

# Effectiveness of Mathematical Comics as the Development of Teaching Material

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## ABSTRACT

This study aims to determine the improvement of mathematics learning outcomes through mathematical comic teaching materials for seventh grade students on the rank and root materials. The method used in this research is Research and Development method. The developed product is comic teaching material in mathematics learning for 7<sup>th</sup> grade students. The steps of developing the research and development model are carried out in 3 phases which includes: the needs of analysis phase, the design phase and the development and implementation phase. Data collection techniques is completed by observation, interviews, questionnaires, and tests. The t test is used in the data analysis techniques, with pre-test and post-test data collection. Based on this research, the mathematics comic teaching materials that were developed comes out with such satisfying grades from experts and teachers in schools. Based on the statistical calculations, it shows that the mathematical comic as teaching materials development are very effective to improve mathematics learning outcomes with a t observe of  $8.98 > t$  table 2.045.

**Keywords:** *Development, Comics, Mathematics, Education*

## 1. INTRODUCTION

Mathematics is a science that is always used in life. Mathematics is the queen of knowledge as it is the basis of every science. The basic concepts of mathematics should be taught to students from an early age. These concepts include mathematical problem solving, mathematical reasoning, systematic thinking and others. The development of mathematics learning can be done if each teacher has diverse methods, models, media and learning materials. Sanjaya states that many factors affect the learning process; teacher factors, student factors, facilities, tools and media availability, teaching materials, and environmental factors. [1].

One important factor that needs attention in learning is the teaching material. Nowadays, teaching materials which are mostly textbooks used by teachers, are less interesting and less attractive to students. Based on Wahyuningsih's statement [2] that learning materials are currently more in the form of textbooks, even though there were several variations but have not had sufficient influence on increasing students' interest in reading. Therefore, it is necessary to improve teaching materials that can attract more students' interest. Teaching materials need to be developed to fit the demands of the curriculum, the characteristics of the target, and the demands of problem solving. Teaching material is a set of systematic substance or material, both in written and

unwritten, so that it can create an appropriate environment or atmosphere to support learning activities to achieve the students' goals [3]–[5]. Teaching materials are packaged in the printed form, listened (audio), auditory-sight (audio-visual), and interactive [6].

Febrianto et al in [7] explained that in order to foster the learning process and to improve students' learning outcomes, a good quality learning media is needed that is feasible to use, can be accepted by students and help student learning processes.

One of teaching material alternative that can improve in mathematics learning outcomes is comic. Comics is one of the visual communication media used in learning. Comics consist of images that express characters and act out stories to convey information and entertain the readers [8]. The images in the comics are used to convey efficient and effective information for the readers. Thus, comics can be used as a learning media. Claud quoted by Fahyuni & Fauzi in [9] states that comics are collections of words and images that are close together. The images in comics can enrich and clarify the contents of the text and concretize the character and imagination of children against the narrative of the text which is still limited. In addition, Lesmono argues that comics are not only pictures, but also messages to learnt about.[9]

Mustajab said, as quoted by Teresia, the types of comics include: 1) Cartoons, 2) Strip Comics, 3) Annual Comics, 4) Web Comics, 5) Comic Books, 6) Simple Comics, 7) Instructional Comics [10]. Comics are not

just pictorial stories that are as entertaining as people's views in general, but have a deeper meaning as well. Comics is a form of visual communication that has the power to convey information in a popular manner and easy to understand [11]. No wonder, people, especially children, prefer comics to verbal books. This is because comics are presented with various interesting drawings and light grammar so that readers will be easily understand and fascinated. Therefore, it is worth to elaborate and use the nature of comics, which is entertaining and fun, in the world of education.

Comic as a media is considered suitable to be used for learning mathematics because its delivery is loaded with visual elements and cannot be separated from phenomena that exist in everyday life. This is in line with the research results of Adeliyanti, Suharto and Hobri [12] showing that learning with e-comics is said to be effective which is shown by completeness of 81.25% of 32 students and is said to be practical, indicated by the acquisition of user response questionnaire data with a percentage of 94% and makes learning media are very good categorized. As an interesting teaching medium, comic media is one of the visual media that combines the power of images and copywriting and the discussion of mathematical formulas arranged in a storyline, entertaining, easy to understand by readers. Comics are considered as a suitable means to convey the teacher's message in learning.

