# DESIGN EDUCATIONAL GAMES USING SCRATCH FOR MATHEMATICS LEARNING TOPIC AREAS OF TRIANGLES USING MDLC METHODS FOR STUDENTS SD NEGERI SUKAMENAK SUBANG

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## *Abstract*

*Games have become an integral part of everyday life, especially for children, teenagers, and young adults. They are no longer just for entertainment; they are also used for learning purposes. For instance, educational games can help with subjects like mathematics, which many students find difficult and boring. To address this, this research aims to create a game to teach about the area of a triangle. This game will be designed using the MDLC method with storyboards. The research will involve testing the game on students and teachers at Sukamenak Elementary School in Subang. The testing will consist of 2 parts: game testing and questionnaire assessment testing. The results of the testing can be deemed successful with positive responses from both students and teachers after testing the educational game application based on a website using Scratch for learning mathematics.*

***Keywords*** *: Educational games, Mathematics, MDLC (Multimedia Development Life Cycle), Scratch, Triangle*

## Abstrak

Game telah menjadi bagian penting dalam kehidupan sehari-hari, terutama bagi anak-anak, remaja, dan dewasa muda. Mereka tidak lagi hanya untuk hiburan, mereka juga digunakan untuk tujuan pembelajaran. Misalnya, permainan edukatif dapat membantu mata pelajaran seperti matematika, yang menurut banyak siswa sulit dan membosankan. Untuk mengatasi hal tersebut, penelitian ini bertujuan untuk membuat sebuah permainan untuk mengajarkan tentang luas segitiga. Game ini akan dirancang menggunakan metode MDLC dengan storyboard. Penelitian ini akan melibatkan pengujian permainan pada siswa dan guru SD Negeri Sukamenak Subang, pengujiannya terdiri dari 2 yaitu pengujian game dan pengujian penilaian kuesioner hasil dari pengujiannya dapat dikatakan berhasil dan dapat respon yang positifi setelah diujikan kepada murid dan guru pada aplikasi game edukatif berbasis website dengan menggunakan scratch dalam belajar matematika.

**Kata kunci :** *Game edukasi, matematika, MDLC (Multimedia Development Life Cycle), Scratch, Segitiga*

## 1. INTRODUCTION

*On the 21st – century skills greatly affect various fields, especially education, one of the contents that must be taught in achieving 21st-century skills in mathematics education [1]. Mathematics is a science that is very useful for solving problems in everyday life. This results in mathematics being present at every level of education, starting from simple to complex mathematics. Geometry is one of the important aspects in learning mathematics that must be understood by students because the concept of*

*geometry is very closely related to the context of everyday life [2]. One that is studied mathematics is the area of a triangle which is part of geometry.*

*So far, mathematics has been identified as complex learning, difficult to understand, and boring. Mathematics learning strategies, methods, and techniques rely more on the monotonous approach of the teacher as the main source of information. Mathematics learning generally uses a patterned model of calculation by using formulas that are difficult to understand. The impact of this kind of learning is that students become less enthusiastic about participating in lessons and become bored [3].*

*Students need a new atmosphere that is fun, creative, innovative, and varied and does not only rely on the senses of hearing and sight. Active learning models such as discussions and games can make the atmosphere more lively and foster motivation for students. A study states that games on computer devices can increase the speed and efficiency of distributing information in the nervous system to students and can also improve cognitive and motor skills in children [4]. Educational games can foster students' interest in learning the subject matter so that with their happy feeling's students can more easily understand and remember learning material. With educational games, children will not feel burdened in mastering the material because they think they are playing with the games they like every day. Learning material can be understood by the child's own will, Children become motivated to learn to do the game well. However, the potential application of the game in learning can still be further explored by applying suitable framework methods in its development [5].*

*This paper discusses research on the design of educational games to introduce mathematics material to elementary school students. In addition, this game contains information about mathematics, its formulas, and how to solve them as taught in school. This research will prove that educational games improve students' mathematical knowledge. One of the applications for learning multimedia is the Scratch application. Scratch is a new programming language that makes it easy for everyone to create interactive stories, interactive games, and animations, as well as share one's work with other via the internet [6]. Scratch is an application to create a product without having to think hard about programming languages. Although it is easy and simple to make, Scratch can and is feasible to use as a learning medium [7].*

