e-ISSN : 2722-4368

Development of Flat Shape Learning Media to Improve Children's Mathematical Understanding Using Macromedia Flash

Tonni Limbong[1)], Zekson Arizona Matondang[2)]
[1,2] Sistem Informasi, Fakultas Ilmu Komputer, Universitas Katolik Santo Thomas
Email : [1)]tonni.budidarma@gmail.com*, [2)]zekson.arizona@yahoo.com

Abstract
Problems in learning that do not use media in the teaching and learning process and the low ability of children's mathematical understanding in learning flat shape material because there are not many media used for learning. This study aims to obtain the benefits of learning media for flat shapes using Macromedia Flash. This research method uses a research and development model. The development model used is MDLC (Multimedia Development Life Cycle), namely concept, design, material collecting, assembly, testing and distribution. In the field trial, the average pretest score was 68.24 while the posttest average score was 86.76. The average increase is 18.52. The minimum gain value is 0.62 while the maximum gain value is 1.00. In the distribution test the average pretest score is 60.33 while the posttest average score is 81.33. The average increase is 21. The minimum gain value is 0.77 while the maximum gain value is 0.83. Based on these data, the flat shape learning media using macromedia flash software can help improve students' understanding significantly in recognizing flat shapes.

Keywords: Learning Media, Flat Shape, Macromedia Flash, Children's Understanding Ability

INTRODUCTION

The learning process is a complex learning process or activity that occurs in everyone in his life, the learning process will occur because there is interaction and communication between a person and other people or with their environment [1], [2]. In other words, learning can take place anywhere and anytime. One of the signs to know someone has learned is by a change in the level of understanding/knowledge, skill level and attitude.

A flat shape is a two-dimensional shape that only has length and width that is limited by straight or curved lines. Another meaning is that a flat shape is a form of illustration of real things so that the explanation cannot be separated from symbols or symbols. The symbols found in flat shapes have many meanings and significances. The symbol is written or described in a simple way but has a broad meaning [3], the reality in the field is that there are many children who find it difficult to understand the concept of a flat shape. Therefore, efforts are needed to develop appropriate learning media by instilling the concept of understanding geometric shapes so that these problems can be solved. Through learning media and appropriate and effective learning methods, understanding geometric concepts will be more easily conveyed to students and students will more easily understand the concept of flat shapes [4]. can provide hands-on experience to students. In learning something students need real objects or also called reality. Therefore, the teacher in explaining the flat material needs to be assisted with realia media to be able to concrete the flat shape [5]. There is a link or relationship between understanding the concept of a flat shape and three-dimensional learning outcomes that are unidirectional (positive) or, if the level of student understanding for the concept of a high-level figure definitely results in high learning outcomes for understanding three-dimensional dimensions, and vice versa [6].

In reality, in the field, mathematics teaching and learning activities, especially flat shapes, which are currently being carried out have not met the expectations of the teachers as the development of learning strategies in the classroom, where students are still having difficulties in learning mathematics, especially in solving problems related to understanding flat shapes. Thus, understanding ability is the most important factor for the cognitive development of each student and greatly influences students' motivation to learn mathematics [7]. It can be proven by measuring the

mathematical understanding ability of each student, for example by explaining that the area of a square is 48 cm^2. What is the length and width of the square in cm? In solving this problem, students are expected to find the length of the salash of one side of the rectangle, but most students cannot solve the problem because students in solving the problem only enter the value in the problem into the formula for the area of a square.

Interactive learning media with macromedia flash can be seen from the presentation of the results of the validation conducted by three lecturers at the Catholic University of Santo Thomas, where there are validators who act as media and material experts. The average value obtained from media experts is 98.75% with the criteria of "Very Appropriate to use", and the value obtained by material experts is 94.16% with the criteria of "Very Appropriate to use" [8], [9].

Mathematics learning designed using macromedia flash software with validation results from material experts an average of 3.73, while in the linguistic aspect an average value of 3.64, also the feasibility aspect of the evaluation obtained an average result of 3.66, and by media experts obtained an average of 3.87, from the aspect of the function of the learning media buttons with an average value of 3.5 and the aspect of Graphic display obtained an average value of 3.4. The product of the validation results obtained was good, namely in the appropriate criteria, (2) the attractiveness of the mathematics learning media using macromedia flash software. The response of the students obtained an average score of 3.61 with the criteria of "very interesting" [10]. Mathematics learning media developed with macromedia flash really helps teachers in the process of transforming material for students to understand the subject matter presented so that students' creativity in learning increases [11].