To develop teaching materials, an appropriate mathematical comic development model is needed. Jailani [13] explains that the compilation of comic as learning media must include the aspects of comics preparation and the aspects of the textbook preparation. Therefore, the development of mathematical comic teaching materials must be based on both aspects. According to Rusijono and Mustaji the core of the development is the use of theories, concepts, principles, or relevant research findings to solve problems [14]. Hence, it will be further studied with theoretical concepts that will support this research development. Therefore, in conducting research and development, it is still based on emphasizing the use of theoretical, concepts, and problem-solving principles in learning. This current study carries out the model developed by Hannafin and Peek. Arifin stated that this development was product oriented. The Hannafin & Peek development model consists of three phases: the needs for analysis phase, the design phase and the development and implementation phase.[15]

Furthermore, the research and development is conducted by developing comic teaching materials for learning mathematics. The results of the development are tested to evaluate the improvement of students' learning outcomes. Hopefully this research and development may generate effectively and practical for teaching materials used in the learning process so that students are interested in learning mathematics and be able to improve their achievement.

**3. METHOD**

The method used in this research is research and development. The product to be developed is the

mathematics comic teaching on root and rank material for seventh graders of junior high school students. The developing of the model was carried out in several steps, those are: 1) Preliminary Research: In this stage, some preliminary research must be done first by conducting observations and interviews. Interviews were conducted to three 7<sup>th</sup> grade students and three mathematics teachers in a junior high school. 2) Model Development: it is carried out through three phases: the needs analysis phase, the design phase and the development and implementation phase. Data Collection is completed by 1) Observation: Observation is done by direct observation in the field to strengthen the information obtained in an effort to overcome the problems that arise. 2) Interview: Interviews are used in the initial stages to determine the initial conditions at the site to become as the research take place. 3) Questionnaire: Questionnaire is used during the evaluation before and after the product testing by the experts of subject matter, linguistics and development. While the questionnaire for students is used to study the response of students and teachers to the teaching material to be developed. 4) Test: The test is carried out on students after using the developed product.

The data analysis technique used is quantitative descriptive statistics. The descriptive statistics used to analysis quantitative data obtained from the questionnaire are the results of validation by the experts of subject matter, linguistics, development specialists. Data obtained using a modified questionnaire Likert scale is a scale 4 = Very Good, 3 = Good, 2 = Good Enough, and 1 = Less Good. Based on that scale, determination of the qualitative criteria listed in the following table :

**Table 1.** Qualitative criteria program

No	Interval	Criteria
1	4 to 5	Very Good
2	3 to 3.9	Good
3	2 to 2.9	Good Enough
4	1 to 1, 9	Less Good

In addition to expert validation, this research also carried out trials of comics that had been developed. The test was conducted on 30 students at one private junior high school in Jakarta. The statistical tests used in this calculation include a descriptive data test, a prerequisite test for data analysis and a hypothesis test using the t test.

**4. RESULT AND DISCUSSION**

The development of illustrated comic mathematics teaching materials uses the reference model developed by Hannafin and Peck. The development steps consist of three stages: needs analysis, design, and development and implementation.

**4.1. Needs Analysis Phase**

The needs analysis of teaching materials is carried out by qualitative methods on the results of interviews with the teacher concerned. In this phase, the researchers

get information from the teachers who require comics as the learning materials for students in class or at home to study independently. In the preparation of teaching materials, the learning objectives to be achieved based on the 2013 curriculum was firstly analysed. At this stage, it found that there were no teaching materials in learning mathematics in the form of comics as the supporting teaching materials. Currently mathematics teachers still use textbook-based teaching materials.

This needs analysis was given to students and teachers in each school where the research is done. The results of this study indicate that there are many students who still do not like mathematics. The teacher has not used teaching materials that withdraw students' interest in learning mathematics. In fact, the teacher has tried to approach students, one of which is, by providing learning motivation and using new models in learning in the classroom. Unfortunately, not all students understood and interested in learning model applied by the teacher. This might be the reason why students were not familiar with the new learning models they used.

The needs analysis conducted above indicated that one of the difficulties experienced by the teachers in delivering mathematics is the lack of students' interest in learning the subject. Many students are not interested in reading mathematics learning materials which are currently still in text books form. As Wiratomo stated [16] on the lack of students' interest in reading textbooks. They prefer to spend free time at home to watch television, play smartphones or gadgets or just play with their friends rather than reading mathematics text books. So, it needs teaching materials that can attract and motivate students in learning to improve their competencies. In short, if the students' motivation and competitiveness occur increasingly, it is expected that the student learning outcomes can be improved consequently.

