

Development of an Android Based First Person Shooter Math Educational Game Application

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Abstract

This study aims to develop an Android-based math education game with the Unity game engine as a learning medium for elementary school children. The formulation of the problem of this research is how to build an Android-based first-person shooter (FPS) math educational game as a learning medium for elementary school students. The researcher only took the material model that was applied to a limited game for the calculation model for the addition and subtraction of integers. The type of game used is a first-person shooter (FPS). The method used by the researcher is the Game Development Life Cycle (GDLC) method with stages: initiation, pre-production, production, game testing, beta, and release. The benefit of this research is to provide exciting and interactive alternative mathematics learning media. The final result of this research is an educational game entitled "Pistol Math" which can be played on Android devices. Based on user trial interviews with 20 respondents, 18 of 20 children became more interested and enthusiastic about learning with the learning method while playing the educational game "Pistol Math".

Keywords: Educational Games, Android, FPS, GDLC, Math

I. INTRODUCTION

Elementary school children will be more interested in fun learning styles that do not cause boredom when learning, which can cause interest in learning from elementary school children to quickly decrease as if they are fixated on learning only from textbooks. This can be concluded according to data from the Program for International Student Assessment (PISA) in 2018 [1], which shows the ranking of students in Indonesia in the reading section is still far below the average in the Organization for Economic Co-operation and Development (OECD) countries. This is due to

the influence of technological developments and learning in Indonesia, which still cannot match the OECD countries. This research aims to develop an Android-based math educational game application as a learning medium for elementary school children.

According to research by Friantini and Winata [2], learning mathematics requires various methods, such as learning using games or role-playing. Meanwhile, research by Prayuga and Abadi [3] states that student interest in learning is related to the characteristics of interest in learning, types of interest in learning, factors that influence interest in learning, and efforts that can increase interest in learning. From the work results, indicators of interest in learning can be identified: feelings of pleasure, interest, acceptance, and student involvement.

Previously a marginal application, mobile gaming has become something familiar or mainstream [4]. All other devices and platforms that can be used to play games, such as computers, consoles, or websites, are far behind in popularity compared to mobile gaming [5]. Games in the First Person Shooter (FPS) genre can be a means of connecting players.

This research starts with a survey conducted on five elementary school children as representatives of their elementary school to find out what subjects they found challenging and what kinds of games they liked, and the results were as follows: they felt bored with textbook learning, and they expressed interest in using learning with educational games. FPS is their favorite type of game, and the android platform is their preferred platform to play games. Therefore, an android-based math educational game in the First Person Shooter genre was developed, which is expected to increase enthusiasm for learning mathematics. The benefit of this research is to provide exciting and interactive alternative mathematics learning media.

II. Literature Review

A. Game

The game is a form of play that often involves conflict, both with other players and the game system itself [6]. The game itself is always based on a conflict situation. A conflict situation is when the interests of two or more parties are confronted. The outcome of the game is a direct consequence of the actions taken by all game players. The game is defined by sets of rules and agreements that players must abide by, which define the structure of some conflict situations. These rules become the alternatives for the users. At each stage of the game, information is provided when choosing alternatives and the rewards that motivate the user to complete the game successfully.

Meanwhile, according to Salen & Zimmerman [7] quoted in Dirgantara & Septanto [8], a game is a formal interaction that occurs when players follow the rules of the game and gain experience through the game.

B. Educational Game

Educational games are games as learning media. Games can provoke the players' interest in learning, resulting in new experiences such as feelings of pleasure which, in the end, game players can easily accept the material to be conveyed. Various studies have proven the effectiveness of games in influencing players. Players easily understand the content or content in the game. This is due to the game's interactivity and immersion in the game, putting players in the most relaxed and open conditions in receiving material [9].

According to Noemi and Maximo [10], cited by Wahyudinata and Dirgantara [11], educational games are games or interactive applications to provide entertainment media and training and learning in specific fields. Whereas Hssina, et al. [12], educational games introduce interactive learning activities. Educational games can complement conventional learning methods that can impact the learning experience and improve other abilities such as: following rules, adapting, solving problems, interaction, creativity, critical thinking, and working together in teams. Educational games have the following goals and objectives: to build student/student enthusiasm, motivate and focus students, reduce monotonous learning methods, and improve memory [13].

