Developing Mathrun with construct 2 on the solid geometry with flat faces for junior high school

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Abstract. This study aims to: 1) produce Mathrun with Construct 2 on the Solid Geometry with Flat Faces for Junior High School which is valid, practical, and effective. The subjects of this study were 8th grade students of MTs Madani Alauddin Pao-Pao, Gowa in the 2019/2020 school year. This study used a development model proposed by Borg and Gall with 10 stages, namely: 1) problem analysis; 2) Media Design; 3) Product improvement; 4) Individual Test; 5) Validation; 6) Small Group Test; 7) Repair; 8) Field Test; 9) Repair; 10) Dissemination and Reports. However, due to limited time, funds and personnel, this research was limited to the 9th stage. The data collection instruments used questionnaires, responses and test questions. The validation was carried out by education experts, teachers and students. Based on the results of the validation of the feasibility average score for the development of learning media using the Construct 2 software by educational experts, it was obtained 3.40. The practical aspect based on the teacher's assessment of mathematics was 3.45 which is good criteria. The score of practicality based on the students' attractiveness was 3.449 which is very good criteria. Meanwhile, the average learning outcome test is complete. Therefore, it can be concluded that the learning media developed have met the criteria of validity, practicality, and effectiveness.

1. Introduction

Mathematics is common for everyone, especially for school children. Mathematics as one of learning subjects must be taught at all levels of education, starting from elementary schools, secondary schools, and vocational schools. Most of students said that mathematics is an uninteresting, boring and very difficult subject. A few of them dislike this subject. Apart from this, the interest level of students in a subject is influenced by several factors. According to [1], the factors that cause many students to be less interested in learning mathematics are cultural factors, educational system factors, parental factors, and teacher factors or educators.

The Solid geometry with flat faces is one of mathematics lessons that requires supporting learning methods and media. However, current learning methods and media make teachers experience a little difficulty, namely teachers experience difficulty in demonstrating geometric concepts due to inadequate media, so that students cannot understand the concept of geometry flat side as well. This also supported by several studies, one of those is [2] study, which stated that the concept of geometry flat side definition is still difficult to understand. [3] also argued that there are still many mistakes made by students in solving geometry flat side material problems that were tested in the class 8B. the biggest mistake was the misunderstanding of the concept which was 48.87%. [4] revealed that students do not repeat the material they have learned in school, resulting a lack of strengthening the basic concepts of the geometry flat side material.
The results of observations made by researchers at MTs Madani Alauddin Pao-Pao showed that the value of student learning outcomes in the geometry flat side material was still below the standards that had to be met. Based on interviews that have been conducted with mathematics teachers at school, this is caused by students who do not repeat the material that has been given by the teacher so that the lack of concept reinforcement. To solve these problems, we need a learning media that can be used by students at school or at home as a media to strengthen the concepts that are designed in a didactic manner. [5] stated that the media affects the results of knowledge and learning achievement because the complexity will be simplified through a learning media.

According to [5], learning media are all physical equipment that can provide information and create interactions that are designed in a planned manner. Olson in [6] stated that the media meet to convey knowledge, but they differ with the skills they assume and develop. [7] stated that the media affect the results of knowledge and learning achievement of students in various recent studies. The media that is presented or used in the teaching and learning process is designed based on the needs of the field or the students [8].

Along with globalization era which is marked by the rapid use of products and the use of information technology, the concept of learning has shifted to an effort to create a modern learning. [9], [10] defined learning as a form of effort so that students can learn. Learning is a complex process that occurs to everyone and it is forever, started when they were a baby and died [11]. [12] classified learning media into 5 categories, namely a) print / text media, b) graphic media and exhibition / display, c) audio media. Meanwhile, according to [13], There are 5 types of multimedia learning, namely text, lectures, pictures (graphics, photos and videos), sound (recordings) and computers. Learning media facilitate students to learn wherever and whenever so that the frequency of student learning can be higher graduate to high student retention [14]. The media needed can be used not only in class, but it can be used anywhere and anytime. This happens along with the development of the world of technology so that it requires learning media that is practical and efficient enough to be used, such as smartphones and gadgets to find information. smartphones or gadgets are efficient and practical, because they are easy to carry everywhere [15]. [16] stated that online and mobile learning applications are able to motivate students so that learning mathematics is more interactive and fun than ordinary teaching practices.

