



Cultural-Based Comics for Learning Equation of Straight Line and System of Linear Equation in Two Variables

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Abstract

The aim of this research is to develop cultural-based comic-based mathematics teaching materials. This research was conducted on 8th grade students of junior high schools precisely at Al Ma'ruf Islamic Middle School, Al Wahyu MTs, and Madrasah Tsanawiyah Insan Kamil. This study used research and development methods with the ASSURE model. In this study, the products were tested on material experts (lecturers), material experts (teachers), linguists, development experts, graphic design experts, 3 students selected from 3 schools for one to one test, 15 students from 3 schools for a small group test, and 20 students from 1 school for a large group to test the effectiveness of the product. This product test used the ttest to obtain ttest is 8.225 and ttable is 2.093 or ttest mpre than t table. Then it can be concluded that there is an effective use of mathematics comic teaching materials between pre test and post test scores and can be categorized as feasible.

Keywords: Teaching Materials, Math Comics, Culture.

Abstrak

Tujuan dari penelitian ini adalah untuk mengembangkan bahan ajar matematika berilustrasi komik berbasis budaya. Penelitian ini dilakukan pada siswa kelas 8 Sekolah Menengah Pertama tepatnya di SMP Islam Al Ma'ruf, MTs Al Wahyu, dan Madrasah Tsanawiyah Insan Kamil. Penelitian ini menggunakan metode research and development dengan model ASSURE. Pada penelitian ini, produk diuji cobakan kepada ahli materi (dosen), ahli materi (guru), ahli bahasa, ahli pengembangan, ahli desain grafis, 3 peserta didik yang dipilih dari 3 sekolah untuk uji one to one, 15 peserta didik dari 3 sekolah untuk uji kelompok kecil, dan 20 peserta didik dari 1 sekolah untuk uji kelompok besar menguji efektivitas produk. Uji produk ini menggunakan uji t sehingga diperoleh thitung = 8,225 dan ttabel = 2,093 atau thitung > ttabel. Maka dapat disimpulkan bahwa terdapat efektivitas penggunaan bahan ajar komik matematika antara skor pre test dengan post test dan dapat dikategorikan layak.

Kata kunci: Bahan Ajar, Komik Matematika, Budaya.

How to Cite: Jayanti, M., & Wiratomo, Y. (2019). Cultural-Based Comics for Learning Equation of Straight Line and System of Linear Equation in Two Variables. *Journal of Mathematical Pedagogy*, 1 (1), 18-29

Introduction

Mathematics is one of the important subjects in school, it can be seen from the number of hours of mathematics more than other subjects. Mathematics is also included in subjects that are tested nationally from elementary to high school level. But in reality, mathematics is still considered difficult by middle school students. The report on the results of the 2018 National Examination submitted by Totok Suprayitno as the Head of the Research and Development Agency of the Ministry of Education and Culture stated that "The average national math score is always low every year. This 2018 will be even lower, with a national average of 31.38. In 2016, the national average mathematics score was 61.33, and dropped to 52.69 in 2017 (detiknews, 2019).

According to Slameto (2013) low student mathematics learning outcomes can be caused by two factors, internal factors and external factors of students. Other factors that influence mathematics learning include boring teaching methods, inadequate and less interesting teaching materials. Based on the factors above, strengthened by the results of the researchers' questionnaire, there are still many students who have difficulty learning mathematics, are less interested in mathematics and always regard mathematics as a difficult science that causes fear to learn mathematics. Mathematics lessons when

combined with comics will become more interesting. It is necessary to develop interesting new teaching materials to support the learning process so that student learning outcomes improve and the learning objectives of mathematics are realized.

One of the goals can be achieved if students' interest in reading is high. However, the interest in reading Indonesian people, especially children, is still very low. Data from UNESCO in 2016 showed that the percentage of Indonesian children's reading interest was only 0.01 percent. That is, of 10,000 children of the nation, only one person who likes to read (Kompas.com, 2019). In addition, based on the results of the 2017 National Library research by Puan Maharani as the Coordinating Minister for Human and Cultural Development (PMK) revealed that the average Indonesian only reads books 3-4 times per week with an average reading time duration per day of 30 -59 minutes. While the number of books completed per year on average is only 5-9 books (Kompas.com, 2019). So we need a solution to overcome the lack of interest in reading in students, including by making teaching materials that can increase students' desire to read.