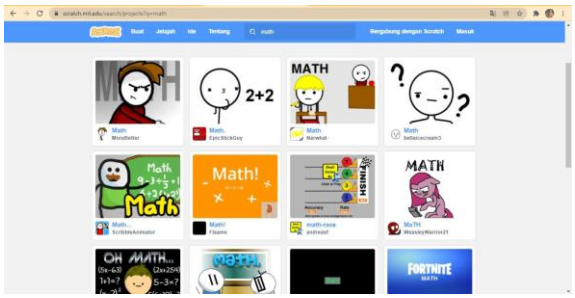


*Figure 1. Some Math Games On Scratch*

*There is research on the application of Scratch in learning. However, according to the researcher's study, it is known that there is no regional-wide topic learning media using Scratch, One of them is Epon's research in developing educational games for flat shapes [8], in his research developing a website-based educational game on the subject of rectangular flat shapes, the results of the development of which can be tested by schools or on the internet which can be used by students. Then the research carried out by Eka was to build a website-based calculator application using scratch [9], the aim of the development was to increase the competence and skills of teachers in interesting learning media using scratch. Thus, this paper describes the results of research on the design of learning media on the topic of the triangular area using the Scratch application.*

## 2. RESEARCH METHODS

*The six stages of the Multimedia Development Life Cycle (MDLC) development model are used in this research design. First, there is the concept, which is identifying the users and program goals. Creating a blueprint for the program's display is the second design. The third is gathering, namely gathering resources in accordance with requirements. Creating apps based on the design stage is the fourth assembly. The fifth step is testing, which involves executing the program to ensure that it is correct. The program and the six distributions are kept on a storage media.*

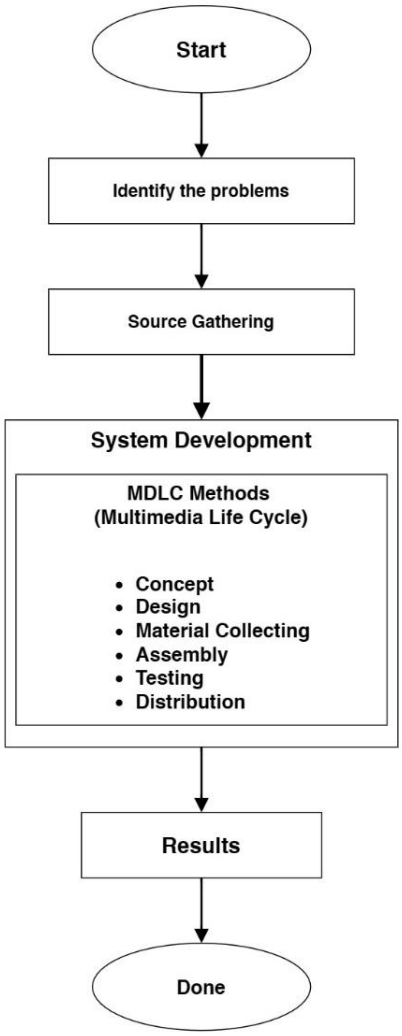


*Figure 2. Stage Of Research Method*

*Based on Figure 2, the explanation of the steps of the research method are as follows:*

