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## RESEARCH ARTICLE

# Development of Basic Mathematics Educational Game Based on Construct 3 as an Effective Interactive Learning Solution

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**Abstract:** Game media as a learning medium in Indonesia does not have a long tradition. The image of games in the eyes of many people as a medium that can give the impression of entertainment compared to learning media, that's why the author decided to make a basic mathematics educational game. The purpose of this thesis proposal is 2, first to create an android-based basic mathematics education game application for children using construct 3, second to hone children's ability to calculate precisely with easy play. The type of research method used in making this educational game is Research and Development (R&D). This research process adapts the ADDIE development model according to Branch (2015), which is a development model consisting of five stages which include Analysis, Design, Development, Implementation, and Evaluation. The results of the research in this thesis proposal are producing basic mathematics educational games that focus on addition and subtraction material for children with an attractive display concept and easy way to play, this game can be accessed on Android smartphones.

**Keywords:** Game Development, Education, Math, Construct 3

## 1. Introduction

In Indonesia, the tradition of using games as educational media is relatively new. Many people still view games primarily as entertainment rather than as educational tools (Dewi & Putri, 2020). However, recent years have seen a growing interest in educational games as effective and engaging learning tools, particularly for children (Adnan, 2023; Usability Testing Analysis on The Bana Game, 2023).

This study aims to design an Android-based educational game for basic mathematics using Construct 3. The game is intended to enhance children's arithmetic skills in a fun and accessible manner (Dewi & Putri, 2020; Journal of Information Engineering and Educational Technology, 2023). The research method adopted is Research and Development (R&D), utilizing the ADDIE model (Analysis, Design, Development, Implementation, Evaluation) as outlined by Branch (2015) (Usability Testing Analysis on The Bana Game, 2023).

The study highlights that educational games can significantly boost students' motivation to learn. Previous research supports this, indicating that educational games increase students' interest and



engagement in learning activities (Girard, Ecalle, & Magnan, 2013; Cheng et al., 2015). Additionally, educational games have been shown to help students grasp complex concepts through interactive learning (Arnab et al., 2015; Indonesian Journal of Computer Science, 2023).

This research aims to contribute substantially to the development of technology-based learning media in Indonesia, particularly in the field of basic mathematics education. The developed game focuses on addition and subtraction, featuring an attractive interface and simple gameplay, making it accessible on Android smartphones (Dewi & Putri, 2020; IJASEIT, 2023; Computer Science Research and Its Development Journal, 2023).

Therefore, this study not only seeks to enhance the quality of education in Indonesia but also to pave the way for future development of interactive, game-based learning media (Usability Testing Analysis on The Bana Game, 2023; Journal of Applied Computer Science and Technology, 2023). The main section of an article should start with an introductory section which provides more details about the paper's purposes, motivation, research methods, and findings. The introduction should be relatively nontechnical, yet clear enough for an informed reader to understand the manuscript's contribution.

## 2. Literature Review

### 2.1. Theoretical Descriptions

#### 1) The Definition of Design.

Designing is an activity with the goal of creating a new system that can solve the problems faced by a company, achieved through selecting the best system alternative (Sutabri, 2012).

#### 2) Definition of Game

A game is something that can be played with specific rules, resulting in winners and losers, usually in a non-serious context or for refreshing purposes (Hasanah et al., 2021) It is a learning method used to analyze interactions between individuals or groups, demonstrating rational strategies. Games consist of rules that create competitive situations for two or more individuals or groups, with strategies developed to maximize one's own victory or minimize the opponent's victory. The rules dictate possible actions for each player, and players receive various information as the game progresses, along with victories or defeats in different situations.

#### 3) Definition of Educational Game

According to Sanjaya, an educational game is a game that contains educational content or focuses on providing educational content. Gunawan et al. state that educational games can facilitate learning by helping students understand difficult topics, making lessons more comprehensible and engaging. Hayhow et al. note that educational games in learning approaches provide engaging activities, create a logical structure for learning through established rules, and offer opportunities to enhance knowledge with feedback. Using games in education fosters a sense of community, goal achievement, motivation, activity, learning, and problem-solving.

#### 4) Definition of Mathematics

Mathematics is a structured subject with interconnected topics. Students often find mathematics challenging, leading to a lack of interest in learning and an unengaging learning environment. Teachers must find ways to capture students' interest. With technological advancements, various tools, including games, can be used to support learning.

