

DESIGN OF A PLANE FIGURE MATHEMATICS EDUCATION GAME FOR CLASS IV STUDENTS BASED ON ANDROID

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Abstract

Mathematics is a branch of knowledge related to developing abstract concepts, structures, and relationships in the form of numbers, symbols, and patterns. The issue some students still have trouble recalling formulas, doing division in one of the flat shape materials, and doing multiplication using the formula for the perimeter and area of flat shapes. This research discusses the design of educational games to help fourth-grade students learn flat-shape mathematics. Interviews were conducted with class IV teachers at SDN Sirnajaya Five in conveying material to students; they did not use learning media or visual aids. The problem that often arises is that some students still need help learning flat-shape mathematics. This research aims to build a flat-shape math educational game application for fourth-grade students so that these students can quickly understand the basics of flat-shape material, the definition of flat shapes, formulas, and the properties of flat shapes. The method used is the Multimedia Development Life Cycle (MDLC), a pattern for developing software systems consisting of Concept, Design, Material Collecting, Assembly, Testing, and Distribution stages, which form a workflow for planning and controlling the design of Educational Game applications. This research results in an Android-based flat-shape mathematics educational game application.

Keywords: *Android Application, Educational Game, MDLC, Plane Figure Mathematics.*

1. INTRODUCTION

The material used is the ESPS Erlangga class IV elementary school book, which uses an independent curriculum, only provides theory, questions, and examples, and students immediately work on them, according to the background, which is based on the results of interviews with class IV teachers at SDN Sirnajaya 5. This leads to the issue that some students still have trouble recalling formulas, doing division in one of the flat shape materials, and doing multiplication using the formula for the perimeter and area of flat shapes. The role of schools is significant in developing students' potential so that they can face tasks and challenges in everyday life, both individually and in their social lives [1]. Science, technology, and engineering advancement depend on mathematics [2]. One discipline that calls for the use of constructivist-based learning is mathematics. In addition to reading and memorization, students actively search for concepts. Mathematics is a less desirable subject, particularly in Indonesia. Innovation in education is therefore required [3]. Teaching and learning activities in schools must be distinct from the central role played by the class as the primary learning environment [4]. This shows that the use of Android devices in the children and teenagers age category has experienced a drastic increase. Currently, teachers must be able to increase students'

active participation, which will impact their understanding during the learning process. Several essential aspects must be considered in designing plane figure for class IV, such as creating an effective and enjoyable learning environment for students. This can include designing a room layout that facilitates easy interaction between teachers and students. The design of an Android-based mathematics educational game for fourth-grade elementary school students aims to increase students' understanding of learning. In this way, students can play Android-based games with learning elements. Previously, teachers only provided direct explanations by providing students with materials, questions, and examples.

Mathematics is a scientific discipline that studies concepts in numbers, symbols, and patterns. Mathematics has a significant role in our daily life. However, for some students, understanding formulas in mathematics can be difficult [5]. Therefore, to overcome challenges in learning mathematics, the curriculum for grade IV students currently adopts an independent curriculum approach. This approach tries to change how students learn by providing theories, examples, and questions during the learning process. Nonetheless, more support was needed to maintain students' interest and attention during the lesson. In addition, the material presented is also often difficult for some students to understand. Most teachers use textbooks, such as math books for class

