DEVELOPMENT OF SCRATCH-BASED TEACHING MATERIALS ON TRIANGLES AND RECTANGULAR

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ABSTRACT

This study aims to find out the process of developing Scratch-based teaching on triangle and rectangural materials and find out the responses of students in their use. The teaching materials in it contain material, sample, practice questions, and quizzes. The method use is the Reseach & Development (R&D) method with the Analysis, Design, Development, Implementation & Evaluation (ADDIE) model. Data collection techniques are carried out with interviews, observations, documentation and validation sheets given to material and media experts, response questionnaires for students. The results shows the form of Scratch-based teaching products on triangle and rectangural materials that have been validated and are suitable for use and can be accessed though smartphones, tablets, computers and laptops. Based on the validation results carried out, the validation results of material experts obtained an average percentage value (%) of 88.09% with the criteria "Very Valid / Very Feasible" and media expert validation obtained and average percentage value (%) of 73.75% with the criterion "Valid / Feasible". The small group trial (limited tes) given to 10 students of class VII A SMPN 1 Bojongasih on learning using Scratch-based teaching on triangular and rectangural materials produced an average of 90.73% with a very interesting category and questionnaires given to 32 students of class VII A SMPN 1 Bojongasih in large groups obtained an average of 93.93% with very interesting categories. It can be concluded that scratch-based teaching materials on triangular and rectangural material developed are feasible and interesting to use in the learning process of students.

Keywords: Development of Teaching Materials, Scratch, Triangles and Rectangular

INTRODUCTION

Triangles and rectangurals are geometry material for SMP/MTs class VII even semester. In this material there are sub-materials that describe the types of triangles and rectangurals, the lines on triangles and rectangurals, the sizes of the angles of triangles and rectangurals, as well as the perimeter and area of triangles and rectangurals. Basically, geometry has a greater chance to be understood by students. This is in line with Sholiha & Afriansyah (in Hidayah & Fitriani, 2021) stating that geometry has great opportunities compared to other materials, where the basic concepts of geometry have been known since childhood regarding lines, planes and space.

Based on the results of the researcher's interview with the mathematics teacher at SMP Negeri 1 Bojongasih, information was obtained that students still had many difficulties in geometry, especially in the material of triangles and rectangular. Where students often make mistakes in identifying triangular and rectangular shapes, have difficulty distinguishing the types of triangles, and even still make mistakes in determining the formula, where the dominant learning process is supported by using general (conventional) teaching materials, in the form of textbooks, worksheets, and there are also make your own teaching materials by summarizing from reconstructed package books in the form of soft files.pdf into E-Modules where everything

is only oriented towards one-way learning. Besides that, the use of book packages is more dominant compared to reconstruction teaching materials, so innovation is needed in learning media.

Along with the rapid development of today's technological world which is very rapidly producing one of the new innovations in the world of education, in line with Charismiadji (in Armiati & Yanrizawati, 2020) where learning media is now developing rapidly, one of which is using e-learning based learning methods. E-learning brings a very new atmosphere as a means of development in terms of world learning, especially in terms of learning media which aims to facilitate students in learning in the Digital Age. One of the efforts that can be made in learning is designed systematically, by activating learning technology and learning media in the classroom. Because in essence, media can represent what teachers are less able to say either through certain words or sentences that can be conveyed properly and can be understood by students, there are lots of learning media that can be used, one of which can use application-based learning media, in line with according to (Saleh and Arhas, 2018) concluded that the use of electronic media can show very good results in the learning carried out, many technologies offer in making and designing a model through various applications. One of them is Scratch, where Scratch is a program developed by the Massachusetts Institute of Technology (MIT) Mesia lab, United States.

Scratch is a new easy-to-use programming language for creating animations and games. So as to provide convenience in making animation, and can be utilized in making images. The advantage of Scratch is that it is freeware which does not cost its users. Apart from that, Scratch has advantages in terms of capabilities and compatibility with various operating system platforms, such as Windows, Mac, and Linux. In line with what was stated by Padretti et al (in Akhlis, 2019) who revealed that the Scratch application is a programming language that is relatively easy and can change the mindset of students that a programming language they consider difficult and complicated becomes an easy and simple programming language that can be develop creativity, the ability to think systematically and moreover to be able to work in groups where these three are basic abilities that must be in the 21st century. In this study, the researcher wanted to try to develop mathematics teaching materials by applying technology-assisted ideas and concepts, in this case using Scratch.