### 5) Definition of Construct 3

Construct 3 is an HTML5-based game development tool focused on 2D platforms by Scirra. It can run on various platforms like Windows, Linux, Mac, and Android through the Chrome browser via <https://www.construct.net/en>. Construct 3 can be used offline, even with the Chrome browser, so an internet connection is not required. It works by adding objects and assigning properties or behaviors to them, followed by adding game logic with conditions and actions. For instance, if a player collides with or passes an object, they can either lose or continue the game. Construct 3 is user-friendly, involving drag-and-drop functionality without complex programming. Before Construct 3, there was Construct 2, also by Scirra. The main difference is that Construct 2 required downloading the game engine from [www.scirra.com](http://www.scirra.com) and installing it on a PC or laptop, whereas Construct 3 runs directly in a web browser. A significant difference is in behavior actions like tweening, which Construct 3 includes natively, unlike Construct 2, which requires separate extensions. Construct 3 also simplifies project building for Android. This research uses Construct 3 for its ease of use, which is fundamentally similar to Construct 2.

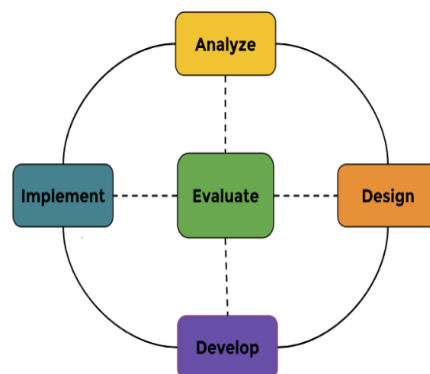
### 6) Definition of Android

According to Nazruddin (2014), Android is:

- a. An open-source platform for developers to create applications.
- b. An operating system acquired by Google Inc. from Android Inc.
- c. Not a programming language but provides a runtime environment called DVM (Dalvik Virtual Machine), optimized for devices with limited memory.

## 3. Research Method and Materials

The type of research method used in developing this educational game is Research and Development (R&D). This research process adapts the ADDIE development model according to Branch (2015), which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. These stages are interdependent, providing continuous feedback for the ongoing refinement of the product. The detailed development procedure in this research can be seen in the figure 1 and explanation.



**Figure 1.** ADDIE 's Research Model

- 1) Analysis Stage, this stage involves identifying problems, objectives, content or learning material, and delivery strategies in learning. This analysis stage is where information is collected as the basis or material for application development.

- 2) Design Stage, in the development of educational game learning media, this stage involves determining learning objectives.
- 3) Designing the scenario or learning activities using the educational game application. The design includes the conceptual design of the material, the concept of the educational game, and the control concept. The educational game design is created based on the game's process flow.
- 4) Development Stage, this continues from the design stage. The development stage is used to realize the planned design.
- 5) Implementation Stage, this is where the educational game is implemented using the software used to create the game. For instance, this educational game uses the Construct 3 application.
- 6) Evaluation Stage, this stage involves testing the basic mathematics educational game. The purpose of this testing is to obtain valid and practical learning media. Validity and practicality are derived from trials using this educational game with a group of people, after which the test results can determine whether the game is valid for use as learning media.



**Figure 2.** FlowChart Diagram of Application Game

### 3.1. Analyzing

Analyzing is an activity to examine or investigate an event through data to understand the actual situation. Analysis is conducted in the context of research and data processing. The results of the analysis are expected to help improve understanding and facilitate decision-making

- 1) Comparative Analysis of Similar Applications

An overall description of the educational game system by outlining the game's process flow and the workflow of the educational game itself. The game requires the user to find the correct answer as determined by the system. This game has several levels that must be played by the user; to proceed to each level, the user must obtain the correct answer according to the requirements. If the user does not get the correct answer to proceed to each level, the game must be restarted or return to the main page.

## 2) Problem/Requirement Analysis

Problem analysis in learning mathematics lies in the lack of interest among children to study it. Mathematics is often perceived as a boring and difficult subject, leading many students to be reluctant or not make it their favorite subject, with very few enthusiasts for this subject. Sometimes, no matter how enthusiastic and engaging math teachers are, they fail to change the mindset of children who dislike mathematics.