In particular, the objectives of learning Mathematics at the elementary school level are [12]: a) understanding mathematical concepts, the ability to explain the interrelationships between concepts, and the application of concepts or algorithms, b) through reasoning on patterns and properties, is expected to be able to manipulate mathematics in general , perform proofs, or explain mathematical ideas and statements, c) solve problems which include the ability to understand problems, design mathematical models, complete mathematical models, and interpret the best solutions obtained, d) communicate ideas through symbols, tables, diagrams, or other media to explain a situation or problem, e) have an attitude by applying mathematics in everyday life. Teachers are also expected to be able to use or create a learning media that suits the needs of students to improve mathematical understanding skills in mathematics subjects. One of them is the development of learning media through macromedia flash software. Macromedia flash is an effective application for presenting material visually and animatedly so that it becomes one of the supporters of an effective, efficient, and also fun way of learning. With the difficulty of students understanding the concept of flat shapes and in general to address the problems that occur in the learning process to improve students' mathematical understanding abilities, it is increasing so that student learning outcomes are also getting better.

RESEARCH METHODS

The development model for this learning media uses the Multimedia Development Life Cycle (MDLC) model.

This study has the aim of developing learning media that are more attractive and efficient than previous learning media using Macromedia Flash with 6 stages, namely concept, design, collecting material, assembly, testing and distribution [13], [14]

e-ISSN : 2722-4368

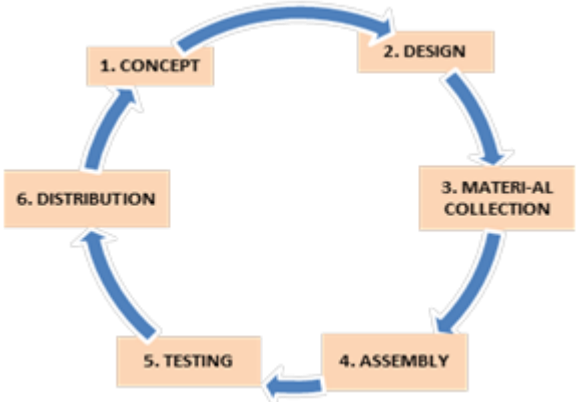

Figure 1. Stages of MDLC model development

The explanation of the image is as follows:

1. Concept

The concept stage is in terms of determining the goals and who will be the program users (identification audience), the form of the application, the purpose of making the application, and general application specifications. The basic rules used for the design are also determined at this stage, for example the size of the application, the target application, and others as needed.

The purpose of this definition stage is to define and define everything that is needed in an instructional concept. There are 5 things to do in this stage, namely:

a. Initial and final analysis
   Research and find out about what are the basic problems faced by teachers regarding teacher performance. During this research, better and more efficient problem solving alternatives will be found through all considerations.
b. Student analysis
   Identify the character of the students who will take part in the lesson. The characters in question are student competence and background of student learning experience, general behavior of students towards learning topics, selection of learning media, format and language to be used.
c. Task analysis
   Identify the main skills students need in learning and break them down into more specific skills.
d. Concept analysis
   Identify the main concepts that must be taught by the teacher, rearrange the concepts into a hierarchy and detail the nature or characteristics of each concept. This analysis will help identify a set of thoughts on examples that could be brought into development.
e. Set learning objectives
   Converting the results of the analysis of all tasks and analysis of all concepts into a goal in the form of expected behavior. This set of objectives will be used as the basis for the preparation of the test, the design and further integration of these objectives into the subject matter.

2. Design

Design is compiling details regarding the architecture of the application to be built, the style, form of the display and what material/material needs are for making learning applications. The specifications made must be very detailed so that at the next stage, namely collecting and assembly materials, new decisions are no longer needed, but use what has been determined at the design stage. Even so, there are still frequent additions of materials or parts of learning applications, sometimes they are omitted or changed at the beginning of project work.

The purpose of this design is the initial design of the learning material interface. This stage can be carried out if the objectives of the subject matter have been properly defined in the previous stage. There are four steps at this stage, namely:

a. Constructing criterion test (setting test reference criteria)

e-ISSN : 2722-4368

This step is a bridge that connects stages I and II. The developed criteria convert the objectives into a framework of learning materials.

b. Media selection (media selection)
Selection of appropriate media to present the material / content of learning. This process includes teaching resources, dissemination plans and the properties of learning media.

c. Format selection (format selection)
This step is related to the previous media selection. The learning format refers to the media communication used, teaching strategies and media use techniques. The choice of this format depends on the visual, audiovisual, non-verbal format and so on.

d. Initial design
Presenting the basics of learning through the right media and in the right order. This step also includes the preparation of various teaching and learning activities such as reading reference books, interviewing certain students and teachers and applying different skills by paying attention to each student and teacher.