According to Prastowo (2016) teaching materials are all materials (both information, tools, and text) that are systematically arranged, which display the full body of competencies that will be mastered by students and used in the learning process with the aim of designing and studying the implementation of learning (p. 17). Lots of teaching materials have been used and developed to improve the quality of education in Indonesia. Researchers want to develop new teaching materials to complement the learning approach using Scratch based teaching materials. This Scratch-based teaching material is a reconstructed teaching material that applies various multidisciplinary sciences which are put together into one unified whole. This can support the learning of mathematics in class VII SMP/MTs, one of which is on triangles and quadrilaterals. Learning using teaching materials based on the Scratch application is not only used to display triangular and rectangular material in the form of ordinary teaching materials, but can also display media that is played directly by students through two-way learning which can be done through the interaction of programming instructions on teaching materials. Scratch-based teaching material products can be uploaded via the Scratch website so that they are easily accessed by student gadgets, in line with the conclusions put forward by (Kurniawan & Rohmani, 2019) which states that in delivering material it is better to use application-based learning media that can be supported by gadgets that in the future The media can be further developed by adding features or materials that were not previously included in the learning media used before. Based on the description above, the authors conducted a study entitled "Development of Scratch-Based Teaching Materials on Triangles and Rectangulars".

METHOD

The method used in this research is included in Research and Development (R&D) to produce products. The product to be developed is in the form of mathematics teaching materials with the help of Scratch software on triangular and rectangular materials. The steps in this research refer to the ADDIE model, which is aligned according to Barnch (in Makmuri, 2021) which has five stages in developing a product namely Analysis, Design, Development, Implementation, and Evaluation (Evaluation).

The following is an explanation of the stages.

Analysis is (Analysis)

At this stage the researcher conducted an analysis from start to finish regarding information related to teaching materials obtained from interviews with
mathematics educators at SMP Negeri 1 Bojongasih. In general, the stages of the analysis carried out by the researcher are as follows:

a. Needs analyst
b. This stage is used in determining the purpose of the product to be developed, namely in the form of development media, the media here is in the form of teaching materials that are really needed by students which can later be used in learning.
c. Curriculum analysis
d. It is an analysis of the curriculum implemented in SMP Negeri 1 Bojongasih. This study made adjustments to the content of the material contained in the learning media in the form of developed learning materials.
e. Student character analysis
f. In this study it is useful to know the character of students in the use of technology in learning that is applied at SMP Negeri 1 Bojongasih d. Analysis of the school situation or environment
g. In this study it is useful to see the supporting facilities in learning which will later be implemented at SMP Negeri 1 Bojongasih
h. e. Technology analysis
i. In this study it is used to determine suitable applications as teaching materials in learning on predetermined materials.

Design (Design)

In the second stage of the ADDIE model, namely the design or display stage. The design stage here is carried out by identifying the elements needed in making teaching materials as follows:

a. Design Storyboard
b. The storyboard in this study is in the form of a step-by-step sketch made rectangular to describe the flow of the product to be developed. In making a product flow display design by considering the obtained interview data b. Collection of materials for making learning media
c. At this stage the researcher collects the materials needed to make the developed teaching materials.
d. Arrange Instruments
e. In this study, the researcher made a product research instrument in the form of a checklist questionnaire which would be given to the validator team to test the validity of the teaching materials before being tried out in the field, and the questionnaire was given to students after the product was feasible to be tested.

Development (Development)
At the development (development) stage, the researcher builds and develops the initial material from the designs that have been made. This teaching material was developed and developed using the Scratches Application. After the product developed has been designed and ready to be assessed by the validator team. Validation was carried out until in the end the teaching materials that had been developed were deemed feasible to be implemented in learning activities at SMP Negeri 1 Bojongasih.
Implementation (Implementation)
This step is the application of teaching materials through the Scratch Application on triangular and rectangular materials. Where in its
implementation it is limited to schools designated as research locations. Class teachers teach using teaching materials that have been developed. After the teaching materials developed are declared valid and suitable for use, the next step is to conduct field tests on one class, namely class VII A. To find out the students' responses to the products of the teaching materials developed, a questionnaire will be given.