These days when most of the people talk about technology, what they think of are things like computers, MP3 players, and shuttles [17]. Smartphone is a small device that combines conventional cellphone which uses with pocket PC. They offer internet connectivity and various functions which are in the elaboration of documents and multimedia for the realization of web 2.0 activities. Smartphone can be used in a broad mobile learning experience, from game-based learning activities to distributing an electronic learning content [18]. [19] stated that the use of mobile devices for educational purposes has received considerable attention by researchers in improving the discipline of learning technology. The results of this study revealed that smartphones are currently the most widely used device for Mobile Learning. Smartphones include android and iOS systems. [20] revealed that the meaning of learning with a smartphone uses a phenomenological design. This study stated that participants in their study saw smartphones as a device to help their education, career and make contact with their friends. [21] revealed that the development of mathematics learning media by making mobile devices can expand the frontier of mathematics instruction and learning outside the classroom.

Based on the research conducted by [22], it was found that the application of science with a smartphone vision conversion is appropriate for learning concepts. [23] in his research which developed mobile applications for mathematics education in elementary schools, stated that this application is capable of being a learning application for elementary school children, besides, the successful of this application in class is more than just playing. In addition, [24] in the research, developing a learning media explained that based on the validation and testing of the results of the product, it was appropriate to use. [25] in the research result stated that teaching realistic mathematics using software, namely tablets, results better learning. Furthermore, [26] stated that the pocket book in
the form of e-learning is a practical and easy learning media to learn anywhere and anytime [26]. Based on the description above, the researcher is interested in developing Mathrun with Construct 2 on the Solid Geometry with Flat Faces for junior high school students which is valid, practical, and effective.

2. Methods

The research method used in this research was (Research & Development) which was proposed by Borg & Gall in 1989. According to them, a research and development approach is research oriented to develop and validate the products used in a research. Meanwhile, according to [27] to produce certain products, it was used research needs analysis and to test the effectiveness of the product, so that it can function in the community. So research and development is longitudinal (gradually can be multi years). The research development model used was the result of the Borg and Gall development design model in [27] with 10 stages which then modified the model only up to the 9th stage, namely:

2.1. Preliminary study

The preliminary study is the initial stage of this development research. The preliminary study includes collecting various information such as making classroom observations about the ongoing learning process which is the place of research and reviewing several journals relevant to this research.

2.2. Planning

After conducting a preliminary study, the next step is development planning in the form of an Android-based application that will be developed through the Construct 2 software. Product design includes, choosing a learning model to be used in the application, making flowcharts and developing applications using Construct 2.

2.3. Validation

The product that has been developed will then be validated by several experts so that it determines the suitable product. The validators are educational experts and teachers.

2.4. Small scale use test

After validating the product, the next step is to test the use of the product on a small scale, meaning that the test only consist of 2-3 students. Furthermore, it assesses the advantages and disadvantages of the product that has been developed.

2.5. Revision

After conducting small-scale test, by knowing the advantages and disadvantages of the product being developed, the next step is to revise the product by fixing the deficiencies of the product to be better.
2.6. Large scale use test
Furthermore, the large-scale test was that the test were participated by 8A grade students of MTs Madani Alauddin Pao-Pao, Gowa for the 2019/2020 Academic Year.

2.7. Revision and final stage
After the test, if there are still deficiencies, it will be revised again until the product is suitable to use. After the product is suitable to use, namely fulfilling the criteria of validity, practicality, efficiency and effectiveness, the product reaches the final stage, namely the product is suitable to be used as a learning media for geometry flat side materials of junior high school students.

2.8. Product test
In this study, the test design consisted of 3 stages, namely expert validation, small-scale use test and large-scale use test. The subjects of this study were 8A students of MTs Madani Pao-Pao, Gowa for the 2019/2020 academic year. In this study, the type of data used was qualitative data and quantitative data. Qualitative data was the responses of education experts as validators and teachers in the field of study about the quality of the product developed which consists of aspects of suitability (valid, practical, and effective). Meanwhile, quantitative data was the validator response scores for the products developed and student learning outcomes scores using the developed media products. The instrument in this study consisted of validation sheets, teacher assessment sheets, student assessment sheets, and learning implementation observation sheets, as well as learning outcomes tests.