The needs analysis is divided into two parts: functional needs analysis and non-functional needs analysis. Functional needs analysis in the development of this educational game involves collecting information about mathematics learning materials in the form of an Android-based application game. Meanwhile, non-functional needs analysis entails hardware and software requirements for the development of this basic mathematics educational game:

- a) Hardware Requirements
  - ✓ Laptop Asus X441M
  - ✓ CPU intel celeron N4000
  - ✓ HDD 1TB
  - ✓ RAM 4GB
- b) Software Requirements
  - ✓ Windows 10
  - ✓ Chrome
  - ✓ Construct 3

## 3) Proposed Problem Solution

Based on the issues explained above, the proposed solution in this thesis proposal is the creation of an Android-based basic math educational game. As we know, the times have advanced, and the use of technology has rapidly increased, including the use of online and offline games among both children and adults. Therefore, the author decided to create an educational game as an alternative learning method. The aim is to increase children's interest in learning mathematics and to transform the concept of learning math from being very boring to being enjoyable with the concept of learning while playing.

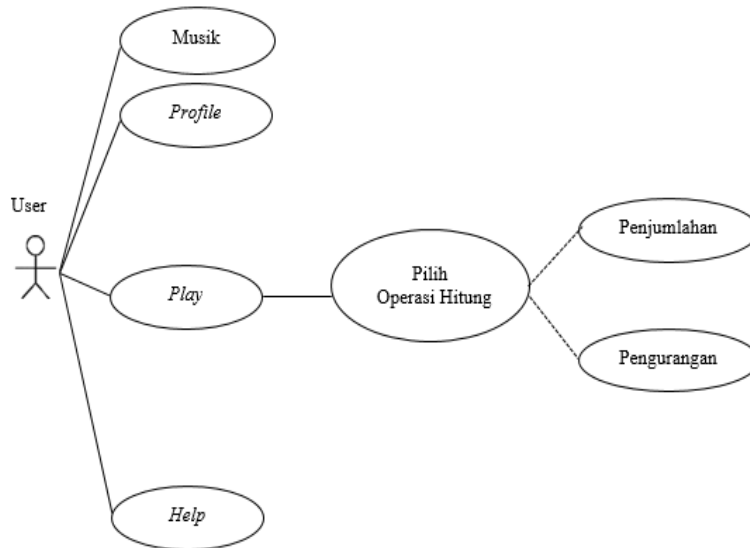
### *3.2. Designing*

#### a. Unified Modelling Language (UML)

The system design used is Unified Modelling Language (UML) modeling. The UML diagrams used in this system design are as follows:

##### 1) Use Case Diagram

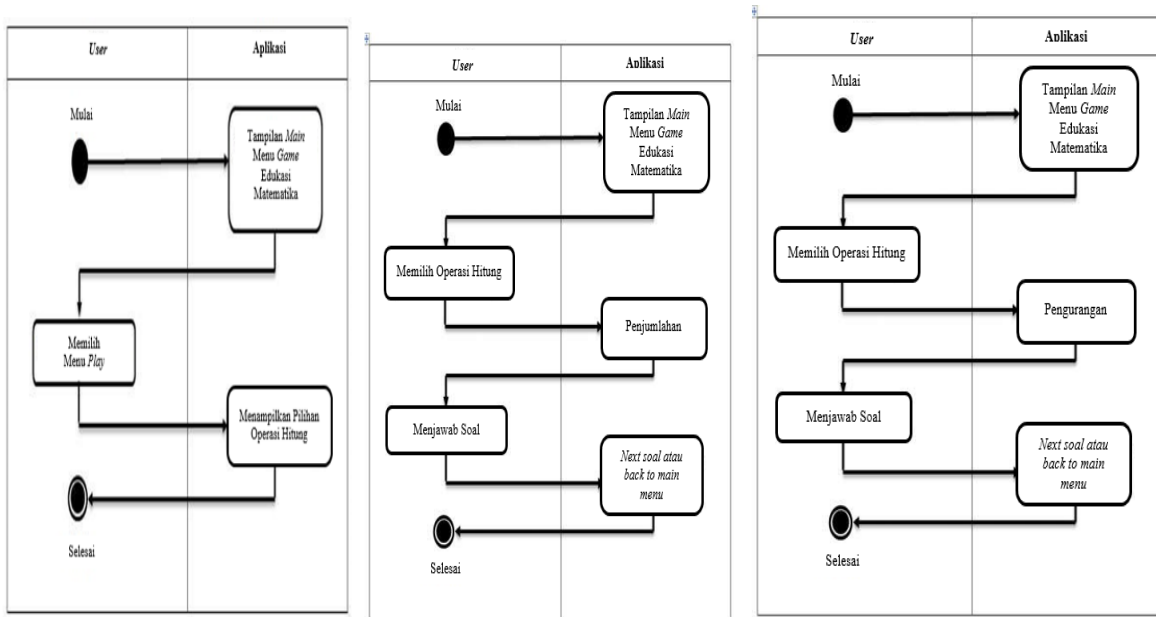
A Use Case is an abstraction of the interaction between a system and an actor. A Use Case works by describing the type of interaction between a system and itself through a story of how the system is used. Meanwhile, diagrams facilitate communication between analysts and users as well as between analysts and clients. The use case employed in the math game serves as the initial screen/main menu, and the designed use case diagram is as follows:



**Figure 3.** Use Case Diagram of Application Learning

2) Activity Diagram

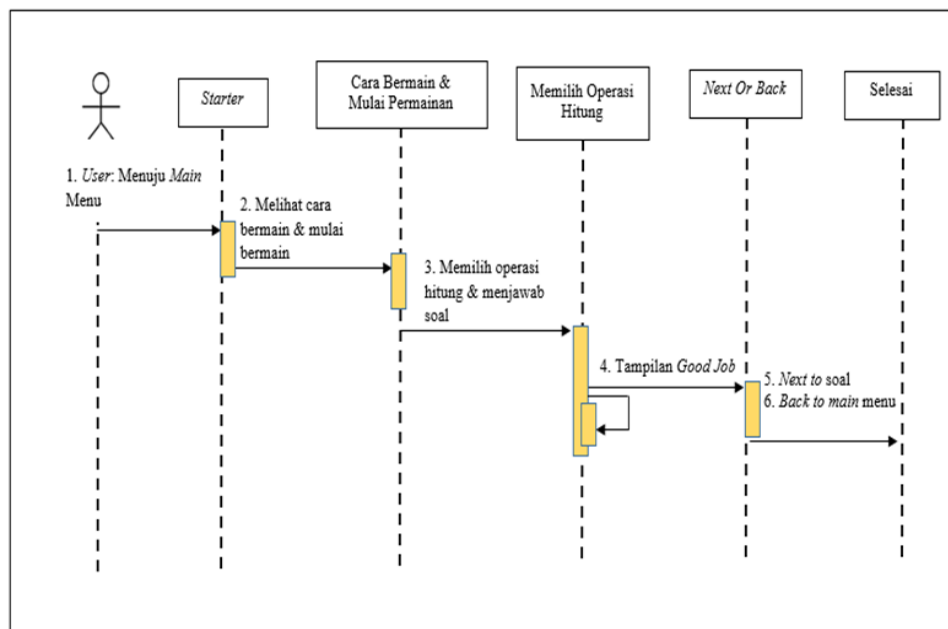
The Activity Diagram in this application shows the sequence of activities in operating the application. The designed activity diagram is present in the initial screen/main menu, which consists of the learning menu, game, education, about, and exit options.



**Figure 4.** Activity Diagram Of Application Learning

3) Sequence Diagram

A sequence diagram depicts the behavior of objects in a use case by describing the lifespan of objects and the messages sent and received between objects.



**Figure 5.** Sequence Diagram of Application Learning

b. User Interface Design

User Interface, often abbreviated as UI, is what interacts with users as part of an experience. UI is not just about colors and shapes, but about demonstrating the right tools to achieve its purpose.

## 4. Results and Discussion

### 4.1. System Specification

Specifications of the basic mathematics educational game based on Android are as follows:

- 1) The basic mathematics educational game is a simple game application focusing on addition and subtraction topics for beginners, compatible with Android smartphones.
- 2) Game ini dibuat menggunakan aplikasi construct 3 berbasis HTML 5.
- 3) The game includes two arithmetic operations: addition and subtraction.
- 4) The basic mathematics educational game features 5 screens::
  - ✓ Main Menu Screen
  - ✓ Operation Selection Screen (addition and Subtraction)
  - ✓ Question Screen.
  - ✓ Next Question Screen.
  - ✓ Help Screen).
- 5) The basic mathematics educational game can be played offline.
- 6) The game concept is designed to be appealing to children, with a cute and cheerful theme.
- 7) The gameplay is very simple and suitable for children.