1. ***Identify the problems***
   *The issues addressed stem from the elementary school educational background, where some students still struggle to comprehend mathematical subjects, particularly in the topic of triangles. One of the challenges is the need for visualization in their learning process and the requirement for interactive media to facilitate understanding [10].*
2. ***Source Gathering***
   *Then, in collecting data, the author reads several literature studies from previous research that have already been conducted, such as developing educational game applications for elementary school students using the Scratch platform.*
3. ***Concept***
   *The concept stage is a stage that includes activities to determine the goals, who the users of the program will be (useridentification), and the concept of the game that will be created. Apart from determining various applications such as presentations, interactive, etc. Conceptualization will also determine the gameplay or interaction process.*
4. ***Design***
   *Design is the stage of making specifications regarding program architecture, style, appearance and material requirements for the program, including level design, music design, character design, and user interface design. This stage involves defining the overall structure and visual elements of the game, ensuring that they align with the intended educational objectives and target audience preferences. Level design encompasses creating the layout, challenges, and progression of gameplay to maintain engagement and promote learning [11].*
5. ***Material Collecting***
   *The stage where the collection of materials according to needs is carried out. This stage can be carried out in parallel with the assembly stage. In some cases, the Material Collecting stage and the Assembly stage will be carried out linearly, not parallel.*
6. ***Assembly***
   *The assembly stage is a critical phase in which data is gathered for all objects or multimedia materials designed during the earlier stages of the process. This includes collecting graphics, animations, audio files, and any other resources necessary for the development of the application [12].*
7. ***Testing***
   *Following the assembly phase, execute the application or program to identify any potential errors. This phase, known as alpha testing, involves assessing the software within the manufacturer's environment or by the manufacturer itself [13]. Subsequently, the outcomes of the game development will undergo evaluation among 30 students from SD NEGERI SUKAMENAK Subang.*
8. ***Distribution***
   *After completing the development and testing on elementary school students for the game application, the author here proceeds to the distribution stage by saving the developed game and distributing it in the form of a website or through links.*

*Additionally, it is distributed in the form of an application that can be played by students even without internet access to access the application.*

9. ***Results***
   *In the results stage, the author analyses data from the testing and feedback from users to evaluate the effectiveness and success of the implemented features in their research. Additionally, the author compares them with predefined standards or criteria to assess the performance and quality of the developed educational game. From this analysis, the author can identify strengths, weaknesses, and potential improvements for further development, as well as draw conclusions on the overall research findings.*

*Based on these phases, it is envisaged that engaging math games would be made available as learning resources for mathematics, benefiting parents, instructors, and students alike. Additionally, it is intended that by using this media, students will be more inspired to learn and develop their comprehension of the course materials.*

## 3. RESULT AND DISCUSSION

*The following is the step-by-step process of designing math learning games, which involves careful planning, development, and implementation to ensure the effectiveness and educational value of the games.*

### Concept

*The program is in the form of online math games that elementary school children can play. It is intended that by playing this game, children will like and be enthusiastic about learning mathematics, which will help them to comprehend it better. The area of a triangle for elementary schools is the material used in this study's game design. Also, the game was designed through the Scratch application, which provides a user-friendly platform for creating interactive stories, animations, and games. Utilizing Scratch, the game designers could employ its drag-and-drop interface to easily develop characters, backgrounds, and game mechanics without needing advanced programming knowledge.*

### Design

*The following is one of the outcomes resulting from the design of a game centered around the concept of triangular area.*

*TABLE I. RESULTS OF GAME DESIGN*

| Visual | Sketch | Audio |
|---|---|---|
| *In this frame there is a background layer along with a cute character that will guide the game.*<br><br>*And in its visuals, the game background is set in space with bright colors and patterns.* | ***Definition of Area of a Triangle***<br><br>*Before we discuss further what is the area of a tringle, we must know the basic definition of the area of a triangle.*<br><br>*So, what is the area of a triangle? The area of a triangle is a measure of the area bounded by three sides that meet each other, from one side to the other.* | *Explanation voice* |

*Based on Table 1, several design implementations for the educational game encompass various aspects. One of these is creating background designs within the game, aimed at crafting an engaging and enjoyable atmosphere for users during gameplay. Additionally, a key feature developed is the design of the questions provided within the game. Furthermore, other additions include the incorporation of levels in the game to gradually increase difficulty levels as users progress in understanding the material. Another subsequent design addition is music in the game, which serves to create a more immersive and enjoyable atmosphere for users while playing. With suitable and captivating music, users will feel more connected to the game and experience a more enjoyable and entertaining gaming experience.*

### Collecting

*At this stage, the collection of learning materials will be carefully chosen to ensure the success of the game design. Every element, from images explaining mathematical concepts to ambient sounds, will be meticulously crafted. This is crucial*

*to creating an educational and enjoyable gaming experience for players. By utilizing various types of media, such as images, animations, and sounds, we can enhance the appeal and effectiveness of learning through this game. Furthermore, the assets collected for this game will utilize free animation, image, and audio assets provided by the Scratch platform, eliminating the need to purchase assets from external sources.*