3. Material collecting

Material collecting is the stage for collecting materials needed in the development of learning media, such as flat figures, photos, animations, videos, formulas, descriptions of flat shapes, audio, and others obtained from the mathematics teacher and made according to the design themselves. This stage can be done simultaneously with the assembly stage.

4. Assembly

The assembly stage is the stage of making all multimedia objects or materials. Making objects and applications based on storyboards, flow charts, and navigation structures according to the design stage. The purpose of this stage is to modify the content of the existing learning materials in the initial draft. The results of the design phase must be considered as the initial basis so that in the end an effective result is obtained, namely a technique for obtaining suggestions for improving the material. A number of experts or experts are also involved to evaluate and provide advice on the material from the point of view of learning and material delivery techniques. Based on expert feedback, this initial draft has been modified.

5. Testing

After the application has been designed, the next step is to test and measure the ability and performance of the learning media, whether it is as expected. Here we recompile (recompile) whether all text, links, buttons, and other features can function properly. In this step, the material is used in mock conditions that demonstrate who is learning, what is being learned, under what conditions and how much time is used. At this stage the material must also be examined by a professional person to obtain an objective opinion on its adequacy and relevance. Implementation of material testing on students to determine the parts that require revision. Based on student responses and student comments, the material can be modified. The cycle of testing and revising is carried out in order to obtain material that is consistent and effective.

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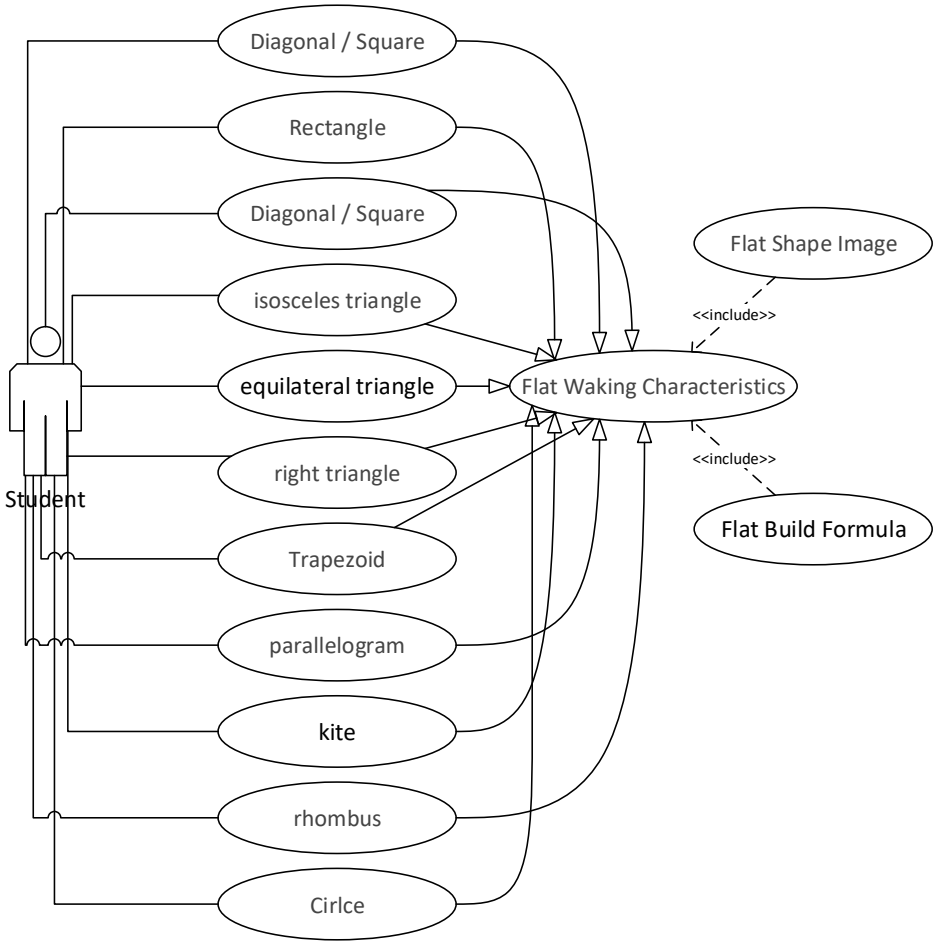

Figure 2. Usecase of Learning Media Testing

RESULT AND DISCUSSION

At this stage the application will be stored in a storage media, this stage can also be called the evaluation stage for the development of finished products to make it better. The results of this evaluation can be used as input for the next product concept stage. The final draft of the learning material will be obtained if the media development test phase shows consistent results from experts who give positive comments. Producers and distributors are selected and must cooperate cooperatively in packing all materials into acceptable forms. Special efforts are needed to disseminate the material widely to teachers and students through learning media and must be generally accepted.