IV from Erlangga publishers, and try to explain various materials, including related formulas, such as the perimeter of a square, rectangle, perimeter of a triangle, area of a rectangle, and the difference between regular polygons and polygons. Irregular. However, this makes some students learn because of the lack of learning media. Especially in mathematics lessons, this will make them bored because only the teacher explains a theory without any android-based learning used in teaching activities. Of the many learning in elementary schools, they still use books, as is the case at SDN Sirnajaya 5 for learning mathematics. Based on the problem above, several other factors make students not interested in learning because of a lack of media, so making this educational game attracts students' attention to learning while playing. Fun activities can arouse children's curiosity and enthusiasm for learning [6]. Learning like this will be carried out by students in the future to make learning more engaging and raise the need for knowledge about Android-based learning games. Based on the first research regarding the development of the Android-based Om-Tur (Omah Miniatur) educational game, materials were used in grade IV elementary school. This research will produce an Om-Tur educational game product with titles, instructions, profiles, and materials. There are five levels containing games, then calculate the area and perimeter of the square [7]. The second research discusses how contextual mathematics learning methods can be used with 2D content. This study aims to provide teaching materials in the form of contextual learning applications about the circumference and area of flat shapes [8]. In the third study, scratch was used to make a learning game on the characteristics of rectangles. Based on the findings of this research, learning games about the characteristics of rectangular shapes can be created successfully using initial programming languages and the Multimedia Development Life Cycle design model [9]. The fourth research is creating a spatial plane figure learning application for fifth-grade elementary school students using the Unity Engine and game development life cycle approaches. To keep children interested and engaged in learning, the authors of this study designed a quiz game application for education with a focus on mathematics [10]. The fifth research focuses on creating AR-based educational resources for two-dimensional geometric shapes. To assist students in learning geometric objects, especially flat-sided geometry material, this research creates augmented reality-based learning media that can be operated via devices with the Android operating system [11]. Recently, gamification has gained popularity in the field of education. Its benefits include allowing kids to study in a multisensory, active, and exploratory setting, among others [12]. They have been created to help individuals learn or practice a skill or strategy while playing a game, expand on concepts, and educate

people in particular areas or all of the above [13]. Aristotle and Plato, two ancient Greek philosophers, first proposed using games as a teaching technique. Game-based learning has been incorporated into educational philosophies more recently [14]. Serious games or game-based learning settings are terms used to describe games that are created or modified for educational purposes. Game-based learning is a new paradigm for instructional improvements that may be used at all academic levels and disciplines [15]. According to their cognitive and affective domains, students gain from exploring new learning methods using game-based learning. Due to the competitive components that motivate students to study mathematics, well-designed and practical lessons can enhance students' learning. The effects of the rewards serve as incentives and can pique a student's interest in learning, particularly when it comes to their cognitive component [16].

Based on the results of interviews with class IV teachers at SDN Sirnajaya 5, the learning media is still as usual without using teaching aids; the material used is the ESPS Erlangga class IV elementary school book, using an independent curriculum, only providing theory, questions, and providing examples and students do it straight away. Therefore, the problem is that some students still need help memorizing formulas for division in one of the flat-shaped materials. Students have difficulty calculating multiplication using the formula for the perimeter and area of flat shapes. However, this problem can be overcome by creating one of the solutions, a mathematical educational game design about class flat shapes for class IV students based on Android, which can make it easier for students to know formulas, multiplication, division, the perimeter of a square, rectangle, perimeter of a triangle, area of a rectangle, the difference between regular and irregular polygons.

2. RESEARCH METHODS

The methodology used in designing a flat geometric educational game is the Multimedia Development Life Cycle (MDLC).

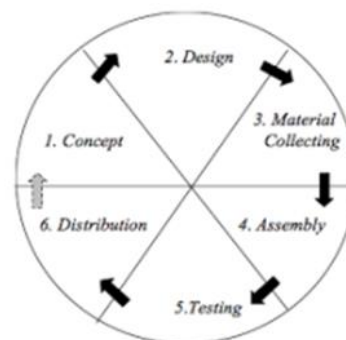


Figure 1. Multimedia Development Life Cycle Stage

Figure 1 shows the stages of the MDLC method, which consist of the following:

1. **Concept:** This stage is the first step in the application development process, where researchers plan the goals, benefits, and users of the application to be built. This concept is the basis for determining the target of the application.
2. **Design:** This stage is the stage for the Initial specifications regarding the description of an application, starting from the form of the application, type of application, needs, and appearance. The Android application is an open-source system used on Android, and this application can make things easier for users. The display design is built by determining a unique display with appropriate images and sounds for children.
3. **Material Collecting:** This stage involves collecting all materials needed to create an application, including images, video, audio, and text that will be used to support educational games. The data used in this application relates to grade IV maths flat shapes.
4. **Assembly:** The assembly stage or stage creation is the process of plane figure a system based on the purpose and use of the application, which involves design, such as creating a storyboard and combining all the necessary elements, including data and materials. This process includes integrating all concept, design, and application requirements elements.
5. **Testing:** This stage is the testing stage, an application that has been built. After the manufacturing or assembly stage is complete, the application is tested by the user, in this case, the student. The trial involved the use of unique images and the integration of data in the form of video and audio in the application.
6. **Distribution:** This stage can also be called an evaluation stage to develop a finished product to improve it. The results of this evaluation can be used as input for the concept stage in the following product development.

