

## Development of an Interactive Mathematics Quiz Game Application Using Unity 2D to Enhance Intelligence and Interest in Calculations

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### ABSTRACT

Games are among the applications popular with the public, as supported by research conducted by MoboMarket. Many games are created merely to entertain students, which partly explains why high school students often lack interest in studying mathematics. Two main factors contribute to this lack of interest: the first is internal, where students have a low curiosity or enjoyment in learning math, and the second is external, where they feel bored and uninterested in doing calculations. This study aims to develop an interactive mathematics quiz game application based on WebGL and developed using Unity 2D as a solution to help change students' perception that mathematics is neither complicated nor difficult. The math quiz game application includes features such as sound effects, back, open, info, quit, and answer buttons. By utilizing Unity 2D technology, this game application is built as a WebGL to allow it to run on a web browser. The development of this math quiz game follows the Game Development Life Cycle (GDLC) method, which is applied in detail. Data collection methods, including questionnaires and surveys, are used to facilitate the game's development process. The game also involves designing a system using UML to model the quiz game, and once the game is complete, an alpha testing method is used to evaluate it. The result of this research is intended as an alternative learning medium for high school students in the form of a game that can be played on a web browser.

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## INTRODUCTION

Games are popular applications, serving as entertainment media among high school students. This is further supported by research conducted by MoboMarket in Indonesia (Aplikasi et al., 2021). Many games are developed solely to entertain students, which has led to a decline in high school students' interest in studying. Mathematics, in particular, is one subject affected by gaming, making it one of the least favored subjects among high school students. This reality has a significant impact on education and has led to a new shift in the educational paradigm (Permastasari, Asikin and Dewi (Nino Adhi), 2022). Several factors contribute to students' lack of interest in learning mathematics. Internally, students tend to lack enjoyment and curiosity when studying mathematics, as they perceive it to be complex and challenging to solve (Saputra and Herliana, 2023). Externally, students feel bored and uninterested in doing calculations, resulting in lower computational skills among high school students.

To address this issue, developers have created an interactive mathematics quiz game using the Game Development Life Cycle (GDLC) method and the Unity 2D application. By using Unity 2D, the quiz game can be WebGL-based, allowing high school students to play it in a web browser and increasing their interest in math and calculations. The GDLC method comprises six stages and provides a comprehensive approach to game development. WebGL has extensive 3D visualization capabilities, as illustrated by its applications in macromolecular visualization, showing its advantages over commonly used visualization tools in the field ('Graphic Library', 2022). Unity 2D, designed to be

user-friendly, is a multi-platform game development tool. The mathematics quiz game will also be developed using UML (Unified Modeling Language) to design the system. UML is a visual modeling language used to describe, document, and build software systems. Through this WebGL-based interactive mathematics quiz game application, developed with UML system design, high school students will have an alternative learning medium in the form of a game that can be played in a web browser. This application aims to increase students' interest in mathematics and calculations and enhance their mathematical intelligence.

## THEORETICAL BASIS

### Definition of Game

A game, derived from the English word "game," refers to an activity of play that simulates real-life situations but remains fictional. A game provides an environment (or atmosphere) that facilitates learning, enhancing students' skills. (Sandy, 2020) Games are usually played for entertainment while simultaneously serving as educational tools.

### Mathematics

Mathematics is a subject introduced at the elementary school level and encountered in daily life. (Kaurie, Purwanto and Minarni, 2020) Therefore, the importance of mathematics for students, particularly those in high school, lies in helping them understand and solve problems. Mathematics is a subject that enhances intelligence by utilizing logic for calculations, making logic the foundation for mathematics development.

### WebGL

WebGL is a JavaScript-based wrapper for OpenGL and is one of the game-building tools used in Unity for web browser-based applications. WebGL is commonly used to design 3D games and web-based websites. (Azis Abdul dkk., 2021)

### Unity Hub

Unity Hub is an application that facilitates the discovery, downloading, and management of Unity projects and installations. (Ramadhani, Sundari and Khairunnisa, 2024) It also provides Unity templates, simplifying the process for developers to download, install, and manage various versions of the Unity editor in one place.