Determination of mathematics teaching materials for teachers is a very important thing to do, the success and interest in student learning will depend a lot on these mathematics teaching materials. However, there are many students who are less interested in reading textbooks, especially books that lack pictures and are lacking interesting illustrations. Because seen from the nature of the presentation of the message, the book tends to be informative and emphasizes more on the presentation of teaching material with a broad and general scope so that the communication process takes place in one direction and the reader tends to be passive. Picture books can help the learning process, can foster student interest and can provide a relationship between the content of subject matter with life. The teacher must be able to provide interesting mathematics teaching material for students. One of the right teaching materials is comic teaching material.

Comics are actually more than just light and entertaining picture stories, comics have the power to convey information in a popular and easily understood manner because comics combine the power of images and writing, which are assembled in a picture story line making information more easily absorbed. The text makes it more understandable, and the flow makes it easier to follow and remember. So that comics are suitable as mathematics teaching materials, especially in the system of two-variable linear equations and straight-line equations. Interest in comics in Indonesia can be said to be quite high. Based on a survey conducted by NTV Sekai Banzuke in 2013, Indonesia ranked second in the world for the number of Japanese manga or comic readers. Based on the survey, an average person reads 3.11 comic books or about 3 comic books per person (Tribunnews, 2019). The Ministry of National Education in 2011 made a new breakthrough by presenting textbooks in the form of comics. The comics were made respectively for Mathematics, Natural Sciences, and Social Sciences for Junior High Schools (Antaranews, 2019).

According to Gene Yang (Avriliyanti, 2013) comic has five advantages when used in the study, namely: comics can motivate students during the learning process; comics consist of images which are media that can improve the quality of learning; comics are permanent; comics can arouse interest in reading and direct students to the discipline of reading, especially those who do not like to read; comics are part of popular culture.

Based on the background of the problems above, we make comics a form of teaching material that will be used in learning mathematics. We developed the material of straight-line equations and two-variable linear equation systems because this material is easier to learn if given a picture in real life and we take the theme of culture so that Indonesian culture can still be preserved. So this research is entitled "Development of Mathematical Comic Teaching Materials on the Material of Straight Line Equations and Linear Equation System of Two Variables of Class 8 Middle School Based on Culture."

Method

Development research was carried out in the 8th grade of this middle school in three Islamic schools at Jakarta. The research method used is the research and development method with the ASSURE development model, which is a development consisting of six stages which include: Analyze Learner; State Standards and Objectives; Select Strategies, Technology, Media and Materials; Utilize Technology, Media, and Materials; Require Learner Participation; Evaluate and Revise.

Result and Discussion

Result

The development of this mathematics comic teaching material using the Research and Development (R&D) method with the ASSURE model, the following stages:

1. Analyze Learners

The steps taken in the needs analysis in this study are the distribution of questionnaires to students and teachers. Researchers conducted a needs analysis in three Islamic School at Jakarta. Learning analysis includes:

a. General characteristics of students

Generally, students of class VIII think more about playing compared to learning. The use of teaching materials that are unique, colorful and interesting will increase learning interest and can influence good mathematics learning outcomes. The teacher states that students of class VIII SMP are very interested and enthusiastic when there are new, interesting, and easily understood teaching materials, so that students can be more eager to learn mathematics, increase student interest in learning mathematics and reduce boredom of students towards teaching materials. From the results of the analysis of students, we make an interesting comic mathematics teaching material.

b. Learning styles of students

The class observed was class 8 of 3 schools with a total of 15 students. From the results of the research conducted, most students have a visual learning style. According to Ahmadi (2013) that someone who is of a visual type, will quickly learn the materials presented in writing, charts, graphs and pictures. Because comics are presented in the form of images, comics will be easier to understand.

2. States of Standards and Objectives (Defining Standards and Objectives)

- a) Students can determine the gradient if a line through a center and one point is known.
 - b) Students can determine the gradient if a line through two points is known (x_1, y_1 and x_2, y_2).
 - c) Students can determine the straight line equation if the gradient is known and through 1 point (x_1, y_1)
 - d) Students can determine straight line equations if 2 points are known, namely (x_1, y_1) and (x_2, y_2)
 - e) Students can determine the linear equations of two variables with methods of elimination, substitution, combination and graph.
- #### 3. Select Strategies, Technology, Media, and Materials

The learning strategy used is open ended learning with Student Center Approach using grade 8 mathematics comic teaching materials. Math comics teaching material with 4 puppets "punakawan" characters, cultural backgrounds are designed as attractive as possible with the discussion of straight line equations and linear equation systems of two variables according with

the applicable curriculum.