3. Results and discussion
The product produced in this study is a learning media in the form of an android application developed with Construct 2 software named MathRun. Construct 2 is a software developed by Scirra based on HTML5 specifically for 2D software platforms. The language used in Construct 2 is not a programming language, but the program is arranged in the EventSheet, namely Events and Actions. By using the Construct 2 software, you do not need to use a programming language, just visual drag and drop. Although construct 2 is game-based software, we can also add other tools, such as adding material to the program. The research design used was Research & Development with 10 stages which were later modified to only reach 7 stages due to limited time, energy and funds, the stages are as follows:

3.1. Preliminary study
The preliminary study is the initial stage of this research, which begins with class VIII observations of MTs Madani Pao-Pao, the researcher found that the value of student learning outcomes on the material of geometry flat-sided is still below the average. After conducting interviews with the teacher, this was caused by the lack of supporting media as a means of strengthening the basic concepts of geometry flat-sided materials by students which could be accessed not only at school but anywhere. So that we need a development of innovative learning media that can increase the enthusiasm and motivation of students in repeating the material of geometry flat side, that they have learned at school, at home.

3.2. Planning
The planning stage is the initial stage in developing a product after finding problems in a preliminary study. This stage includes the flowchart design of module development and learning media development, namely an android-based application developed in the Construct 2 software. The flowchart is intended to determine easily the components needed in the application. The following is the Flowchart in the MathRun application on Figure 2.

Based on Figure 2, it can be specified that when the user opens the application, the main menu will be displayed. The main menu has 2 options, namely, start and material. To start means to begin playing the game. The material will present a summary of the material related to geometry flat-sided as a reinforcement of the basic concept of geometry flat-sided along with examples of questions. Then the start menu will display the select level, namely the level selection. The selection of this level is divided based on the distribution of the geometry flat-sided material, namely cube, block, prism, and
Pyramid. Finally, play, which means that the user will play a game, to complete the game the user must answer the questions. Level 1 question is cube question, level 2 is block and level 3 is pyramid and prism. After planning the existing flowchart, it can be seen that several components need to be prepared, namely a summary of the material or modules and questions. The material summary is made based on the applicable curriculum at MTs Madani Pao-Pao, while the sample questions are also adjusted to the indicators that will be achieved by students. After the components are met, the development of learning media based on construct 2 is carried out. Construct 2 is a simple game maker software that can be used.

![Flowchart of learning media for Android-based geometry flat-side](image)

**Figure 2.** Flowchart of learning media for Android-based geometry flat-side

3.3. Validation

After the product is developed, validation or assessment of the development design is carried out by education experts and field teachers. Each validator provides the assessment of the product being developed. The results of the assessment are that the product is declared valid, practical and effective to be used after being revised. The results of the validation can be seen in the following table:

| Average Score | Criteria  | Note   |
|---------------|-----------|--------|
| 3.40          | Suitable  | Revision |
| 3.45          | Suitable  | Revision |

Table 1. Validation results by two education experts

Based on the table above, it is obtained the average score of the validation results by educational experts. The score is the validation of education experts 3.40 for the first education experts who are declared suitable and 3.45 for the second education experts who are also declared suitable based on the results of their assessment.

3.4. Revision

Suggestion and advice from educational experts plays a very important role in product suitability. Guided by the input and suggestions obtained from the expert the validation of the resulting product is suitable, it can be continued to the next stage.