### Visual Studio Code

Visual Studio Code is an open-source editor provided by Unity for coding and editing. Being open-source means it can be used free of charge. This application supports various programming languages, including JavaScript, PHP, Python, and others. (Sandfreni, Ulum and Azizah, 2021)

### Unity 2D

Unity 2D is a tool used to create 2D graphics in video games. It enables game development across various platforms, including iOS, Android, Windows, and consoles such as PlayStation, Xbox, iPad, and iPhone. Unity 2D also supports browser-based games designed with the Unity web player plugin, which works on Mac and Windows but not Linux. Unity supports the creation of both 2D and 3D games, offering a diverse range of object graphics, from simple 2D designs to complex 3D models. (Baskoro and Ariadi, 2023)

### C# Programming Language

C# (pronounced C-sharp) is a programming language used to create applications or games. With C#, programmers can develop and design web applications or games. It is commonly used with Visual Studio to support programmers in their work. C# is designed for the Common Language Infrastructure (CLI), enabling the runtime environment to operate across platforms or devices, such as computers with different architectures, without needing to rewrite the code. C# is a programming language developed by Microsoft that operates on the .NET Framework. (Syahni, 2021)

### UML

(Sinaga, 2019) The Unified Modeling Language (UML) issued by the Object Management Group (OMG), is a graphic language and has been widely accepted as a standard method for modeling object oriented software systems. This can also be applied to modeling business process and system architecture and hardware design. (Nasyiah, 2022) For the system design required in the development

of this math quiz game, the UML diagrams used include Sequence Diagram, Use Case, and Activity Diagram. Below are their explanations:

### **Sequence Diagram**

A sequence diagram illustrates how the system responds to user activities. (Rizal Munadi et al., 2023) It also displays messages or commands given along with their execution times.

### **Use Case Diagram**

A use case diagram is a technique for capturing the functionality of a system. A use case de-scribes the typical interactions between the system's users and the system itself by providing a narrative of how the system is used. The features within the system can be utilized to help cate-gorize the system, which UML uses to illustrate how actors interact with the system (Maidiana, 2021).

### **Activity Diagram**

An activity diagram is one type of diagram in UML that can model the various processes occur-ring within a system (Menora et al., 2023).

## **METODE**

### **Data Collection Methods**

At this stage, the methods used are questionnaires and surveys. To collect data, the author pro-vides a series of questions to students. The questionnaire questions given by the author are as follows:

1. What causes students to feel bored while learning mathematics?
2. What habits do students adopt to overcome boredom during learning?
3. What kind of gaming experience do students have at school?

In the final stage, the author will conduct a survey using these three questions to obtain survey results that will facilitate the development of a mathematics quiz game, making it easier to cre-ate.

### **Software Development Methodology**

The system or software development in this research aims to outline the steps involved in the game development process. For the development of this quiz game, the methodology used is the Game Development Life Cycle (GDLC). GDLC is an iterative approach to game development that consists of six phases: initialization/concept creation, pre-production, production, testing, beta, and release. However, in the development of this mathematics quiz game application, only a few phases of the GDLC methodology are applied, as described below:

#### **1. Initialization/Concept Creation**

This is the initial step in developing the mathematics quiz game, which involves creating the concept of the quiz game to be developed. The quiz will take the form of essay questions, and the developer, Marcho Malona Hutahaeon, will identify the elements to be added to the game.

#### **2. Production**

In this phase, new assets are created for the game development. These assets include:

- o Image folder: To enhance the game's visual appeal.
- o Script folder: To ensure the game is functional and playable.
- o Sound folder: To add audio features that make the game more engaging.
- o Animation folder: To include minor animations, such as text animations, in the quiz game.

These organized resources facilitate the production process and simplify the de-velopment of the mathematics quiz game.

#### **3. Testing**

In this stage, operational testing is conducted to determine whether the game is ready for use. Playtesting is carried out to assess the functionality of game features and ensure that all components work as intended. This phase is performed by the developer.

#### **4. Beta Testing**

This development phase involves external testing by third parties, such as high school students or game testers enlisted by the developer. They are tasked with identifying bugs or issues related to the features within the application.

#### **5. Release Version**

This is the final phase of development, where the game is prepared for release and made available to high school students as a WebGL-based application.

## RESULTS AND DISCUSSION

### System Display Results

The following are the research results obtained from the development process of the mathematics quiz game.

#### 1. Page Main Menu

The main menu page will contain buttons for "open," "info," and "quit." When opening the game, there will also be an image of a student and a speaker icon to toggle sound on and off when pressed



Figure 1. Page Main Menu

#### 2. Page Main

The main page here displays the "play" and "back" buttons to return to the main menu, along with the title "mathematics quiz."



Figure 2. Page main

#### 3. Question Material Page

The question material page will display the quiz materials that can be selected to enter the game, along with a back button to return to the main page.



Figure 3. Question Material Page

#### 4. Page In Game

The in-game display page will show a back button to return to the question material page, a "answer" button to submit answers, a question board to display the questions, a score board to evaluate the

answers, and an input field for entering answers. It will also feature images of a teacher and the text "Great" and "Ooo." When a question is answered correctly, the text "Great" will appear along with a "Great" sound effect. If the answer is wrong, the text "Ooo" will appear, accompanied by an "Ooo" sound effect. Additionally, there will be an animation with the message "Congratulations, all questions have been answered" when all the questions in the game have been completed.