Evaluation (Evaluation)
The evaluation stage is the final stage of developing teaching materials through the Initial Application on triangular and quadrilateral material which can be used as a reference for educators and students in the learning being carried out. In this stage the researcher carried out a final revision of the teaching materials which were developed based on the results of the assessment of material experts, media experts and student responses. it is intended that the development of Scratch-based teaching materials on triangular and rectangular materials is truly appropriate and can be used by a wider range of schools.

RESULTS

Analysis (Analysis)
This analysis step aims to find out the needs in the process of developing learning learning materials, where researchers carry out the following activities:
a. Needs analyst
Based on the results of a needs analysis carried out through direct interviews with mathematics educators at SMP Negeri 1 Bojongasih, information was obtained that the use of application-based teaching materials on triangles and quadrilaterals which can be accessed via a good link using smartphones, tablets and laptops has never been used in the mathematics learning process . Learners tend to have difficulty identifying triangular and quadrilateral shapes, have difficulty distinguishing the types of triangles, and are even still wrong in determining the formula, where the dominant learning process is supported by using general (conventional) teaching materials, in the form of textbooks, worksheets, and there are also make your own teaching materials by summarizing from reconstructed package books in the form of soft files.pdf into E-Modules where everything is only oriented towards one-way learning. Besides that, the use of book packages is more dominant compared to reconstruction teaching materials, so innovation is needed in learning media. Therefore the researcher decided to develop application-based teaching materials on triangular and rectangular materials that were interesting for students so that they could be more active in learning activities.
b. Curriculum analysis
In this stage, curriculum analysis is carried out. Data on curriculum analysis were obtained from recruitment referring to the 2013 curriculum. The materials used were triangles and quadrilaterals which were one of the materials for even semester VII grade students. The curriculum contains Basic Competency (KD), and Competency Achievement Indicators (GPA) for the subject matter of Triangles and Quadrilaterals.

c. Student character analysis

Middle school students who are in class VII on average have reached the age of their teens (12-13 years). At this time, students are able to use increasingly sophisticated technology. This is reinforced by the existence of smartphones owned by each student and there are even students who have their own laptops. Even though the school does not contain ICT learning in subjects, some subject teachers are already using technology such as infocus, laptops, school-owned tablets, and the internet in the learning process. Therefore, students are already familiar with the technology itself. Learning using scratch-based teaching materials is felt by researchers to be in accordance with the character of students in the use of technology, information and communication that refers to digital technology, so that students are expected to compete and not be left behind by technological advances.

d. Analysis of the school situation or environment

Based on the observations of researchers when conducting research at SMPN 1 Bojongasih, the school situation is conducive for conducting learning using smartphones, tablets available at the school, along with devices that can connect to the internet using the school's Wifi network. So that researchers in learning can use student application-based learning materials which can later be accessed by students via the shared Web link

e. Technology analysis

Scratch is a programming application that functions to create animations and games. One of the advantages of Scratch is that the programming does not use a word base but uses coding blocks of colors arranged sequentially so that this program is easy. The advantage of Scratch is that it can be accessed online using the Scratch Web and offline (by downloading the Scratch application via a computer).

Based on the results of the evaluation at the analysis stage, it shows that needs analysis, curriculum analysis, student character analysis, school environment analysis and technology analysis where Grade VII students of SMP Negeri 1 Bojongasih require renewal in the learning process. Based on the information obtained, the researcher proceeded to the design stage

Design (Design)

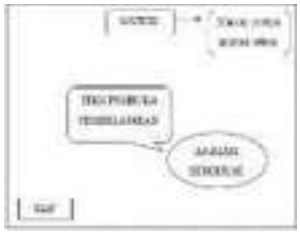
At this stage the researcher designed, designed, made the development of Scratch-based teaching materials on triangular and rectangular materials. The stages of designing teaching materials to be made are as follows: a. Design Storyboard

Storyboard is a description of every display that exists in the process of learning teaching materials by listing all the objects or elements that will be made in Scratch-based teaching materials. Displays of the developed teaching materials include initial display, display of instructions/operation steps, display of the main menu, display of competencies and indicators, display of the learning menu, display of sample questions, display of questions and profile view.

