FIRST PERSON SHOOTER GAME DEVELOPMENT FOR ENHANCING BASIC MATHEMATICS LEARNING

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Abstract

The rapid advancement of technoogy has opened up significant opportunities for creating more engaging and effective learning media. One promising innovation is the development of a learning game based on the First Person Shooter genre for basic mathematics instruction. This study aims to design and develop an FPS – Based for Basic Mathemaric Learning game that capable of increasing student motivation and understanding through an interactive gaming experience. This learning game is made through 4 steps, such as Analysis, Design, Development, and Testing. The resulting game integrates basic mathematical problems directly into the gameplay challenges. To acquire necessary items for escaping the maze, players are required to explore the map, locate chests, and solve mathematical challenges, such as integer operations, fractions, and ratio problems to unlock them. The results of the initial trials indicate that the game successfully fostered students interest in learning and provided a more enjoyable learning experience. Therefore, the design and development in this FPS – based mathematics learning game are expected to serve an effective alternative learning medium to enhance the quality of education.

1. Introduction

The foundation of academic success across various disciplines relies heavily on a solid understanding of basic mathematics. However, contemporary educational settings frequently encounter challenges in maintaining student engagement and motivation when teaching fundamental concepts, such as arithmetic, fractions, and ratios. Traditional instructional methods often lead to passive learning, low retention rates, and negative perception of mathematics as a difficult or tedious subject (Thompson, 2019).

Simultaneously, the rapid advancement of digital technology has made interactive media, particularly video games, an integral part of modern youth culture (Kirriemuir & McFarlane, 2004). This context presents a significant opportuinity to harness the inherent psychological principles of engagement, challenge, and reward in popular gaming genres and redirect them toward educational ends. However, mathematics remains one of the subjects where many students experience low motivation and anxiety. To address this issue, the incorporation of game mechanics into mathematics instruction has been explored as a strategy to make learning more interactive and appealing (Prensky, 2001).

Among various game genres, the First Person Shooter type is known for its immersive environments, fast paced challenges, and active player engagement. Although typically associated with entertainment, the FPS game presents unique potential as an educational medium. Its mechanics, such as exploration, quick decision making, and real – time feed back can be adapted to promote cognitive skills and reinforce learning objectives in a dynamic setting (Green & Bavelier, 2003).

This study aims to design and develop a First Person Shooter – based learning game focused on basic mathematics learning. The goal is to investigate how FPS gameplay elements can be effectively utilized to deliver mathematical concepts while maintaining user engagement. The research adopts 4 important steps, such as analysis, system design, implementation, and testing..

The outcome of this study is expected to contribute to the growing field of educational technology by providing an innovative framework for integrating action oriented gameplay into learning environments. By transforming mathematical exercises into interactive missions and challenges, this FPS based learning game seeks to create more enjoyable and effective learning experience for students (Pressman & Maxim, 2019).

1.1 Literature Review

Game

A game is one of the media than can be used to convey a specific purpose. The objectives found in games can vary such as educational, entertainment, or simulation purposes (Mahmud, 2023). Throughout human history, games have always existed and always existed and will continue to attract people of all ages. Their presence is eagerly awaited as a way to releive fatigue after a long day of activities. In addition, games have also filled the childhoods of many people, creating a sense of nostalgia when replayed later in life. A game is an interactive medium centered on achievement, involving an active player and an opponent. Some experts define a game as a form of art in which players make decisions to manage their available resources through in – game elements in order to achieve specific goals (Zahra, Setiawani, & Hussen, 2022).

Game Based Learning

According to (Rakasiwi & Muhtadi, 2021), Game Based Learning is a learning approach that uses games as the main medium to deliver material and achieve learning objectives. GBL leverages players' intrinsic motivation, driven by challenges, interaction, and curiosity found within the game (Oula, 2024).

The principles of Game Based Learning relevant to language learning include :

1) Immersion and Context
   Games create immersive environments that allow players to use language in simulated contextual situations, thereby promoting functional language use rather than mere memorization.
2) Instant Feedback and Repetition Cycles
   Players receive instant feedback for instance, if they answer incorrectly, then the chest won' t be opened, and the correct answer will appear. The repetition process effectively reinforces basic mathematic mastery.
3) Quiz
   After receiving information about the presented material, players are directed to face a boss or enemy. To defeat the boss, they must answer several questions related to the learned material. However, if their answers are incorrect, their health decreases, and they must try again. (R. Hidayat, et al., 2024)

Educational Game

An educational game is a software based game designed with the primary purpose of providing a learning experience or training specific skills, while also offering entertainment value. The main role of educational games is to transform passive learning environments into active and enjoyable ones without reducing learners' motivation. Thus, the use of games as a learning medium holds great potential to support.

Mathematics

Mathematics is a universal science that trains logical, analytical, and systematic thinking skills. However, this subject is often considered abstract, making it difficult for students to relate theoretical concepts to real – world applications. The main challenge lies in students' lack of intrinsic motivation and conventional teaching methods that fail to provide interactive contexts (S. Rahmawati & Jamaluddin, 2024).