Figure 3. Main Page of Learning Media

e-ISSN : 2722-4368

Figure 4. Learning Material Menu Page

Figure 5. Learning Materials Page

1. Data Collection Instruments

The instrument for data collection used is a questionnaire sheet containing an assessment sheet or suggestions for products or learning media that will be used to improve the media that will be produced in the research process.

The questionnaire sheet consists of:

1. Questionnaire sheets are prepared for material experts, namely to get an assessment of the quality of learning materials and a review from the point of view of developing aspects of the learning delivery system
2. Questionnaire sheets are prepared for learning instructional design experts, namely an assessment of the quality and quality of the learning design and the technicalities of the application of the designed instructional media.
3. Questionnaire sheets are prepared for media experts, namely the quality and quality of software engineering that has been developed, especially regarding learning media
4. Questionnaire sheets are prepared for students, namely to get responses to the use of learning media and the benefits of learning media that have been developed
5. Questionnaire sheets are arranged to get responses from students, namely about responses to learning media that show a sense of interest or not to learning media.
6. Questionnaire sheets are prepared to obtain teacher perceptions, namely teacher responses to the use and benefits of learning media that have been developed

2. Test Instrument Test

1. Test Validity

To measure the test, Pearson's Product Moment correlation was used to correlate the scores obtained by students on an item with the total score [15]. The formula used is:

e-ISSN : 2722-4368

$$r_{xy} = \frac{N\sum xy - (\sum x)(\sum y)}{\sqrt{(N\sum x^2 - \sum x)^2 (N\sum y^2 - \sum y)^2}} \quad \text{..... [1]}$$

with :

r_{xy} = Correlation coefficient x and y
N = Number of respondents / number of students taking the test
x =Total score obtained by students for each question item
y = Total correct score

To determine the significance of the correlation obtained, tested by the formula t:

$$t = r_{xy}\sqrt{\frac{N-2}{1-(r_{xy})^2}} \quad \text{.....[2]}$$

With;

t = power difference test t
N = number of subjects
r_{xy} = correlation coefficient between item scores and total score

Determine the validity of a question item. The criteria that must be met so that an item is said to be valid is if $t_{hitung} > t_{tabel}$ with $t_{tabel} = t_{(1-\propto)(dk)}$ for dk = N – 2 and (significance level) is selected 5%. To interpret the reliability coefficient of an evaluation tool [15] provides table 1 criteria as follows:

Table 1. Validity Criteria

Value	Category
0,80 – 1,00	Very high
0,60 – 0,79	High
0,40 – 0,59	Enough
0,20 – 0,39	Low
0,00 – 0,19	Very low

2. Test Reliability

The reliability of the test instrument is calculated to determine the determination of the test results. To calculate the reliability of this test item, a formula that is in accordance with the form of an essay test is used, namely the alpha formula as follows:

$$r_{11} = \left(\frac{n}{n-1}\right)\left(\frac{s^2 - \sum pq}{s^2}\right) \quad \text{.....[3]}$$

With :

r_{11} = Test reliability
p = Proportion of subjects who answered the item correctly
q = Proportion of subjects who answered the item incorrectly
Σpq = The sum of the product of p and q
n = the number of items
S = Standard deviation

The formula for finding the standard deviation is as follows:

$$SD = \sqrt{\frac{\sum fx^2}{N}} \quad \text{.....[4]}$$

With :

SD = Standard Deviation
Σfx^2 = the number of times the frequency of each interval with the frequency squared
N = number of samples

The interpretation of the value of r_{11} is presented in table 2 below:

Table 2. Qualification of Correlation Coefficient

No	Correlation Coefficient	Qualification
1	$0,80 < r_{xy} \leq 1,00$	Degree vey high
2	$0,60 < r_{xy} \leq 0,80$	Degree high
3	$0,40 < r_{xy} \leq 0,60$	Degree enough
4	$0,20 < r_{xy} \leq 0,40$	Degree low
5	$r_{xy} \leq 0,40$	Degree vey low