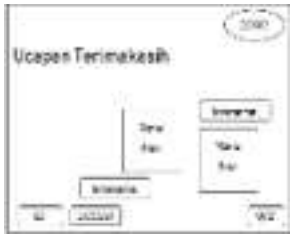
The following Storyboard is designed.

No.	Page	Visual	Audio	Explanation

1	Beginning		Background sound	This page contains the title of the teaching material being developed, the Play button and the Application Instructions button Title : Teaching materials based on Scratch on triangles and quadrilaterals Background : School Picture- This page contains the title of the teaching material being developed, the Play button and the Application Instructions button Title : Teaching materials based on Scratch on triangles and quadrilaterals Background : School Picture- This page contains the title of the teaching material being developed, the Play button and the Application Instructions button Title : Teaching materials based on Scratch on triangles and quadrilaterals Background : School Picture

2	Opener/ intro		Backsound / Background Sound. Audio sound on animation	This page contains an introduction to the teaching materials developed Title : Opening speech of learning Material button and Skip button Background : School Picture
3	Menu Utama		*Backsound* /Suara Latar Belakang . Suara audio pada tampilan materi dan pertanyaan	Halaman ini berisi Judul materi Tombol Menu Utama: Sub materi, KD, Latihan dan Quiz Logo Sekolah dan Kurikulum 2013 Tulisan *Text* menggunakan Tipe Tahoma ukuran 12 *Latar belakang* : Buku
4	Theory		Backsound / Background Sound. Audio sound on the display of material and questions	This page contains material Material Menu Button: Sub material, KD, Practice and Quiz 2013 School and Curriculum Logo Text writing uses Tahoma type size 12 questions must use the description "MANDATORY FILLED" may be continued with questions using the description "< ENTER = SKIP>" Background : Adjusting materials

5	KD (Basic Competencies)		Background sound / Background Sound	This page contains KD, Indicators and Learning Objectives Material Menu Button: Sub material, KD, Practice, Quiz, Forward and Backward 2013 School and Curriculum Logo Text writing materials use Tahoma type size 12
6	Exercise		Backsound / Background Sound. Audio sound on initial view, question and Voice. Answer audio effect	This page contains practice questions Exercise Menu Button: KD, Practice, Forward and Backward 2013 School and Curriculum Logo Text writing material using Tahoma type size 12 Background : Blackboard

7	Test		Backsound / Background Sound.	This page contains Quiz Questions Quiz Menu Button: Score, Home, Forward and Backward 2013 School and Curriculum Logo Text writing material using Tahoma type size 12 Background : Customize Slide Moving animations Description of the question "MANDATORY FILLED"
8	Maker profile		Backsound / Background Sound .	This page contains the creator's profile KD, Practice, and Quiz Menu Buttons. 2013 School and Curriculum Logo Text writing material using Tahoma type size 12 Background : Photo

b. Collection of materials for making learning media

After doing the design, the researcher collects the materials needed to make the developed teaching materials. The first step, the researcher downloaded the scratch application which is available at scratch.mit.edu. then collection of teaching materials, practice questions for class VII obtained from books and the internet, collection of interesting pictures, types of text, as well as sound and effects added to teaching materials developed in learning. The images used are in the form of background, button icons, animation and other images needed in making teaching materials. As well as sound effects and audio recordings needed in compiling teaching materials that are developed and can be downloaded directly via the internet. Furthermore, the researcher looked for books and watched video tutorials

about the Scratch application to make it easier for researchers to make teaching materials better and more interesting. After designing and collecting materials needed in making teaching materials with the scratch application, in the next stage the researcher begins the process of developing Scratch-based teaching materials on triangular and rectangular materials.

c. Arrange Instruments

In this study the instrument used was a questionnaire designed to evaluate Scratch-based teaching materials that had been made. The preparation of the instrument was carried out according to the aspects with the objectives of each questionnaire. The instruments were then given to a competent validator team consisting of material experts and media experts in order to test the validity of the teaching materials before being tested on spaciousness. Response questionnaires were given to students after the product was feasible and had been tried out. The assessment instrument for product quality that has been developed is in the form of a checklist questionnaire which is given an assessment by material experts and media experts as well as students. An assessment questionnaire given to experts to determine the quality of teaching materials that have been developed, as well as a questionnaire for students to find out students' responses to teaching materials that have been developed.