In the context of basic learning games, the focus is an operational ability and quick computation. The main components that underlie numerical skills are basic arithmetic, which includes :

1) Addition
2) Substraction
3) Multiplication
4) Division

2. Research Methods

This execution of this research was carried out using 4 main steps, such as Analysis, Design, Development, and Testing.

Requirement Analysis

At this stage, an identification of user needs and the system to be developed is carried out. The goal is to determine the main features tha tmust be included in this FPS (First Person Shooter) learning game. The analysis is conducted through literature study and observation of the needs for interactive basic mathematics learning media (Hidayat, Prasetyo, & Utomo, 2024).

Literature Study

This method is carried out to obtain theoretical foundations and relevant references related to game based learning development, particularly in the application of the First Person Shooter genre. In addition, the literature study is also conducted to determine the direction of the research to be undertaken.

Observation

The observation aims to examine the process and various aspects directly to learning activities. It is conducted to monitor the learing process and identify problems faced by students. Through this observation, the researcher can understand and address the students' needs, enabling them to receive a more interactive learning medium.

After conducting both the literature sutdy and the observation, it was found that users have several needs, which can be classified into two types :

1. Functional Requirements

Functional requirements describe the main functions that the system must possess in order to operate according to its objectives. The functional requirements for this genre include :

1) Level and Mission System
   Each level contains missions with basic math challenges. As the player progresses to higher levels, the level of difficulty will be increased.
2) Question and Answer System
   When the player opens a chest, a question will appear on the screen. If the answer is correct, the chest opens and the player obtains an item. But if the answer is incorrect, the chest remains closed.
3) Feedback System
   Displays the correct answer or correction when the player's answer is incorrect.

4) Data Storage
   Saves player data, so that progress can be continued in future sessions.

2. Non – Functional Requirements
   1) Interactivity
      The game's responsiveness to player actions.
   2) Performance
      The game must be able to run smoothly on computers with medium level specifications.

Design

In the game system design stage, the process begins with planning the game flow structure and user experience. The game is designed using a 3D interface and a First Person Point of View. With relatively dark visual elements, appealing icons, and simple animations, the design aims to stimulate the player's adrenaline and create an exciting learning experience through play (Hidayat, Prasetyo, & Utomo, 2024). The interactive storyline serves as a connector betwewn each learning stage, providing relevant context and encouraging students to remain engaged. The gameplay design is illustrated using a flowchart to describe the sequence of actions, interactions, and decision points that occur throughout the game.

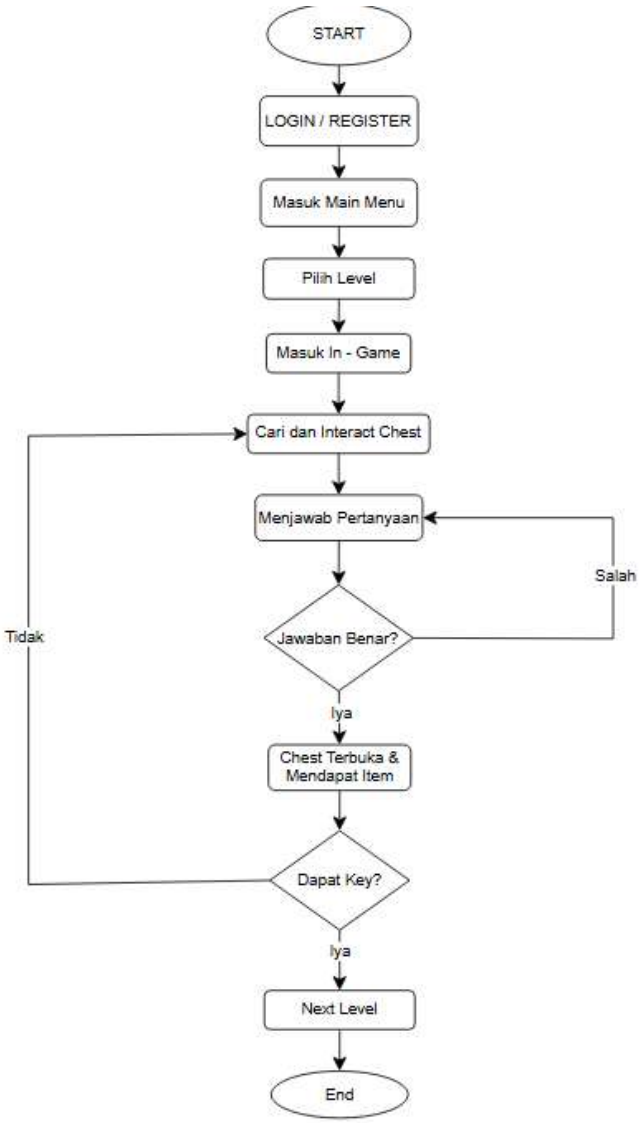

Fig. 1 Flowchart

1. Login / Register

This is the initial stage where players access the game. They can either create a new account (register) or log in to an existing account. This system is used to store player progress data such as completed levels. With a login system, each player has personalized data that can be continued at any time without losing their progress.