C. First-Person Shooter Game

A first-person shooter (FPS) game is a shooter game with a first-person (self) perspective. Whenever the player interacts with the FPS virtual environment, the player observes all the actions as if he were observing everything through the character's eyes. Images are viewed from a first-person perspective because a simulation is as realistic as possible [14]. According to Voorhees, et al. [15], FPS games feature a first-person perspective, with the player seeing the action through the eyes of the player character, unlike a third-person perspective that is seen from behind or from the side, which allows the player to see the character they are controlling.

D. Game Development Life Cycle

GDLC (Game Development Life Cycle) is a cycle of game development stages [16][17]. The GDLC phases can be seen in Figure 1. GDLC consists of 6 phases as follows.

1. Initiation Phase

The initiation phase is the stage where game development begins. At this stage, the design and preparation of the game concept are carried out. These include: determining game settings, themes, game objectives, target audience, and game platforms.

2. Pre-Production Phase

The pre-production phase is the design and prototype stage of the game being built. At this stage, follow-up is carried out from the concept made in the initiation phase by making game designs and mockups.

3. Production Phase

In this production phase, the development stage is carried out. From the design that has been designed, the coding is done to build the game that has been defined.

4. Testing Phase

The testing phase is carried out if all programming code and assets have been completed and can be operated. Stages of testing carried out by internal parties. This phase includes formal detail testing and refinement testing. Testing is done using playtest to assess the game's feature functionality and difficulty. Accessibility in the game can be tested by observing the tester's behaviour. The testing phase results are bug reports, change requests, and development decisions.

5. Beta Phase

A third party or external party carries out the beta testing stage. In addition to testing errors or bugs, users are also required to provide criticism and suggestions regarding the accessibility and attractiveness of the game. The results of the beta testing phase are bug reports and user feedback.

6. Release Phase

The release phase is the final stage in game development. The application is ready to be released to all users at this release stage. The release phase results in documentation, maintenance planning, and the game's expansion.

III. METHODOLOGY

A. Previous Research

Several studies form the foundation of this research. These studies have similarities regarding the methods used and the types of applications produced, but there are differences in the cases. Research by Dirgantara et al. [17], Research on building an educational-adventure game about mixed math calculations using Unity with the Game Development Life Cycle framework. The result is an educational game with features to train one of the cognitive abilities, namely remembering, understanding, and evaluating.

Research by Randiani [18], Development of an android-based educational game about odd-even traffic rules in Jakarta using Unity with the Game Development Life Cycle framework. The result is an educational game that the people of Jakarta can target. Another research by Amirulloh et al. [19], Development of an android-based educational game targeting students of grades IV and V SD to learn fractions. The research uses the ADDIE model. The result is a game worthy of being an educational medium in elementary schools—another research by Rofiqoh et al. [20], Development of an educational game targeting fourth-grade elementary school students to learn fractions. The research uses the RnD (Research and Development) method. Obtained results can improve student learning outcomes by as much as 32.79%.

B. Thinking Framework

The thinking framework is based on an observation showing the interest of elementary school children. This research originated from researchers' interest in developing educational games for elementary school children, so they can learn by playing while learning. From that came the idea to make an educational game about a math game combined with a First-Person Shooter (FPS) type game. In developing this game application using the game development life cycle (GDLC) method. GDLC is a cycle similar to the Software development life cycle (SDLC), but additional stages focus on GDLC. The thinking framework is shown in Figure 1.