Development

At the development stage, teaching materials were developed using the ready-made Scratch application, then a validation test was carried out by experts from 2 lecturers in the Masters of Mathematics Education, namely material experts and media experts. Material expert validation test where the material that has been included in the developed teaching materials is valid but with revision, after revision the teaching material is said to be valid for use. The following are the results of validation, suggestions and comments from material experts.

Table 1 Validator's Suggestion 1 Material Expert on Teaching Materials

Initial Components	**Repair Results**
In the material, if possible, there will be an apperception/starting from the beginning of the story added	
	

Table 2 Validation Results of Scratch Teaching Materials by Material Experts

No	Aspect	Validators 1		
		Stage 1	Stage 2	Stage 3

1.	Content Eligibility	9	11	12
2.	Eligibility of Presentation	12	14	16
Amount		21	25	28
Max Score		28		
		75%	89,28%	100%
Percentage (%) average		88,09%		
Criteria		Very Valid/Very Eligible		

Data Source: processed from the results of the number sheet Percentage

= ◆◆◆

In the hint display, you have a special space when using a costume

Table 4 Validation Results of Scratch Teaching Materials by Media Experts

No	Aspect	Validators 2	
		Stage 1	Stage 2
1.	Legibility	4	7
2.	Appearance	5	6
3.	Convenience	5	7
4.	Answer Handling	7	10
5.	Documentation	4	4
Amount		25	34
Max Score		40	
		62,50%	85%
Percentage (%) average		73,75%	
Criteria		Valid/Eligible	

Data Source: processed from the results of validation assessment questionnaire sheets by scratch-based teaching material media experts on triangular and rectangular material

Percentage = ◆◆◆

triangles and quadrilaterals. The teaching materials developed refer to the product development procedures developed by Barnch (in Makmuri, 2021), namely the ADDIE model for producing teaching materials in learning. This model consists of five stages, namely Analyze, Design, Development, Implementation, and Evaluation. The process of developing teaching materials begins with an analysis to find out the state of learning in schools and what is needed in developing teaching materials which includes a needs analysis and analysis of the curriculum used in teaching materials. In the analysis stage it shows that the needs analysis and curriculum analysis in class VII at SMP Negeri 1 Bojongasih require renewal in the learning process. Furthermore, the developer designed the components contained in the Scartch-based teaching materials, namely the selection of appropriate material used in schools, menu design and features both cover and content of teaching materials. After developing according to the design made, it is implemented in the form of the Scratch web by opening it online at the address https://scratch.mit.edu/users/BahanAjarku/. Furthermore, it was assessed by material experts, media experts and mathematics educators to be tested for feasibility and then revised so as to produce Scratch-based teaching materials that were ready to be tested on students to find out the students' responses in presenting teaching materials that had been developed by researchers.

Scratch-based teaching materials on triangular and quadrilateral material can be accessed via various flat forms, both smartphones, tablets and computers, more easily accessible where Scratch-based teaching materials can include computer teaching materials (Prastowo, pp.42). Because of its ability to store and construct an object in the form of a sprite, it can be displayed again. In terms of material in Scratch-based teaching materials, it contains triangular and quadrilateral material based on basic competencies (KD), competency achievement indicators, and learning objectives. Where students are able to explain the types of triangles based on the size of the angles, the sides, find the formula for the perimeter and area of a triangle, are able to explain the meaning and look for formulas for squares, rectangles and parallelograms, trapezoids, rhombuses and kites according to their nature , as well as being able to solve contextual problems related to associating perimeter and area formulas for various types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezium and kite) and triangles. In the material content there are several menu columns that can be accessed by students and in each material there is an input column for students where there is an instruction if there is an information <Enter = Skip> means you can skip if you don't want to answer, but if there is no information like before then must be required. If the answer is correct, a trumpet sound will appear or a "yes, that's right" sound will appear, but if the answer entered is not correct, a fail trumpet sound will appear or a "less precise, more careful" sound will appear. This system combines coding blocks - color blocks from looks, events, sound and sensing (message). As in the practice menu with additional background, it is made using background from the internet web in SVG format plus writing from the edit menu on background Scratch and in the question quiz there are additional sensing, operator and variable effects so that the score icon appears. If the answer is correct, the score will increase and a correct sound effect appears, if not correct, the score will remain and a wrong sound effect will appear.