2. Home

The home screen serves as the main interface of the game. From this menu, players can select several options such as start game, or quit. The interface is designed to be simple and intuitive, making it easy for users especially high school students, who are the primary target audience to navigate.

3. Select Level

Players can access this menu after pressing the play button in the main menu. From this menu, players select the level they wish to play. Each level represents a topic of basic mathematics with gradually increasing difficulty. The next level will be unlocked once the player successfully the previous one with a minimum score requirement.

4. Gameplay

This stage as the core of the game. Players control the main character in a first person point of view, to explore 3D environments, search for hidden chests and overcome obstacles. During exploration, players can also interact with objects in the environmentm such as chests, exit door, etc.

5. Level Completion

After obtaining the key to escape, the player will be directed to find the exit door in the maze. If the player find the exit door and successfully escape the maze, the player wins. But if the player died before getting out of the maze, the player failed to finish the level. In this menu, the system displays a summary of the players' performance, including total score, completion time, and the number of correct answers and wrong answers. Player can choose, either to retry or proceed to the next level.

6. Locating and Opening Chests

In every level, players must find the chests around the map. When players interact the chest, the system presents a question related to mathematic topic that's being studied. If the player answers correctly, the chest opens and rewards them an item. However, if the answer is incorrect, the chest remains locked, and the player must try again.

7. Quiz

The quiz section serves as the main educational element of the game. The questions presented are based on the basic mathematics topic of the current level. The questions presented are basic mathematics topic, each level introduces new levels, and the difficulty will increase as the level goes higher.

8. Final Target

The final target of the game is to escape the maze through the exit door, but the player must have the key to open the door. To get the key, player must go around the map to find the key inside one of the chests in the map.

Development

The development stage is the process of building the system based on the results of the previous analysis and design phases. At this stage, the game application for basic mathematics learning using the First Person Shooter (FPS) concept is implemented according to the system design and user requirements.

During this stage, several activities are carried out, for example :

1. Game Environment Development
2. Character and Control Implementation
3. Quiz Integration
4. Scoring System
5. User Interface
6. Database Integration (D. Dan & Kurnia, 2024)

Testing

The testing stage aims to ensure that all features of the game function according to the design and meet the user requirements. This stage is crucial for identifying and correcting errors, both in functionality and user experience, before the game is finalized. Testing stage has two main phases :

1. Black – box Testing

In this phase, testing is focused on the functional aspects of the system without considering the internal code structure. Each game component is tested to verify that it produces the expected output for a given input. The following features are tested :

1) Game navigation (main menu, level selection, and exit)
2) Player control and shooting mechanics
3) Enemy's state
4) Quiz display and answers
5) Scoring and feedback system
6) Level progression

2. User Testing

User testing is to evaluate the usability and learning effectiveness of the game. Participants, typicaly students at the target education level, are asked to play the game and complete the given questions. Afterward, they are asked to fill out a form to assess several aspects in game, such as :

1) Ease of use and control
2) Clarity of the learning material
3) Engagement and motivation while playing
4) Overall satisfaction

The results from user testing are analyzed to determine the game's usability and to identify potential improvements for future development. The testing phase ensures that the game not only functions properly, but also provides an effective and enjoyable learning experience for users (Himmawan & Juandi, 2023).

3. Result and Discussion

The result of this study, is to develop a system design in order to make a functional game. The implementation includes some different scenes, such as the home screen, select level screen, and in – game screen.

Home Screen

The home screen serves as the main entry point of the game. It provides players with easy access to essential features, such as starting the game or exiting the game. The layout is designed to be simple and intuitive, ensuring that players can navigate the game efficiently from the very beginning.

Fig. 2 Home Screen

Select Level Screen

The select level screen allows players to choose which level or stage they want to play. It displays all available levels, but players must finish the previous level to unlock the next level. This screen ensures smooth transition between levels and supports the player's sense of progresssion in the game.

Fig. 3 Level Selection Screen

In – Game Screen

The in – game is the core of the gameplay experience. It presents the game environment, interactive elements, and player controls. the screen provides real - time feedback and guidance, allowing players to interact with the game world effectively and enjoy an engaging and immersive experience.

Fig. 4 In – Game Screen

4. Conclusions

This study successfully designed and developed a First Person Shooter-based learning game focused on basic mathematics. The system implementation produced a functional prototype with key components, including the Home Screen, Select Level Screen, and In-Game Screen, all designed to provide an intuitive and engaging user experience. The game effectively integrates educational elements, such as quizzes and interactive challenges, within an immersive 3D environment, promoting both learning and engagement. User testing and evaluation indicate that the game is user-friendly, motivating, and capable of supporting students' mastery of fundamental mathematical concepts. Overall, this FPS-based learning game demonstrates the potential of combining game mechanics with educational content to create a dynamic and enjoyable learning experience.

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