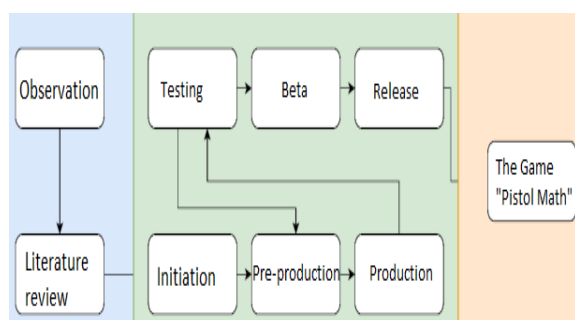


Figure 1. Thinking framework

This research originated from researchers' interest in developing educational games for elementary school children, so they can learn by playing while learning. From that came the idea to make an educational game about a math game combined with a First Person Shooter (FPS) type game. In developing this game application using the game development life cycle (GDLC) method. GDLC is a cycle similar to the Software development life cycle (SDLC), but additional stages focus on GDLC.

In implementing the GDLC method, there are six stages. The first is the initiation stage, which is to create the initial basic concept of the game. The second stage is Pre Production, which is for assembling assets that will later be used in the game, such as game characters, SFX, music, and other assets.

The third stage is the production stage, the production stage, namely the development stage. The results from the initiation and pre-production stages will be included in the programming. The fourth stage is stage trial, which is helpful as a test of game applications to get the test results, whether all the functions of the game work properly or there are errors and bugs.

The fifth stage is the beta stage. At this stage, the game has started to be released and can be played by people who meet these requirements. The last stage is the release stage, where the game has been officially released and can be played by all general users. The results of this study are to foster the enthusiasm of elementary school children in learning mathematics with learning media using this educational game.

The advantage of this research is using a framework with an iteration procedure, so it can be easily adapted if there is a feature change. The advantage of the built educational game is that it provides a sensation of a challenge to the players to motivate students. The limitation of this

research is that it only produces 2D educational games.

C. Initiation Phase

The concept of this game is that players can answer the addition and subtraction of math integers by shooting targets until the target's blood runs out. The aim of this game is that the players must aim and shoot the target correctly. The target is integer numbers, and the answers to questions that will be displayed on the screen board, the questions given are integer calculations.

The rules of this game are that players will be given 50 seconds in one game; if the player aims at the wrong target, then the player's time will be reduced by 10 seconds, and if the player runs out of time, then the game will end, and if the player aims at the target correctly then the player's points will increase by one, will also increase the time of 5 seconds each aiming at the target correctly. If the player runs out of time, the game will end. It is just that the longer the player answers the question correctly, the more time the player has. Players must try to survive long and collect the highest score to be a challenge for players. The game is titled "Pistol Math". The functional requirements of this video game are the features provided by the system when it receives specific inputs.

D. Pre-production Phase

In the pre-production stage, game design is carried out. The game design includes making game mockups, creating assets for games, analyzing material embedded in games, and making components related to game creation, such as sound effects, music, and events. The game navigation structure is shown in Figure 2.

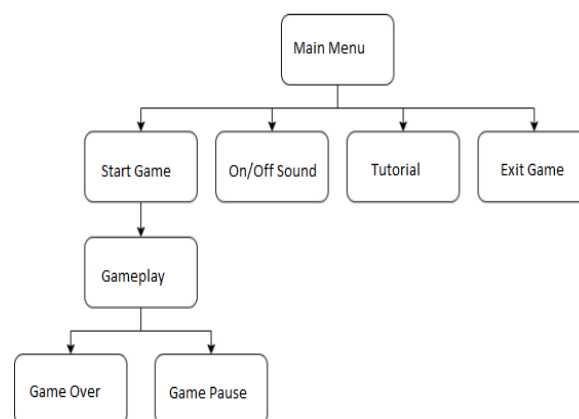


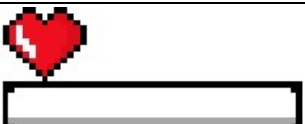
Figure 2. The game's navigational structure

Figure 2 shows the design of the navigation structure starting from the main menu scene followed by four choices, namely:

1. Start. Players will be directed to the main game; then, players can already interact with the game, such as shooting, pausing to get scores and game over.
2. On/Off Music and Sound. Players can enable or disable music and sound.
3. Guide. Players will be directed to the guide menu containing rules and how to play.
4. Exit. The player will exit the game.

The assets used are free. The assets used in this study are shown in Table 1.