The validity of the teaching materials that have been developed by researchers based on validation activities obtains the percentage of material experts with an average percentage value of 89.28% with the criteria of "Very Valid/Very Eligible" and the validation of media experts in the feasibility test obtains an average percentage value (%) - an average of 85% with the criteria "Very Valid/Very Eligible". The data obtained from researchers

are in the form of quantitative data and qualitative data, quantitative data comes from questionnaire scores submitted by researchers to validator experts and qualitative data comes from suggestions and input from validators for improvement in the development of Scratch-based teaching materials. So it can be concluded that teaching materials based on Scratch on triangles and quadrilaterals are very suitable for use in learning.

In the results of trials to find out the attractiveness of the teaching materials that have been developed, two stages were carried out, namely small group tests (limited tests) and field tests. The results of the small group (limited test) got an average of 90.73% with the indicators of material, interest and language getting the criteria of "very interesting" and field trials getting an average of 93.93% with the criteria of "very interesting". So it can be concluded that Scartch-based teaching materials on triangles and quadrilaterals are very interesting to use in learning. This is in accordance with the research results of Izzaturahma, E., Mahadewi, L.P.P., Simamora, A.H. (2021) which explains that the development of animated video media which refers to the ADDIE development model is effective and able to assist the learning process of students and teachers.

From the results of the study, it can be concluded that the product developed by the researcher, namely Scratch-based teaching materials on triangle and quadrilateral material in class VII SMP, is included in the Valid category. 89.28% with the criteria of "Very Valid/Very Eligible" and media experts in the due diligence test obtained an average percentage (%) value of 85% with the criteria of "Very Valid/Very Eligible". Thus, the validity of teaching materials based on Scratch was tested, and small group tests (limited tests) and field tests. The results of the small group (limited test) get an average of 90.73% with the indicators of material, interest and language getting the criteria of "very interesting" and field trials getting an average of 93.93% with the criteria of "very interesting" so suitable for use in learning mathematics. This learning teaching material can also be developed further by using different materials or with different learning methods.The ADDIE model is a cycle, so the result of the evaluation phase can improve the depth of the analysis phase in the future.(Yu, S.J., Hsueh, Y.L., Sun, J.C.Y., and Liu H.Z., 2021).

CONCLUSION

Based on the results of research and discussion, it can be concluded as follows: (1) The process of developing Scratch-based teaching materials on triangular and rectangular material using the ADDIE development model which includes five stages, namely: Analysis, Design, Development, Implementation, and Evaluation. . The resulting product is a Scratch-based teaching material with the Scratch web address https://scratch.mit.edu/users/BahanAjarku/. These teaching materials are supported by updates which can be accessed using smartphones/tablets/computers/laptops. Materials, animations, practice questions, and quizzes are also available according to the indicators in the learning plan. The product developed by the researcher contains triangular and quadrilateral material. The feasibility of Scratch-based teaching materials on triangular and rectangular material where the assessment scores from material experts in the feasibility test obtained an average percentage value (%) of 88.09% with the criteria of "Very Valid/Very Eligible", and media expert assessment scores in the test eligibility to obtain an average percentage value (%) of 73.75% with the criteria of "Valid/Decent". From the results of product validation, the authors can conclude that Scratch-based teaching materials on triangles and quadrilaterals are very suitable for use as teaching materials in learning.

(2) In the small group tryout (limited test) it obtained an attractiveness percentage score of 90.73% with very attractive criteria. Field trials obtained a percentage score of 93.93% with very attractive criteria. From the results of product trials, the authors can conclude that Scratch-

based teaching materials on triangles and quadrilaterals are very interesting and suitable for use as teaching materials

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