## 4.2. Design Stage

At this stage several steps are carried out, including:

### 4.2.1. Determining Basic Competency (BC)

The BC used in making comic teaching materials is based on the syllabus of mathematics for seventh grade of junior high school students,

### 4.2.2. Selecting and collecting teaching materials

At this stage the researcher chooses and collects teaching materials in the form of text and images that can be made into communicative teaching materials so that they can attract students' interest in learning

### 4.2.3. Designing the material map

Material map is a chart of mathematics learning competency material. The material map is arranged by describing the material in the form of some teaching material. The material is used to adjust the basic competencies that have been compiled in developing mathematical comic as teaching materials.

## 4.3. Development and Implementation Stage

At this stage, the researchers start to prepare the learning material in the form of text and images. The preparation process of mathematics teaching materials is made according to the syllabus of material for class VII. In compiling teaching materials, it started with determining the theme, planning, drawing based on storyline, and then colouring using Photoshop software. The final result of this stage is the validation of mathematics teaching materials.

The validation material expert is provided with an evaluation sheet to assess the suitability of the mathematical content of the material illustrated in the comics. The evaluation results of the three experts show the average of 4.32 points on a scale of 5. The results of the first evaluation sheet include advices from the expert and feedback for mathematics comic teaching materials. Some of the suggestions and input from the experts in the subject matter of comic mathematics can be seen as follows:

**Table 2.** The Evaluation of Suggestion and Feedback from The Expert of Content

No.	aspects Rating	Suggestion
1.	Standard of Competence / Competency	View Competency Standards and Basic Competence in comics.
2.	Learning objectives	View Learning Objectives in the comics.
3.	Formative tests	Show Tests Formative in the comics.
4.	Matter	More at deepened discuss the material logarithms.
5.	Linkage to everyday life	At suggest untuk more associate with everyday life.
6.	The comic character	We recommend more modern so that students are more interested.
7.	The concept of logarithms	Please describe more clearly the concept of logarithms so that the students learned about logarithms.
8.	Summary of material	View a summary of the material in the comic.
9.	Exercises	Should be propagated discussion around exercises in comics.

Validation of linguists is given an evaluation sheet to assess the suitability of the contents of the comic with the language used. The evaluation results of the three experts

show the average of 4.23 points on a scale of 5. The results of the second evaluation sheet with the advice of linguists obtained the feedback for mathematics comic teaching materials. Here are some suggestions and input from the linguists:

**Table 3.** Suggestion from Linguist Expert

No.	aspects Rating	Suggestion
1.	fonts	Font writing minimized.
2.	The language used	Do not over use the language of children today, because it is not good when followed by the student.
3.	Punctuation	Use punctuation and correct, fix punctuation suggested.
4.	The use of capital letters	Use capital letters correctly, in writing good name place name, city, and humans.
5.	The use of the word	Use the right word, as the powers instead of reappointment. Note syllables.

The experts of development are given evaluation sheets to assess the suitability of comic content with comic results. The evaluation results from three experts show the average of 4.61 points on a scale of 5. The results from the third evaluation sheet with expert development inform the advice and feedback for mathematics comic teaching materials. Some suggestions and input from development experts are:

**Table 4.** Suggestion from The Development Expert

No.	Rated aspect	Suggestion
1.	Cover	Zoom the image.
2.	Cover article	Customize the text with color.
3.	Column conversation	Reduced line edge.
4.	Picture	The image size is reduced so as not to break.

In addition to evaluating the quality of comics by experts, this study conducted a trial to find out the increase in students' learning outcomes before and after they were taught by using mathematics comic teaching materials. Data test results can be seen in the following table:

**Table 5.** Test Results Data Description

	Pre Test	Post Test
Respondents	30	30
Mean	71.6	80.7
Median	73	80
Modus	60	77
Standard Deviation	9.75	8.10
Varian	95.15	65.60
Maximum Score	87	97
Minimum Score	56	65

The table 5 above shows that there is an increase in the average learning outcomes of students after being

taught by using mathematics comic teaching materials. The average learning outcomes before being taught by using mathematics teaching materials is 71.6 while it is increasing to the average of 80.7 after being taught by using math comics teaching materials. This shows an increase in learning outcomes by 9.1 points.