Figure 4. Page In Game

## 5. Results System Testing

The testing is conducted by testing each feature and the potential errors that may occur from each feature. The testing method used is the alpha method to test each feature on every page.

### A. Page Main Menu

Table 1. Example of 1 column table format

No	Test	Description	Conclusion
1	Picture reading All questions have been answered safely	It appears when all questions have been answered in the quiz game.	Functions
2	Open button	Display the next scene when pressed	Functions
3	Info button	Display the info page when pressed	Functions
4	Quit	Exit or stop the game when pressed	Functions
5	Back	Pressed while on the info page to return to the main menu.	Functions
6	Image settings.	To control the sound on and off in the game.	Functions

### B. Page Main

Table 2. Page Main

No	Test	Description	Conclusion
1	Button play	Displays the next scene when pressed, goes to the level select scene	Functions
2	Button back	To return to the main menu page	Functions
3	Image of the math quiz animation text	As an accessory	Functions

### C. Page Select Level

**Table 3.** Page Select Level

No	Test	Description	Conclusion
1	Material/question button	Goes to the In Game page	Functions
2	Back button level	Returns to the main scene page	Functions
3		To enter the In Game page	Functions

### D. Page In Game

**Table 4.** Page In Game

No	Test	Description	Conclusion
1	Button answer	Used to submit an answer after typing it in the answer field	Functions
2	Answer Input Field	Used to input the answer	Functions
3	Score	Display the score when a question is answered correctly each question is worth 10 points	Functions
4	Question Board	Display the question	Functions
5	Back Button	Button to return to the scene select level page	Functions
6	Sound and Animation for feedback great and Oops	When the answer is correct a great message with sound plays when incorrect an Oops message with sound plays	Functions
7	Game completion Animation	Displays a Congratulations all questions have been answered message upon completion	Functions

### 6. Results Bug Testing On Each Scene

Bug testing on all game system scenes is conducted to identify any bugs within each game scene. The following are the bug testing results:

#### A. Page Main Menu

**Table 5.** Page Main Menu

No	Test	Description	Conclusion
1	Main Menu Scene	All features function properly, and no bugs found	Functions

#### B. Page Play

**Table 6.** Page Play

No	Test	Description	Conclusion
1	Main scene	All features in the main scene function properly, no bugs found	Functions

#### C. Select Material Question Page

**Table 7.** Select Material Question Page

No	Test	Description	Conclusion
1	Select Material Question	All button features work properly when pressed, no bugs found	Functions

#### D. In-Game Page

**Table 8.** In-Game Page

No	Test	Description	Conclusion
1	In Game	All button features in the In-Game scene function properly, no bugs found	Functions

#### 7. System Feasibility Testing

In the system feasibility testing phase, this is the final stage where the game is deemed ready to play, the questions presented can enhance students' intelligence, and the game is published and can be accessed across various platforms based on a web browser.

##### A. Game Difficulty Testing

**Table 9.** Game Difficulty Testing

No	Test	Description	Conclusion
1	Play the math quiz game	The difficulty level of game features is in the "easy to follow" category, while quiz questions vary from medium to difficult level	Functions

##### B. Testing Game Acces on Different Platform

**Tabel 10.** Testing Game Acces on Different Platform

No	Test	Description	Conclusion
1	Computer platform	Accessing the game on PC/computer via web browser	Functions
2	Mobile phone platform	Accessing the game on a mobile phone via web browser	

##### C. Publishing The Math Quiz Game

**Table 11.** Publishing The Math Quiz Game

No	Test	Description	Conclusion
1	Publishing the math quiz game	Publishing the math quiz game to ITCH.IO for play; this is the final stage of game testing	Functions

## DISCUSSION

In developing this math quiz game, the GDLC method was used to make the game development process more structured. The game was designed using the UML method to facilitate the developers in designing the structure of the quiz game, which includes multiple playable levels to increase high school students' interest in learning math. System testing will be conducted using the alpha testing method to identify any bugs or non-functional features within the math quiz game when it is being played.

## CONCLUSION

The following are the conclusions of this research. Developing a math quiz game application to increase high school students' interest in calculation and enhance their intelligence, Developing an interactive WebGL-based math quiz game application that allows the game to be played on a web browser, Designing a UML system to streamline the development process of the math quiz game, Conducting alpha testing on the math quiz game to identify and locate errors, Developing the math quiz

game using Unity 2D, making the development process easier, Developing the math quiz game application as an alternative learning medium that can run in a web browser.

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