3. RESULTS AND DISCUSSION

This section presents the results of the study of each activity carried out according to the MDLC (Multimedia Development Life Cycle) methodology in designing flat-rise mathematics educational games using the multimedia development life cycle methodology.

A. Concept

At this stage, the main activity is to determine the content concept of the educational game to be made. During this phase, the following design objectives were established:

1. **Purpose of Making the Application:** The aim of the flat shape mathematics educational game application for fourth-grade students is so that students can understand the basics of plane shape material, including the meaning of plane

shapes, formulas, and properties of plane shapes. In addition, this application also aims to provide convenience for teachers in teaching and learning activities.

2. **User identification:** From the research results through interviews and questionnaires, the primary users of this flat-shaped math educational game are fourth-grade elementary school students.

B. Design

In this stage, the process of planning and creating object elements is done with an aesthetic aspect. This involves sketching the main page design, making translating the concept into a more tangible and aesthetic form easier. This design is made in the form of a storyboard and navigation structure.

Table 1. Storyboard

No	Scene	Contents	Information
1	Scene 1 (<i>Splash Screen</i>)	Opening page Main menu page	This page displays the start page of the game application
2	Scene 2	Materials Page	This page displays several materials, such as flat figures
3	Scene 3	Quiz page	This page displays several materials, such as flat figures
4	Scene 4	Game page	This page displays an educational game with five game levels.
5	Scene 5	Guide page	This page displays instructions/steps for playing educational games.
6	Scene 6	About page	This page displays the profile of creating educational game applications.
7	Scene 7	Exit	This page displays the exit/exit of the Game application.

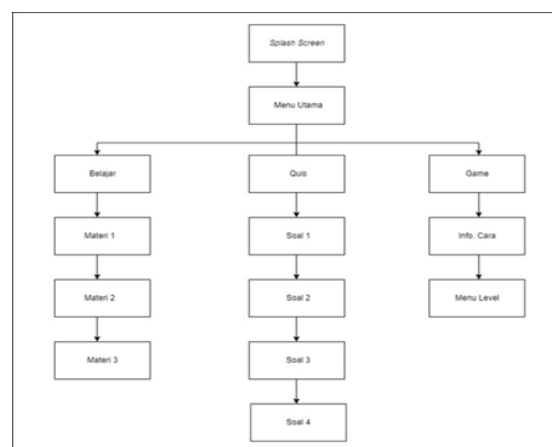


Figure 2. Navigation Structure

C. Material Collecting

In designing this application, assets are needed to support the application in the form of image and sound data in a flat-shape mathematics educational game. In collecting images, the goal is to get files in .jpg and .png formats according to the needs of developing game applications. This stage involves making various images, such as backgrounds,

buttons, and other images that match the game application concept. Several processes are involved in collecting image data at the image collection stage, as shown in Figure 3.

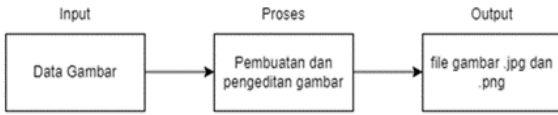


Figure 3. Image data

The collection of sound materials aims to make the application more interesting for elementary school students. The sound files used are in MP3 and Wav formats, then inserted into scenes or objects according to their needs and functions, as seen in Figure 4.

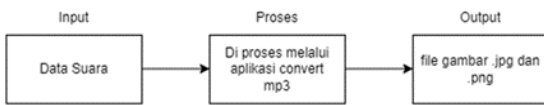


Figure 4. Voice data

D. Assembly

This stage involves making an application or implementation of the previous stage. All data is aggregated, integrated into Adobe Flash software, and converted into an Android-based application. The planned design will be implemented into the program to build the application after the assessment. The following is an implementation of the interface display of the application regarding the application of Adobe Flash CS6 technology in shape math educational games:



Figure 5. Main page

Figure 5 is the opening display page, which is set with an automatic time for 5 seconds with the main display, namely the game icon and some illustrations from the background.