***Assembly***

*This stage involves the implementation of the game based on the designs created in the previous stage. It's the actual development phase where the game mechanics, graphics, and interactions come to life. Utilizing the materials created earlier, such as the triangular area media produced through the Scratch application, developers will begin building the game environment, incorporating elements like player controls, scoring mechanisms, and educational content. Additionally, continuous iteration and improvement are essential during this phase. Feedback from testers and educators can help identify areas for enhancement or adjustment to better align with educational objectives and player engagement, the process can be seen follows in Figures 3 to 8.*

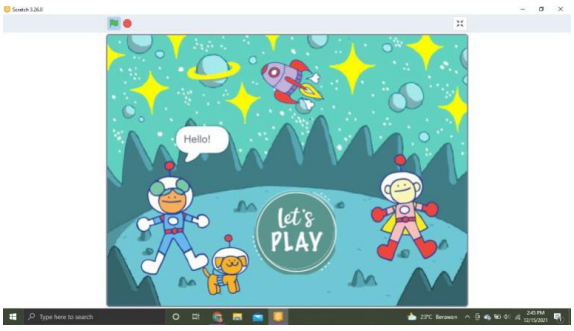


*Figure 3. Program Preview*

*In this display of development, the focus is on creating a captivating user interface that seamlessly integrates animated characters and interactive elements. The animated characters serve not only as guides but also as relatable and engaging companions for players throughout the game. By incorporating greetings and interactive buttons to initiate gameplay, the interface becomes more intuitive and inviting, encouraging players to explore and engage with the educational content.*


*Figure 4. Program Section Display*

*Furthermore, within the game interface, players are presented with a choice of program content, offering options such as definitions, formulas, and definitions comprising questions aimed at reinforcing understanding. These content selections are easily accessible through interactive buttons, allowing players to navigate between different educational materials seamlessly. By clicking on the respective buttons, players can delve into specific areas of interest or focus on particular topics they wish to explore further.*

*Additionally, for a more immersive experience, players have the option to view the game in full-screen mode. When activated, the game interface expands to fill the entire display, providing a more encompassing and visually engaging environment. This full-screen display, as depicted in Figure 5, maximizes the utilization of screen real estate, offering players an uninterrupted and immersive learning experience.*

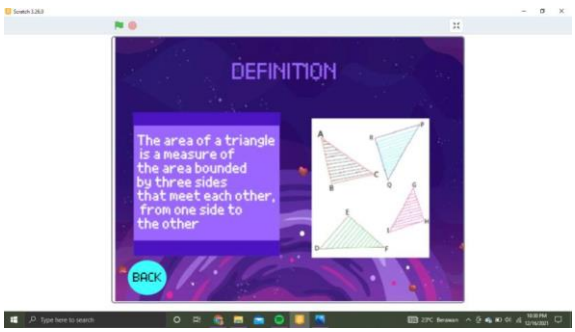


*Figure 5. Definition Button Display*

*If the definition button is selected, the display in Figure 5 will appear, presenting the definition of the area of a triangle. This section of the game interface is designed to provide concise and clear explanations of key mathematical concepts, ensuring that players have a solid understanding of the topic before proceeding further [14]. By presenting definitions in a visually appealing and easily accessible format, the game aims to engage players and facilitate comprehension through both text and visual aids. Additionally, interactive*

*elements may be incorporated to allow players to interact with the definition, reinforcing their understanding through active engagement. Overall, this section serves as a foundational resource within the game, laying the groundwork for deeper exploration and application of mathematical principles.*

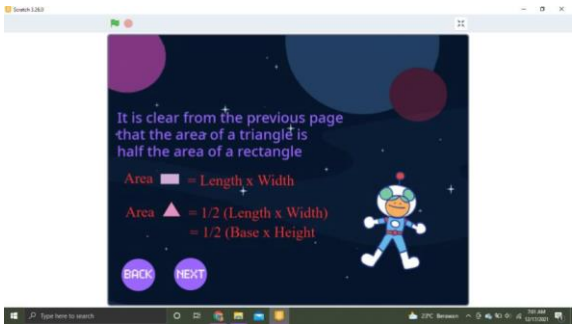


*Figure 6. Formula Button Display*

*In the formula button section, upon selection, players will be presented with Figure 6, which provides step-by-step instructions for deriving the formula for the area of a triangle with a breakdown of each component. By breaking down the formula derivation into manageable steps and providing clear explanations along the way, the game facilitates a structured learning experience that promotes active engagement and mastery of mathematical concepts.*