3.5. Small scale use

This stage is carried out to determine the response of students and teachers to the products developed as well as the quality of the products can be assessed.
Table 2. Results of the practicality assessment by field teachers

| Average Score | Criteria | Note  |
|---------------|----------|-------|
| 3.45          | Good     | Revision |

Based on the evaluation by the teacher, 3.45 was also declared good. So that product development can proceed to the next stage. Small-scale use test is carried out to represent the target population of 5 class VIII respondents. The results of the research product test on a small scale are in table 3 below:

Table 3. Results of the practicality assessment by students

| Respondent | Score | Suitability Score | Criteria |
|------------|-------|-------------------|----------|
| 1          | 44    | 3.38              | Practical |
| 2          | 47    | 3.61              | Practical |
| 3          | 43    | 3.30              | Practical |
| 4          | 43    | 3.30              | Practical |
| 5          | 44    | 3.38              | Practical |
| Sum        | 221   | 16.97             | 3.39     |

In this limited test, the subjects selected were 5 students with two meetings. Based on the table for the description of very interesting. From data testing, it was obtained an average score of 3.39 with very interesting criteria. This means that the response of students to the attractiveness of research and development products in the form of learning media and android applications by the Construct 2 software is very interesting and based on the practicality criteria this learning media is classified as practical.

3.6. Revision
When the limited test process took place, there were several deficiencies that were considered to risk the learning process and lead to mistakes for students when using the media. Some of these deficiencies are the existence of tools that do not work and questions that are not precise in the narrative. Furthermore, the two deficiencies found in the limited test were then revised for later use in the large-scale use test.

3.7. Large scale use test
After the product is declared suitable, namely, it meets the criteria of validity and practicality, the product developed can be retried on a large scale. Large-scale test is conducted on research subjects, namely students of class 8A MTs Madani Pao-Pao, totaling 30 students. The results of the research product test on large-scale use can be seen in the following table:

Table 4. The results of practicality assessment by the teachers

| Average Score | Criteria | Note  |
|---------------|----------|-------|
| 3.50          | Good     | Practical |

Based on the assessment by the teacher, 3.50 is also stated to be practical. So that product development can proceed to the next stage.

Based on the table for note about Very Interesting and THB (test learning outcomes). From the results of the score, it is obtained the average score for the large-scale use test is 3.449 with very interesting criteria. This means that students respond very interestingly to research and development products in the form of learning media and Android applications by Construct 2 software. Furthermore, in the large-scale use test, in addition to measuring practicality and validity, it also measures the effectiveness of the learning media developed using student mathematics learning outcomes tests, especially on the geometry flat-side materials. From 30 students, there were 27
students who scored above the Minimum Mastery Criteria with an average score of 83, 93. Based on the average obtained, it shows that the learning media developed is effectively used as a learning media in the classroom. The results of this study are in line with the opinion of [28] which states that learning media is effective in the learning process because students become more active and more interested in learning. [29] said that while using learning media, teacher activities were in the good category, student activity was in the active category, and students gave a positive response after using learning media. [30] said that learning media developed to support students' reasoning abilities were effectively used in three-dimensional learning.

Table 5. Results of the practicality assessment by students and student learning outcomes tests

| Student | Score | Suitability | Criteria | THB Score | Completeness |
|---------|-------|-------------|----------|-----------|--------------|
| 1       | 45    | 3.46        | SM       | 80        | Complete     |
| 2       | 43    | 3.3         | SM       | 70        | Not complete |
| 3       | 44    | 3.38        | SM       | 90        | Complete     |
| 4       | 48    | 3.45        | SM       | 90        | Complete     |
| 5       | 40    | 3.07        | M        | 85        | Complete     |
| 6       | 44    | 3.38        | SM       | 82        | Complete     |
| 7       | 46    | 3.53        | SM       | 83        | Complete     |
| 8       | 47    | 3.61        | SM       | 80        | Complete     |
| 9       | 48    | 3.69        | SM       | 85        | Complete     |
| 10      | 45    | 3.46        | SM       | 86        | Complete     |
| 11      | 43    | 3.3         | SM       | 85        | Complete     |
| 12      | 44    | 3.38        | SM       | 80        | Complete     |
| 13      | 47    | 3.61        | SM       | 85        | Complete     |
| 14      | 45    | 3.46        | SM       | 85        | Complete     |
| 15      | 48    | 3.69        | SM       | 95        | Complete     |
| 16      | 44    | 3.38        | SM       | 85        | Complete     |
| 17      | 45    | 3.46        | SM       | 88        | Complete     |
| 18      | 43    | 3.3         | SM       | 88        | Complete     |
| 19      | 44    | 3.38        | SM       | 88        | Complete     |
| 20      | 48    | 3.69        | SM       | 95        | Complete     |
| 21      | 40    | 3.07        | M        | 95        | Complete     |
| 22      | 44    | 3.38        | SM       | 83        | Complete     |
| 23      | 46    | 3.53        | SM       | 80        | Complete     |
| 24      | 47    | 3.61        | SM       | 87        | Complete     |
| 25      | 48    | 3.69        | SM       | 81        | Complete     |
| 26      | 45    | 3.46        | SM       | 70        | Not complete |
| 27      | 43    | 3.3         | SM       | 79        | Complete     |
| 28      | 44    | 3.38        | SM       | 90        | Complete     |
| 29      | 47    | 3.61        | SM       | 78        | Complete     |
| 30      | 45    | 3.46        | SM       | 70        | Not complete |