4. Utilize Technology, Media and Materials

Photoshop portable technology is used to make mathematical comics, the media used are printed media in the form of picture comic book teaching materials and the discussion used is straight line equation material and a two-variable linear equation system for grade 8 junior high school. The stages used are the "5P" process, namely:

- a. Previewing, checking the technology, media, and material used to make comics

In order to achieve learning objectives. Making comics using HVS paper, ruler, pencil, drawing pen and eraser, then the image is scanned.

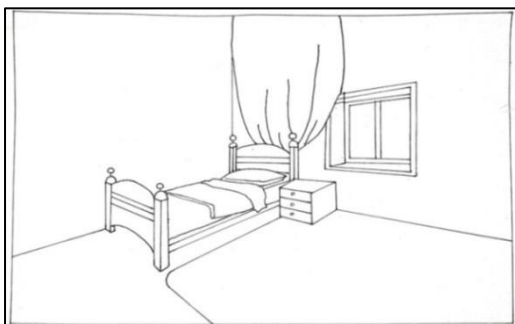


Figure 1. The depiction process in HVS

- b. Prepare, the technology used is Adobe Photoshop Portable software. In the preparation process, all material in a straight line equation and a system of linear equations for two variables of class VIII of junior high school are put into a comic story and give color to a comic image, then stored in the "JPG" format.

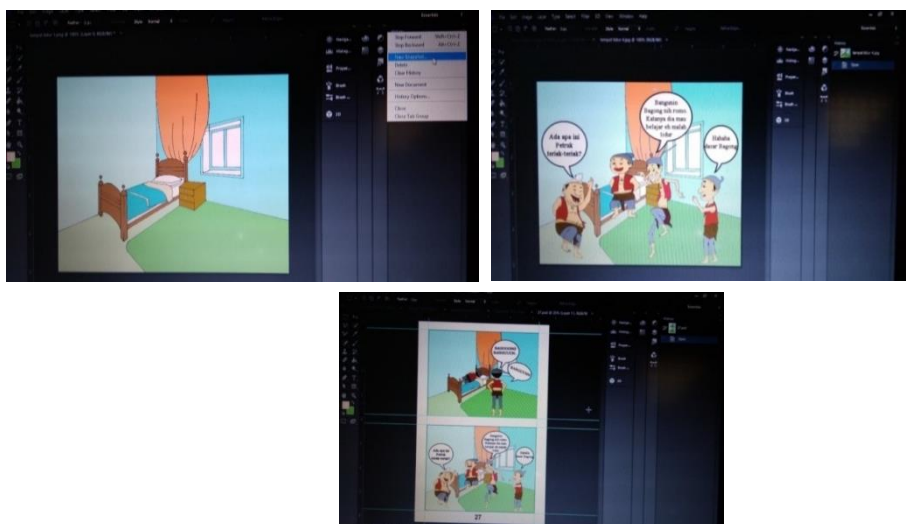


Figure 2. Background Coloring Process, Adding Figures and Merging Pages with Adobe Photoshop Portable

- c. Prepare (Stage 1), at this stage, is prepared for the junior high school environment.
- d. Prepare (Stage 2), then students prepare for 8th grade junior high school to read mathematics comic teaching materials.
- e. Provide, explained how to read math comic teaching materials by reading from left to right. the

atmosphere is made quiet so that students focus on reading comic teaching materials and learning experiences that are new and enjoyable.

5. Require Learn Participation

In the learning process, students acquire knowledge and skills that are more meaningful and remembered by students through comic stories that are connected in real life or concrete objects in the mathematical comic picture display. So there will be a reciprocal relationship between students and teachers and students with students in accepting all responses and correcting all explanations received in comic teaching materials in the learning process. Then all students can participate properly.

6. Evaluate and Revise

a. Evaluation by Material Expert (Lecturer)


The evaluation carried out aims to determine the suitability of the material needed by students. Material expert is a lecturer in Mathematics Education at Indraprasta University, PGRI.