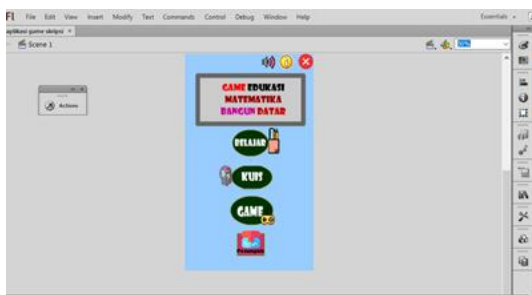


Figure 6. Main menu

Figure 6 is the main menu in the form of a display with the contents of which there are several buttons to enter other main pages.



Figure 7. Material page

Figure 7 is a material page that explains flat shapes, where users can see the information displayed in the application.



Figure 8. Quiz page

Figure 8 is a quiz page that explains the procedures or instructions for using an educational game application to work on the Adobe Flash CS 6 application.



Figure 9. Game page

Figure 9 is a game page that displays educational games with five game levels.



Figure 10. Help page

E. Testing

In this evaluation stage, it is essential to ensure that the efforts made achieve the desired impact and can be continuously improved. Further information can be found in Table II.

Table 2. Alpha Testing

No	Testing	Test scenario	Result	Information
1.	Installation Apps	Installation Apps on Smartphones	Successfully installed	Success
2.	Open Application	Open application on the smartphone	The application opens successfully by displaying the Main Menu page	Success
3.	Start Application	Press the button on the home page	Game to start page	Success
4.	Next Content	Press the next button	Game to the main menu page	Success
5.	Study Menu	Press the material button.	Game to material page	Success
6.	Quiz Menu	Press the tutorial button	Game to the tutorial page	Success
7.	Game menu	Press the previous page	Exit the Application	Success
8.	Buttons	Press the button	Exit from study	Success
		Press the exit button.	Exit Application	Success

Furthermore, beta testing is carried out objectively by involving respondents or users of applications that have been made. This beta test is carried out directly to end users using a questionnaire to measure user satisfaction using the application.

Table 3. Student Respondent

No.	Question	Response				
		1	2	3	4	5
1.	Plane figure Mathematics Educational Game Easy to operate	1	-	-	2	22
2.	The appearance of the Grade IV Flat Shape Mathematics Education Game is attractive and funny.	-	-	-	6	20
3.	Have fun playing Android-based flat-shape math educational games.	-	-	-	8	18
4.	Learning is more fun by getting to know the Android-based class IV flat shape educational game.	-	-	-	9	17

No.	Question	Response				
		1	2	3	4	5
5.	Users enjoy the educational game Flat Shape Math Class IV.	-	-	-	17	8
6.	After playing this educational game, are you interested in playing it again?	-	-	-	17	8
Amount		-	-	-	59	93

The results of the questionnaire obtained the following values:

$TP = \text{Total voters}$ $JP = \text{Number of Questions}$
 $TN = \text{Total value}$ $JU = \text{Number of Testers}$
 $ST = \text{Highest score}$ $HA = \text{Final result}$
 $NT = \text{The highest score}$ $N = \text{Value Scale}$
 $\text{Total Value} = (TP \times N)$
 $= (93 \times 5) + (59 \times 4) + (0 \times 3)$
 $+ (0 \times 2) + (0 \times 1)$
 $= 465 + 236 + 0 + 0 + 0$
 $= 701$
 $\text{Highest Score} = (NT \times JP \times JU)$
 $= 5 \times 6 \times 26 = 780$
 $\text{Final result} = (TN / ST \times 100\%)$
 $= 701 / 780 \times 100\%$
 $= 89,8\%$

Based on the results of the feasibility testing in the field from student respondents, the final result was 89.8%. So, the educational game that was made got the assessment results, and almost all agreed.

F. Distribution

At this stage, the Bangun Datar Mathematics Educational Game has successfully passed the testing process and is ready to be used. The distribution process saves educational games in .exe, .swf, and .apk file formats. After that, the game will be published to class IV students at SDN Sirnajaya 5.

4. CONCLUSION

The conclusions obtained in this research are as follows: Application to math educational game applications: Flat shapes can be used as one of the lessons for students to make them more exciting and fun. Educational game applications can be built flat, making it easier for students to apply to Android-based games. Add motivation to students regarding Android-based technology produces funnier image visualization.

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