#### 4.2. Spesifikasi Aplikasi

The following are the specifications of devices that can use this basic math educational game, as follows:

a. Hardware

This basic math educational game is a simple game designed as a learning and playing tool for children. As explained above, to make it easier for users to use this basic math game application, the game can be accessed on Android smartphones.

b. Software

The following Android versions can be used to run this basic math educational game i:

- 1) Android version 8.0+ (Oreo)
- 2) Android version 9.0+ (Pie)
- 3) Android version 10.0+ (Quine Tart)
- 4) Android version 11.0+ (Red Velvet)
- 5) Android version 12.0+ (Snow Cone)
- 6) Android version 13.0+ (Tiramisu)
- 7) Android version 14.0+ (Upside Down Cake)

#### 4.3. Procedure for Using the Application

The following are the functions of the buttons in the basic math educational game :



**Figure 6.** Main Menu Screen

On the main menu page, there are 4 buttons, namely:

- a. Play button: when clicked, it will direct to the page for selecting arithmetic operations (addition & subtraction).
- b. Help button: when clicked, it will direct to a page containing an explanation of how to play the game.
- c. Music button: used to toggle the music on and off.
- d. Profile button: used to view the profile of the creator of this basic math educational game.



**Figure 7.** The Screen of arithmetic operation option Choice

On the arithmetic operation selection page, users are required to choose either addition or subtraction to continue the game. There is also a back button to return to the main menu page.



**Figure 8.** Addition and Substruction Menu Screen

When answering a question incorrectly, the dragged number will return to its original position, and when answering a question correctly, the following display will appear.






**Figure 9.** Notification Answer Screen

#### 4.4. Black Box Testing

Black box testing is conducted by running the application to identify errors and ensure the system functions as intended. The black box testing table for this game is as follows:

No	Simbol	Komponen yang di Uji	Skenario Pengujian	Hasil yang di Harapkan	Hasil Pengujian
1		Button Play	Memilih <i>button play</i> yang telah disediakan di <i>main</i> menu	Menampilkan pilihan operasi hitung	Berhasil
2		Button Help	Memilih <i>button help</i> yang telah disediakan di <i>main</i> menu	Menampilkan cara menjawab soal pada permainan	Berhasil
3		Button Musik ( <i>Mute Unmute</i> )	Memilih <i>button musik</i> yang telah disediakan di <i>main</i> menu	Mengatur <i>mute</i> dan <i>unmute</i> musik pada permainan	Berhasil
4		Button Profile	Memilih <i>button profile</i> yang telah disediakan di <i>main</i> menu	Menampilkan <i>profile</i> pembuat <i>game</i> edukasi matematika dasar	Berhasil

Figure 10. Main Menu Testing

No	Simbol	Komponen yang di Uji	Skenario Pengujian	Hasil yang di Harapkan	Hasil Pengujian
1		Button Penjumlahan	Memilih <i>button penjumlahan</i> yang ada pada halaman pilih operasi hitung	Menampilkan soal penjumlahan	Berhasil
2		Button Pengurangan	Memilih <i>button pengurangan</i> yang ada pada halaman pilih operasi hitung	Menampilkan soal pengurangan	Berhasil
3		Button Back	Memilih <i>button back</i> yang ada pada halaman pilih operasi hitung	Kembali ke halaman <i>main</i> menu	Berhasil



No	Simbol	Komponen yang di Uji	Skenario Pengujian	Hasil yang di Harapkan	Hasil Pengujian
1		Button Next	Memilih <i>button next</i> yang telah disediakan di halaman <i>next</i> soal	Menampilkan soal selanjutnya	Berhasil
2		Button Back	Memilih <i>button back</i> yang telah disediakan di halaman <i>next</i> soal	Kembali ke halaman <i>main</i> menu	Berhasil

Table 11. Option Choice Menu Screen

The conclusion obtained after performing black box testing of the basic mathematics game is that all scenes in the game function as intended

#### 5. Conclusion

Based on the analysis and design of the basic mathematics educational game based on Android, the following conclusions can be drawn:

- a) This basic mathematics educational game is a simple educational game that contains addition and subtraction material for children.
- b) This mathematics education game is created using the Construct 3 application. Construct 3 is one of the game maker applications based on HTML 5, with a drag & drop concept, inserting action and condition commands on each object. This application is easier and simpler because it does not use complicated programming languages.
- c) This basic mathematics educational game serves as an educational tool for children to improve accuracy and speed in counting, especially addition and subtraction. This game also serves as a playing tool for children because of its interesting and enjoyable concept.

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