J. Pendidik. Tambusai*, Vol. 4, No. 2, 2020.

[12] M. F. Rivaldi And Y. I. Kurniawan, "Game Edukasi Pengenalan Dan Pembelajaran Berhitung Untuk Siswa Kelas 1 Sekolah Dasar," *J. Manaj. Inform.*, Vol. 11, No. 1, 2021, Doi: 10.34010/Jamika.V11i1.4354.

[13] Y. Mayasari, M. Mustika, And A. Sutanti, "Rancangan Bangun Game Edukasi Tebak Gambar Bagi Siswa Smplb Insan Madani Metro," *J. Mhs. Sist. Inf.*, Vol. 2, No. 1, 2021, Doi: 10.24127/Jmsi.V2i1.525.

[14] R. Andriyat Krisdiawan And Darsanto, "Penerapan Model Pengembangan Gamegdlc (Game Development Life Cycle)Dalam Membangun Game Platform Berbasis Mobile," *Teknokom*, Vol. 2, No. 1, Pp. 31–40, 2019, Doi: 10.31943/Teknokom.V2i1.33.

[15] S. Wahyu, "Penerapan Metode Game Development Life Cycle Pada Pengembangan Aplikasi Game Pembelajaran Budi Pekerti," *Skanika*, Vol. 5, No. 1, 2022, Doi: 10.36080/Skanika.V5i1.2904.

[16] Bagus Fikri Ananda And A. Chusyairi, "Perancangan Game Virus Survivor Untuk Pendidikan Kesehatan Dengan Metode Game Development Life Cycle," *Jtim J. Teknol. Inf. Dan Multimed.*, Vol. 1, No. 2, 2019, Doi: 10.35746/Jtim.V1i2.20.

[17] M. Pratama, Y. Yanfi, And P. D. Nusantara, "Wizardofmath: A Top-Down Puzzle Game With Rpg Elements To Hone The Player's Arithmetic Skills," *Procedia Comput. Sci.*, Vol. 216, 2023, Doi: 10.1016/J.Procs.2022.12.144.

[18] S. N. Huda And M. F. Ramadhan, "Designing Educational Game To Increase Environmental Awareness," *Int. J. Emerg. Technol. Learn.*, Vol. 16, No. 15, Pp. 181–193, 2021, Doi: 10.3991/Ijet.V16i15.22661.

[19] R. A. Krisdiawan, M. F. Rohmana, And A. Permana, "Pembuatan Game Runaway From Culik Dengan Algoritma Fuzzy Mamdani," *Buffer Inform.*, Vol. 6, No. 1, 2020.