*Figure 7. Task Button Display*

*Within the game's content, students are presented with questions where they are given 3 answer choices displayed in the game. They are required to select the multiple-choice answer within a given time frame, thus training their brain's speed and agility. Additionally, they are provided with solution options to determine the answer to the question.*


*Figure 8. Solution Button Display*

*There is example of question to calculate the area of triangle like the one in Figure 7 which is accompanied by a formula button for discussion Figure 8.*

***Testing***

*This step is completed after the assembly step, which is completed repeatedly since it frequently needs to be checked after each program segment is completed [15]. The secret is to run the program on Scratch and determine whether it is correct or not. In this testing phase, a table is created to evaluate each feature implemented in the research, which is presented in the following Table 2.*

*TABLE II. GAME TESTING*

| ID | Testing activities | Test Results |
|---|---|---|
| 1 | The user clicks on "Let's play" and enters the main menu page. | Success |
| 2 | The user clicks on the "Task" page to start the game. | Success |
| 3 | The user views the question on the instructional image and selects the multiple-choice answer. | Success |
| 4 | The user selects the solution button to resolve the problem if they are stuck. | Success |

*Based on Table 2, which contains the four tests, it can be concluded that all tests were successfully implemented, covering all features, including those from the initial stage of the game [16]. This includes user initiation of the game until the user exits the game. The next testing was conducted by testing the game on teachers and students to try out the results of the development. Here, the author writes the*

*results of the testing in the form of a table consisting of satisfaction ratings from both students and teachers. The assessment criteria tested for both 5 students and teachers consist of 3 aspects: game interface, game creativity, and ease of use the game. From these three aspects, a multiple-choice rating scale ranging from 1 to 5 is created, where 1 indicates very poor while 5 indicates sufficient. The results of the game questionnaire testing can be seen below:*

*TABLE III. STUDENTS AND TEACHER SCORE RESULTS OF TESTING*

| *User satisfaction Aspect* | *Average Students Score* | *Average Teacher Score* |
|---|---|---|
| *Game Interface* | *4.7* | *4.6* |
| *Game Creativity* | *4.5* | *4.5* |
| *Ease of Use Game* | *4.8* | *4.9* |

*From the table above, it can be concluded that overall, the developed game received positive feedback from both students and teachers. Game interface and game creativity are the aspects most appreciated by both user groups, while ease of use rated quite highly. This indicates that the game has succeeded in delivering learning material in an engaging and creative manner*

***Distribution***

*In the distribution stage, the author packages the game application and stores it in a storage medium accessible to elementary school student audiences, in the form of links. Additionally, the program is made available on the Scratch website, where users can access it after registering or logging in to their accounts. This distribution strategy ensures that the educational game reaches a wide audience, including students, teachers, and parents, who can easily access and engage with the game to enhance their mathematical learning experience. Moreover, hosting the game on Scratch's platform enables it to be discovered by a broader community of users interested in educational content, thereby potentially increasing its reach and impact.*

## *4. CONCLUSION AND SUGGESTIONS*

*Based on this, it can be concluded that research findings indicate that creating a game-based mathematics learning resource on the area of a triangle can be successfully accomplished using the Scratch application during the MDLC stages. Based on the MDLC stages, it is known that the design of the mathematical game program on the topic of the area of the triangle can run well so that the resulting program can be used for learning at school and published via the internet. Because of its accessibility, Scratch is extensively having potential applications in educational settings, to program through Scratch, which have been utilized by researchers for this purpose. In addition, mathematics learning media can be in the form of teaching aids. And the results of testing this game application on students of SD Negeri SUKAMENAK Subang were successfully implemented with positive responses from the participants, including students and teachers. The evaluation conducted after the testing has had several impacts on the students, and consequently, this game will undergo further refinement in its development phase.*

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