Table 1. Average Evaluation Results of Material Experts (Lecture)

Aspect	Score	Category
Matery	4.47	Very Good

Table 2. Results of the Revised Evaluation of Material Experts

Comments / Suggestions Expert Material	Revision Results
Add practice questions	The practice questions have been added



Display After Revision

b. Evaluation by Material Expert (Teacher)

This evaluation aims to determine the suitability of the material with the needs of students. The panelists were Al-Ma'ruf Islamic Middle School Mathematics teacher.

Table 3. Average Evaluation Results of Material Experts (Teacher)

Aspect	Score	Category
Matery	4.14	Good

c. Evaluation by Linguists





Linguists who have assessed and responded to products developed are Indonesian language lecturers at Indraprasta University, PGRI. The aspect of language that is assessed is the readability of mathematics comic teaching materials that are developed such as spelling, grammar, terms, symbols, and icons.

Table 4. Average Language Evaluation Results of Linguists

Aspect	Score	Category
language	3.2	enough

From the results of the data in the above table, the results of the evaluation of linguists are in the "Enough" category with a percentage of 70%.

Table 5. Results of the Revised Evaluation of Linguists

Comments / Suggestions by Linguists	Revision Results
Correct the use of punctuation	punctuation in sentences has been fixed.
	
	
3 Display Before Revision	3 Display After Revision

d. Evaluation by Development Experts

Development experts who have been asked to evaluate aspects of the display include color selection, color display, font type, font size, image clarity, relevance of the image to the material and provide responses to the results of the development product are lecturers of learning technology at Indraprasta PGRI University.

Table 6. Average Language Evaluation Results of development expert

Aspect	Score	Category
language	4.6	Very good

From the results of the data in the above table, the results of the validation of development experts in the "Very Good" category with a percentage of 92% with suggestions the size of the writing must be adjusted.

e. Evaluation by Graphic Design Experts

The graphic design expert was asked to evaluate aspects of the display including color selection, color display, font type, font size, image clarity, relevance of the image to the material and giving responses to the results of the development product were Visual Communication Design



lecturers at Indraprasta University PGRI.

Table 7. Average Graphic Design Expert Evaluation Results

Aspect	Score	Category
Graphic design	4.0	Good

From the results of the data in the above table, the results of the validation of graphic design experts are in the "Good" category with a percentage of 80%.

Table 8. Results of the Revised Evaluation of Graphic Design Experts

Comments / Suggestions for Graphic Design Experts	Revision Results
Adjust the color contrast between text, image and background.	The color contrast between text, image and background has been adjusted.
 <p>3</p> <p>Display Before Revision</p>	 <p>3</p> <p>Display After Revision</p>

f. One to One test for students

One-on-one test was conducted on one student from each school. One trial was carried out by filling out a questionnaire or evaluation of the quality of development.

Table 9. Average Test Evaluation Results One-to-one Test

Subject	Score	Category
First School Student	4,5	Very Good
Second School Student	4,3	Very Good
Third School Student	4,1	Good
Overall average	4,3	Very Good

From the overall average value obtained from students that is equal to 86% with the category "Very Good".

Table 10. One to One Test Comments / Suggestions

Student	Comments / Suggestions
First School Student	Math comics are good but it's better if the covers and pictures are made more interesting to make it more fun to read.

Second School Student	Mathematics comics are interesting, funny, teaching materials that make learning more fun, the writing clearly reads, the language used is very easy to understand. The suggestion is the color should be more attractive.
Third School Student	The math comics are funny, the characters and players are also funny. But the book is not small enough. The book should be reduced slightly.

g. Small Group Test

The results of the evaluation of this study are based on the results of small group test evaluations, aiming to improve and improve the quality of teaching materials developed.

Table 11. Average Evaluation Results of Small Group Tests

Small Group Test	Student	Average	Category
First School Students	1	4.07	Well
	2	4.7	Very good
	3	3.46	Well
	4	4.46	Very good
	5	3.5	Well
School Average I		4.03	Well
Second School Students	1	4.3	Very good
	2	4.14	Well
	3	4.5	Very good
	4	3.92	Well
	5	4.3	Very good
School Average II		4.23	Very good
Third School Students	1	4.4	Very good
	2	4.3	Very good
	3	4.75	Very good
	4	4.8	Very good
	5	4.3	Very good
School Average III		4.51	Very good
Overall average		4.25	Very good

From the overall average value obtained from the students in the form of a percentage that is equal to 85 % with an average of 4.25 and is categorized as " Very Good".