**Table 6.** Normality Test Results

	Lobserve	Ltable	Remarks
Pretest	0.1488	0.1610	Data Normally Distributed
Posttest	0.1094	0.1610	Data Normally Distributed

Based on the table 6 above, it is known that the Lobserve values in the two data groups are less than Ltable. This means that both data come from normal populations. Then, the data is considered steady.

**Table 7.** Homogeneity Test Results

Fobserve	Ftable	Remarks
0.626	1.882	Data homogenous

Based on the homogeneity calculation above, the calculated F value of 0.626 is smaller than the F table of 1.882. This means that the two data are homogeneous so that the data prerequisite tests are fulfilled.

**Table 8.** The result of t test

Responden	t observed	t table
30	8.98	2.045

The results of the t-test assessment found that the *tobserve* was  $8.98 > ttable$  which was 2.045 out of 30 respondents. This shows a significant improvement in the learning outcomes of students after being taught by using mathematics comic teaching materials. This shows that the learning outcomes are higher than before they were taught by using mathematics comic teaching materials on root and rank teaching material. This can be seen from average learning outcomes before being taught by using mathematics teaching materials is 71.6 while it is increasing to the average of 80.7 after being taught by using math comics teaching materials. Sardiman in [17] explains that the process of learning necessarily needs any kind of activities such as working together. Otherwise, the learning might not take place properly. The results of this study indicate the needs for teaching materials that attract students so that they are motivated to read and study independently so that the learning outcomes obtained will be better.

This research is in line with Rasiman dan Pramasyahsari [18] that learning process which uses the e-comic media based on flip book maker better than the learning process which applied in conventional method. Learning mathematics by using comic teaching materials creates effective learning. The use of comic teaching materials can make learning more fun and motivate students to prefer mathematics. According to development experts and mathematics, the making of comic teaching materials are categorized "very good". This is proven by the increasing points in students'

interest in reading mathematics comic teaching materials by 85%. This achievement shows that learning outcomes have increased very significantly and exceeded the expected target. This is in accordance with Denise [19]; the use of comics in learning is able to attract students who are reluctant to read gradually become fond of reading and finally able to read ordinary books with full of writing. The use of comics is one of the new ways to motivate students and help students develop their potential. [9]

Tin Lam Toh [20] in his research explained that the teachers were able to engage more students to learn more challenging algebra (such as communicating in algebra language), involved in the addition and subtraction of algebraic expressions. This is can be caused by the nature of mathematics comic teaching materials is easily understood and applied by students/ It will be easier for students to use it at anytime and anywhere. That is one of the reasons accepted by the users. This indirectly increases the effectiveness of learning [21]. Effectiveness is usually defined as the level of success achieved in a trip or in accordance with certain objectives to be achieved. Jailani [13] explains that mathematics learning comic media function as media that can be used by teachers in the teaching and learning activities. The use of comic media appropriately may create learning more enjoyable so as to generate a more conducive classroom atmosphere. In addition, based on the results of research by Pardimin and Widodo's [22], it is explained that comic quality criteria covering mathematics validity, practicality and effectiveness can be concluded that the comic mathematics learning is feasible and can be used to carry out the teaching and learning activities. With the existence of mathematics comic teaching materials, it makes students interested in learning mathematics. In addition, Lestari and Chandra [23] concluded that the comic had been developed as a medium for supporting mathematics learning. It was hoped that this application would become a solution to increase students' interest in learning mathematics in an easy and more enjoyable way. And with the interest of students in learning mathematics, it certainly can improve mathematics learning outcomes.

## 5. CONCLUSION

The mathematical comic teaching materials effectively improve students' mathematics learning outcomes. The effectiveness of comics in mathematics teaching materials is showed on the increasing of the student learning outcomes. The use of mathematics comic teaching materials is very effective in improving student learning outcomes because it can attract students' learning interest, especially in reading. This increasing points is supported by the toobserve of  $8.98 > t$ table which is 2.045. In addition, the average of students' learning outcomes was 80.7 after being taught by using mathematics comic teaching materials. It is higher than the learning outcomes before being taught by using mathematical comic teaching materials at 71.6.

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