3. Data Analysis Techniques

Data analysis techniques in this study are as follows:

1. Expert Validation Media Validation

Data analysis in this study used quantitative descriptive analysis. Furthermore, from the data obtained the results are averaged and used to assess the quality of the products developed. The product criteria will be converted to a value with a scale of five using a Likert Scale which is analyzed descriptively (average score and percentage) by calculating the percentage of indicators from each category on macromedia flash media that has been developed using the formula:

$$skor\ empiris = (jumlah\ skor\ yang\ diperoleh)/(jumlah\ skor\ ideal\ seluruh\ item)\ x\ 100\% \quad \text{.....[5]}$$

Furthermore, the percentage of validity criteria can be seen in Table 3 below:

Table 3. Percentage of Indicator Compliance Criteria

No	Criteria	Percentage Interval	Description
1	Very good	85%≤X≤100%	No revision needed
2	Good	75%≤X≤84%	No revision needed
3	Moderate	65%≤X≤74%	Revised
4	Less	55%≤X≤64%	Revised
5	Very Poor	0%≤X≤54%	Revised

Meanwhile, in calculating the feasibility level on macromedia flash media as learning media, the assessment is as follows:

Table 4. Percentage of Eligibility Level Criteria

No	Eligibility Level	Score
1	Not eligible	< 65%
2	Less feasible	65%- 74%
3	Eligible	75%- 84%
4	Very feasible	85%- 100%

a. Teacher and Student Response

Data regarding teacher and student responses to macromedia flash media as a developed learning medium, were given a questionnaire after learning the Flat Build material. The criteria for assessing conformity with indicators of teacher and student responses to macromedia flash media as learning media can be seen in table 5. below:

Table 5. Percentage of Teacher and Student Response Criteria according to Indicator

No	Criteria	Interval of Percentage	Information
1	Sangat baik	85%≤X≤100%	Tidak perlu revisi
2	Baik	75%≤X≤84%	Tidak perlu revisi

3	Sedang	65%≤X≤74%	Direvisi
4	Kurang	55%≤X≤64%	Direvisi
5	Sangat kurang baik	0%≤X≤54%	Direvisi

b. Student Response

Data regarding students' responses to macromedia flash media as a developed learning medium, were given a questionnaire after completing the learning of flat shape material. The criteria for assessing conformity with indicators of student responses to macromedia flash media as learning media can be seen in table 6 below:

Table 6. Student Responses according to Indicators

No	Interval of Percentage	Information
1	3,5 (87.6) < average score ≤ 4 (100)	Very Positive
2	2,5 (62.6) ≤ average score ≤ 3,5(87.5)	Positive
3	1 (0) ≤ average score ≤ 2,5 (62.5)	Negative

c. RPP Validation

RPP validation is carried out based on 3 aspects of the assessment, namely format, language and content. The average percentage score for RPP validation can be seen in table 7. below:

Table 7. Percentage of RPP Validation Average Score

No	Criteria	Interval of Percentage	Information
1	Very good	85%≤X≤100%	No revision needed
2	Good	75%≤X≤84%	No revision needed
3	Moderate	65%≤X≤74%	Revised
4	Less	55%≤X≤64%	Revised
5	Very poor	0%≤X≤54%	Revised

1. Improving Students' Mathematical Understanding Ability

To find out the increase in students' mathematical understanding abilities, a pretest (pretest) and a final test (posttest) were carried out. The results of the two tests are calculated by N-gain (g)=gain/(gain)_max = ((posttest)-(pretest))/(100-(pretest)) [15]

Table 8. . Upgrade criteria

Value	Category
g < 0,3	Low
0,3 ≤ g ≤ 0,7	Medium
g ≥ 0,7	High

3. Results

Data on increasing students' mathematical understanding abilities in terms of field trials can be seen in Table 9 and Table 10 below:

Table 9. Field Trial Pretest-Post Data.