Table 12. Comments / Suggestions for Small Group Tests

Small Group Test	Student	Comments / Suggestions
First School Students	1	Comics are interesting and the picture is good.
	2	This comic is good and useful for all of us who read it.
	3	I think the comic is good but my suggestion is that the cover is made to be more interesting.
	4	Actually that's a good idea for comics to learn mathematics so it won't get bored. I think need to be revised to make it even better. Starting from the selection of colors for the comic's cover and drawing, then the size of the comic is rather difficult to carry around.
	5	Math comics are good but it's better if the covers and pictures are made more interesting to make it more fun to read.
Second School Students	1	Mathematics comics are interesting, funny, teaching materials that make learning more fun, the writing clearly reads, the language used is very easy to understand. The suggestion is the color should be more attractive.
	2	This comic is great for me studying mathematics.
	3	In my opinion interesting comics. But the problem is not much.
	4	Math comics are good. But the color of the cover is need to revision.

Small Group Test	Student	Comments / Suggestions
	5	I think the comic is very easy to understand, the clarity of the picture is very interesting .
Third School Students	1	Math comic is funny, character and players are also funny. But the book is not small enough. The book should be reduced slightly.
	2	Comic is interesting, but there is inscrutable writing.
	3	This comic is funny. The character is rarely in the usual comics. The explanation is quite clear.
	4	I think this comic really helped me learn mathematics. Because I like pictures, so studying isn't boring.
	5	This comic is quite clear and interesting.

h. Large Group Test

The evaluation by a large group test on 20 8th grade students at an Islamic Junior High School at Jakarta aims to find out the effectiveness of Mathematics Comic teaching materials on the material of straight line equations and linear equation systems of two variables of 8th grade culture-based SMP. After the students' grade VIII test score data is collected then a hypothesis test is performed with the t-test for two groups of data from one sample group (in pairs). The t-test calculation results are presented as follows: Hypothesis:

H_0 : there is no effective use of Mathematics Comic teaching materials between *pre-test* and *post-test* scores

H_1 : there is effective use of Mathematics Comic teaching materials between *pre-test* and *post-test* scores

$H_0: \mu_1 = \mu_2$

$H_1: \mu_1 \neq \mu_2$

From the data above obtained :

Table 13. Large Group Test Results

Student	Earnings Score		gian [d] [Y - X]	X_d	X_d^2
	Pre Test [X]	Post Test [Y]			
1	35	50	15	- 4	16
2	35	65	10	-9	81
3	50	60	10	- 9	81
4	45	75	30	11	121
5	35	65	30	11	121
6	55	60	5	- 14	196
7	45	60	15	-4	16
8	60	75	15	-4	16
9	55	85	30	11	121
10	40	80	40	21	441
11	50	55	5	- 14	196
12	50	65	15	- 4	16
13	65	75	10	- 9	81
14	45	80	25	6	36
15	55	80	35	16	256
16	50	80	30	11	121
17	55	75	20	1	1
18	35	50	15	-4	16
19	55	60	15	- 4	16
20	65	75	10	-9	81
	amount		380	-	2030

Calculate the average value of *gian* [d]

$$M_d = \frac{\Sigma d}{n}$$

$$M_d = \frac{380}{20} = 19$$

Calculate the deviation value of the score *gian* to the mean

$$X_d = d_i - M_d$$

Determine the value t_{count} by using a formula

$$t = \frac{M_d}{\frac{\sqrt{\Sigma x_d^2}}{\sqrt{n(n-1)}}}$$

$$t = \frac{19}{\frac{\sqrt{2030}}{\sqrt{20(20-1)}}}$$

$$t = \frac{19}{\sqrt{5.34}}$$

$$t = 8.225$$

Hypothesis testing criteria

Decline H_0 , if $t_{count} > t_{table}$ and accept H_0 , if $t_{count} < t_{table}$

$$t_{table}: \alpha = 0.05 \text{ and } db = n - 1 = 20 - 1 = 19$$

$$t_{table} = 2.093$$

Because $8.225 > 2.093$ or $t_{count} > t_{table}$, H_0 is rejected, which means that at the 95% confidence level there is an effective use of Mathematics Comic teaching materials between pre-test and post-test scores and the results of hypothesis testing above indicate the effectiveness of using culture-based mathematics comic teaching materials to the level of students' understanding of the material of straight-line equations and a two-variable linear equation system.