Table 1. The game's assets

Image	Description
	1 (kg)
	Main Menu background
	Tutorial background
	This gun image is used as a complement to the main menu to make it look attractive
	Health point bar

E. Production Phase

During the production stage, the coding of the Pistol Math educational game was carried out. Coding is built into the following script functions: main menu, pause menu, question settings, timer, target, health bar, wanderai (random target movement), and player movement.

F. Testing Phase

At this stage, a black box testing was carried out to ensure the functionality of the Pistol Math game complies with the expected needs and goals. The black box testing scenario for this educational game is shown in Table 2.

Table 2. Testing phase

Components tested	Description
"Play" button	To enter the game
"Exit game" button	To exit the game
"Music on/off" button	To enable/disable music
"Voice on/off" button	To activate/deactivate the sound
"Question mark" button	To display the manual menu
Tap the "back" button	To return to the main menu
Question UI	Text showing the question to the player
Score UI	Text showing the player's score
time UI	Text showing the remaining time the player has
Pause button	To pause the game
Analog	To move the character
View	To set the direction of the character's view
Fire button	To shoot
Jump button	To jump
answer UI	Text showing the player's answer
blood UI	An object that displays the target's blood
AI Patrols	To make the target move continuously
"continue" button	To resume a paused game
"main menu" button	To return to the main menu
"play again" button	To repeat the game
"main menu" button	To return to the main menu

G. Beta Phase

At this beta stage, use a type of open beta testing. In this stage, elementary school children

act as external testers. This stage aims to test the game application and provide feedback on the game being created. The tester will play the game to test whether the functionality can run adequately, whether it can convey educational information about this game well and whether it can make elementary school children more interested in learning to use the game and increase the enthusiasm of elementary school children to learn mathematics.

H. Release Phase

At this stage, the entire development process for the game «Pistol Math» has been completed. The game is released in the .apk format. The game application is uploaded on tch.io and can be downloaded via the link <http://lidiys.itch.io/pistolmath>.

IV. RESULT AND DISCUSSION

A. The Game Screenshot

The result of this research is an educational game application called “Pistol Math. The following images (Figure 3 to Figure 7) show some game screenshots.

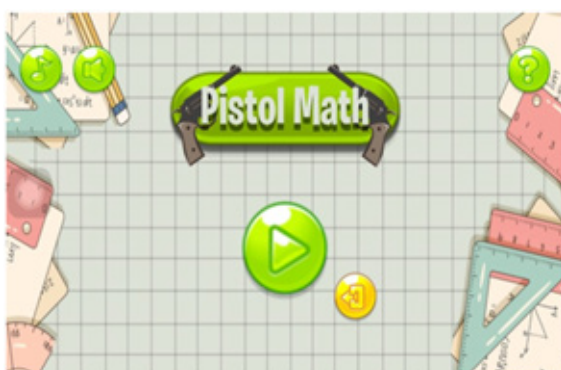


Figure 3. Main menu

Figure 3 displays the main menu. On the main menu, several buttons have different functions, such as the «Start», «Guide», «Exit», «Music», and «Sound» buttons.

Figure 4 displays the guide page. After the user presses the guide button, it will display the guide menu, and the game will display text showing how to play Pistol Math; the guide menu page also has a back button that functions to return to the main menu.

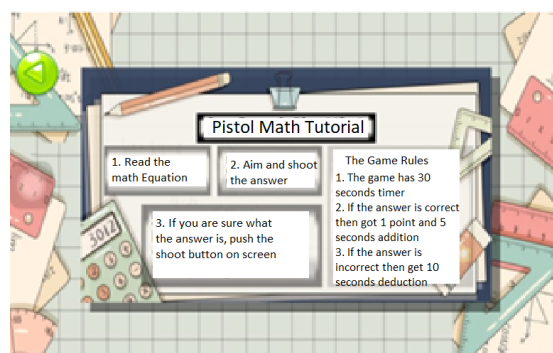


Figure 4. Tutorial menu

Figure 5 displays the game arena. When the user presses the «Play» button, he will enter a game where all systems and rules can work in this game, such as character control, the pause button, UI score and questions, as well as target movement with answers.