Sum 1350 103.47 \(\bar{x} = 3.449\) \(\bar{x} = 83.93\) Complete
3.8. Revision and Final Stage

Based on the results of the product test, if it meets the suitability criteria, namely the validity, practicality and effectiveness of the product, the product has been developed to produce the final product. If the product does not meet the suitable criteria, then the test results are used as material for product improvements and revision to produce a more perfect final product. The final product produced in this development can be seen as follows:

![Figure 3. Main menu page display](image)

Figure 3. Main menu page display

Figure 3 is the main menu display when opening the MathRun application. The main menu consists of start (start playing run games) and materials. So, before starting to play the run game, students can access the material to build a geometry flat side to learn. The background of the main display depicts a person going through various obstacles such as jumping from one island to the next or jumping to reach the island above. In this main menu, you can see that there are still many texts that can be developed for future research so that the application developed is even more perfect. Such as applications that can connect to Facebook and Google. Of course, it requires more time, effort and funds.

![Figure 4. Material summary page view](image)

Figure 4. Material summary page view

Figure 4 is a summary display of the material. From the main menu page, when students click on the material menu, what will be seen is a summary of the geometry flat side material consisting of cubes, blocks, pyramids and prisms. The learning objective in this material is to determine the volume and surface area of the geometry flat side. In this material summary, students can use it to repeat the material at home. The material summary is explained in a simple manner so that it is easy to understand as well as examples. After visiting the material summary view, the next is returns to the main menu.

![Figure 5. Select level display](image)

Figure 5. Select level display
When on the main menu page, clicking play, the application will display a select level menu or select a game level. The game level consists of 3 levels. The level is determined based on the material of geometry flat side. Level 1 will display questions for cubes, level 2 will display questions for blocks, and level 3 will display questions for pyramid shapes and prisms. The question will be displayed on the sidelines of the game run.

![Figure 6. Level 1 display](image)

Then on the select level page, then clicking level 1 then the next screen is playing a game. It is seen someone with a cowboy hat like a detective is a student who will play in this game. The way to use this game is that students have to jump from one island to the next to get coins, keys, and hearts. Coins as the score, the key to open the door for this level at the end of the game, and the heart as life. How to get the key, students must answer the questions by jumping towards the box marked with exclamation. When students jump to open the box, it displays the questions that must be answered. When students pass the island and get the key then the students are at the final door. The key will open the door to the next level. Likewise, at level 2 and level 3.

![Figure 7. The page display for level 1 questions.](image)

Figure 7 is the display when the questions appear at level 1. The answer consists of 4 options. Students must choose 1 option.

4. Conclusion

The development of learning media for mathematics using the Construct 2 software obtained 1) The product of learning media in the form of an android application of Construct 2 software, namely, MathRun. 2) Based on the results of the validation of the feasibility average score for the development of learning media using the Construct 2 software by educational experts, it was obtained 3.40. The practical aspect based on the teacher's assessment of mathematics was 3.45 which is good criteria. The score of practicality based on the students' attractiveness was 3.449 which is very good criteria. Meanwhile, the average learning outcome test is complete. Therefore, it can be concluded that the learning media developed have met the criteria of validity, practicality, and effectiveness.
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