Discussion

Development of mathematics comic teaching materials for 8th grade junior high school students by discussing straight-line equations and two-variable linear equation systems, this culture-based comic aims to support mathematics teaching materials for students in schools. The development of teaching materials also has the aim to provide a comprehensive picture of what the process of developing mathematical comics will ultimately produce a product of teaching materials in the form of mathematical comics and to find out the effectiveness of mathematics comic teaching materials for 8th grade students on straight line equations and systems linear equation of two culture-based variables in the process of learning mathematics.

The development of this teaching material has followed the steps of developing a classroom-oriented model namely the ASSURE model. In the needs analysis phase is done by analyzing the needs of teachers and junior high school students. This stage is used to find out what is needed by students in overcoming problems that occur in the learning process and knowing the needs of developing mathematical comics. The next stage in developing ASSURE is to state specific standards and learning objectives. In formulating standards and learning objectives, we must pay attention to the basis of strategy, media, and selection of the right media. The basis in the assessment of mathematics learning is seen from the ability of students to master the material in accordance with existing basic competencies. Standards that must be mastered by students consist of:

a) Students can determine the gradient if a line through a center and one point is known.

- b) Students can determine the gradient if a line through two points is known (x_1, y_1 and x_2, y_2).
- c) Students can determine the straight line equation if the gradient is known and through 1 point (x_1, y_1)
- d) Students can determine the straight-line equation if 2 points are known, namely (x_1, y_1) and (x_2, y_2)
- e) Students can determine the linear equation of two variables with the method of elimination, substitution, combination and graph.

The third stage in this research is to choose strategy, technology, media, and learning material. Based on the analysis of the needs given to students, the authors chose modern mathematics comic teaching materials with 4 puppet Punakawan figures drawn into cartoons, and set a culture that was designed to be as attractive as possible and use a straight-line equation and a two-variable linear equation system according to the curriculum. The fourth stage is using media, discussion and material. At this stage, we have used Portable Photoshop to create mathematical comics, the medium is the print media of comic books and the discussion used is the material of straight line equations and two variable linear equation systems for grade VIII SMP. To do this stage the researchers conducted the "5P" process: "preview", checking the technology that would be used in the process of making comic learning media. We use HVS paper rulers, pencils, drawing pens and erasers in the process of making this comic. "Prepare", we prepared Adobe Photoshop Portable software for making comics and prepared straight line equation material and a system of linear equations for two variables of class VIII of SMP in accordance with the curriculum. In the preparation process, we included all the material in the straight line equation and the system of linear equations for the two variables of class VIII SMP in the comic story and gave color to the comic drawings, then saved them in JPG format. When it has become a unity of mathematics comics learning media. Preparing for stage 1, at this stage the prepared environment is a junior high school or grade VIII. Next we prepare the eighth grade junior high school students to read the math comic teaching materials that have been given. In the Provide phase, we explain how to read math comics by reading from left to right. We make the atmosphere as quiet as possible and focus on students to make learning fun.

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Conclusion

Mathematics comic teaching materials on the material of straight-line equations and the system of linear equations of two variables of class VIII of culture-based SMP produced were developed with the ASSURE Learning Model, with several stages, namely: a) Analyzing student characteristics through student and teacher questionnaires, b) Stating standards and objectives learning, at this stage mathematics comic teaching materials will involve the use of technology and media in its development in achieving learning standards and objectives, c) Choosing strategies, technology, media, and learning materials, at this stage we try to unite the characters that have been made according to the discussion which is being studied by students at the time the research is conducted, d) Using technology, media and materials, e) We enable student participation in the mathematics learning process by using mathematics comic teaching materials, f) The final stage is evaluating and revising aims to find out the revisions that are made must be done dap teaching material products that are developed to be suitable for use. Evaluations and revisions made by researchers consist of evaluations by expert tests (2 material experts, linguists, and developer experts, graphic design experts), one to one test, small group tests and field trials with large group tests so that the final product is obtained.

Acknowledgement

Thank you to the Principals, teachers and students form an Islamic Schools at Jakarta who where involeved in this reseach.

Thank you to the UNINDRA Mathematics Education Study Program for your help and guidance in this research. materials.

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