Figure 5. The gameplay screen

Figure 6 shows what the game looks like when paused. After the user presses the pause button, it will pause the game and display a «continue button please» and «just leave the game», which has the function of continuing and exiting the game.



Figure 6. Game when paused screen

Figure 7 displays the game over page. When the player has run out of time, the game will end and display the game over menu; this page has a «play again» button to restart the game and a «Just go back to the main menu» button which functions to return to the main menu in the game.

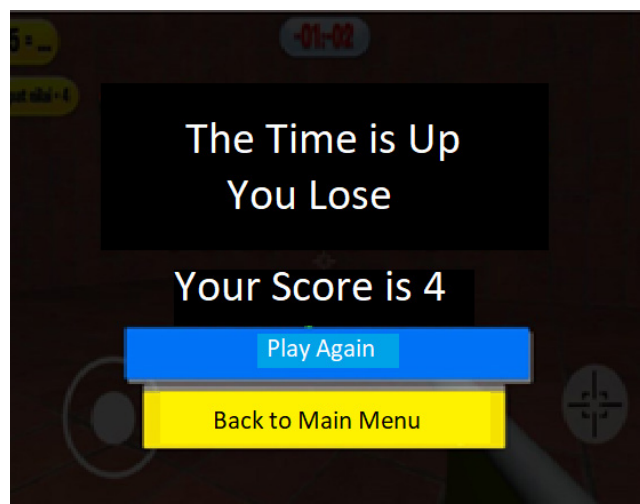


Figure 7. Game over screen

B. Black Box Testing Result

The results of black box testing are shown in Table 3.

Table 3. Black box testing result

Components tested	Description	Result
“Play” button	To enter the game	Succeed
“Exit game” button	To exit the game	Succeed
“Music on/off” button	To enable/disable music	Succeed
“Voice on/off” button	To activate/deactivate the sound	Succeed
“Question mark” button	To display the manual menu	Succeed
Tap the “back” button	To return to the main menu	Succeed
Question UI	Text showing the question to the player	Succeed
Score UI	Text showing the player's score	Succeed
time UI	Text showing the remaining time the player has	Succeed
Pause button	To pause the game	Succeed

Analog	To move the character	Succeed
View	To set the direction of the character's view	Succeed
Fire button	To shoot	Succeed
Jump button	To jump	Succeed
answer UI	Text showing the player's answer	Succeed
blood UI	An object that displays the target's blood	Succeed
AI Patrols	To make the target move continuously	Succeed
“continue” button	To resume a paused game	Succeed
“main menu” button	To return to the main menu	Succeed
“play again” button	To repeat the game	Succeed
“main menu” button	To return to the main menu	Succeed

C. Beta Testing Result

Twenty elementary school children respondents conducted the beta trial. The results of the beta trial are shown in Table 4.

Table 4. Beta testing result

Question	Result
Have you ever played educational games?	7 out of 20 children have played educational games.
Is this Pistol Math game easy to play?	16 out of 20 children said it was easy to play.
Is the text in the game easy to read?	20 of the 20 children answered that the text in the game is easy to read.
Do you like the look of this Pistol Math game?	18 out of 20 kids liked the look of the Pistol Math game.
After playing the Pistol Math game, are you more excited to learn math?	18 out of 20 children said they were more excited to learn math.

V. CONCLUSION

From this research, it can be concluded the following things:

- From the beta test results, it was found that 18 out of 20 elementary school children stated that they became more enthusiastic about learning mathematics after using the Pistol Math educational game.
- From the black box testing results, every function and feature of the Pistol Math educational game can run as it should.

- Based on the beta testing results, 16 children stated that the educational game Pistol Math was easy to play, while four other children stated that it was not easy because they were not used to playing games with the first-person shooter (FPS) genre.

VI. FUTURE RESEARCH

The plan for further research is to add other features, such as power-ups, and build a 3D version. Developing the gameplay is made more varied and interactive by making characters that have an animation to make it more exciting and interactive for players. Added a more varied map. It added versus mode so the players can feel competitive between friends.

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