	Pretes	Posttes	Gain
MIN	45	85	0.62
MAX	70	100	1.00
ST.DEV	10.79	7.06	
Average	68.24	86.76	0.58

e-ISSN : 2722-4368

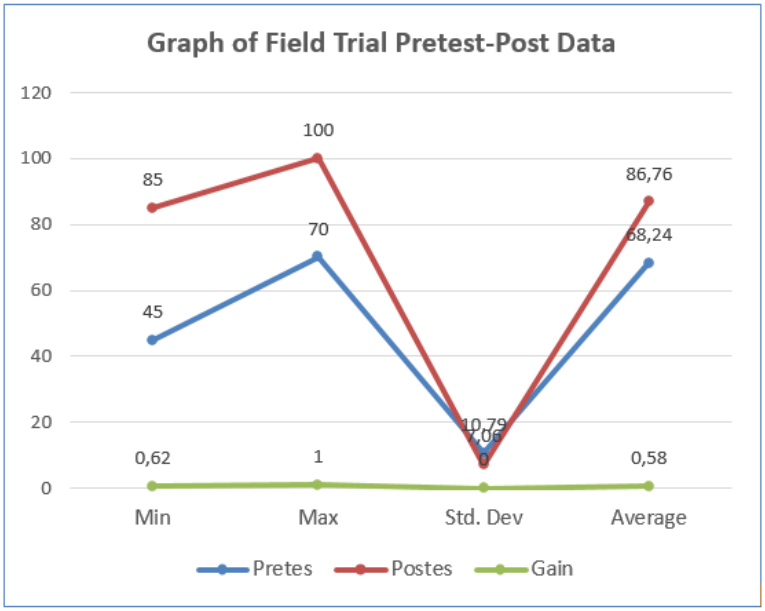

Figure 6. Graph of Field Trial Pretest-Post Data

Table 10. Descriptive Data Pretest-Post Field Trial

Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation
Pretest	34	45	85	68.24	10.793
Posttest	34	70	100	86.76	7.058
Valid N (listwise)	34				

Based on Tables 9 and 10, the average value of the pretest was 68.24 while the average value of the posttest was 86.76. The average increase was 18.52.

The minimum gain value is 0.62 while the maximum gain value is 1.00. The average value of data gain on students' mathematical understanding abilities in field trials is 0.58 (medium category). Data on increasing students' mathematical understanding abilities in terms of distribution can be seen in Tables 11 and 12 below:

Table 11. Distribution of Pretest-Post Data

	Pretest	Posttest	Gain
MIN	45	85	0.77
MAX	70	100	0.83
ST.DEV	13.77	5.40	
Average	60.33	81.33	0.53

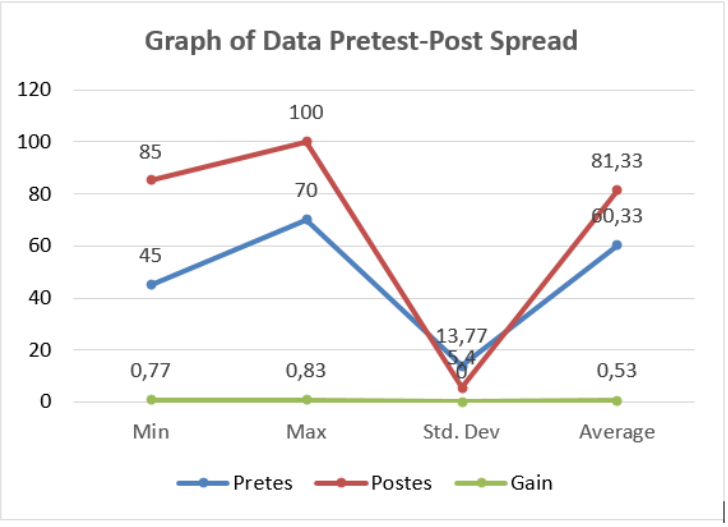

Figure 7. Graph of Distribution of Pretest-Posts Data

Table 12. Descriptive Data Pretest-Post Distribution
Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation
Pretest	30	35	85	60.33	13.767
Posttest	30	70	95	81.33	5.403
Valid N (listwise)	30				

Based on Tables 11 and 12, the average value of the pretest was 60.33 while the average value of the posttest was 81.33. The average increase is 21. The minimum gain value is 0.77 while the maximum gain value is 0.83. The average value of the data gain of students' mathematical understanding abilities in the distribution is 0.53 in the high category. Thus, it can be stated that by using the learning media of flat shapes assisted by macromedia flash, it can improve students' mathematical understanding abilities.

CONCLUSION

The conclusions in this study are as follows:

1. Learning media for flat shapes for rectangles, rectangles, trapezoids, triangles, circles, parallelograms and kites with the help of macromedia flash that was developed is feasible to be applied in learning.
2. Learning media assisted by macromedia flash can improve students' mathematical understanding abilities for the concept of flat shapes.
3. The Bangun Datar learning media with the help of macromedia flash needs to be applied by the teacher so that the learning that takes place becomes interesting, innovative and not boring for students.

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