Implementation of comic on linear program material to increase mathematical understanding for students of XI grade senior high school

S Setiyani
Department of Mathematics Education, Universitas Swadaya Gunung Jati Cirebon, Jl. Perjuangan No. 1 Karyamulya, Kesambi, Cirebon, Indonesia

*setiyani_0401509081@yahoo.com

Abstract. The purpose of this study is to determine the results of educational comic implementation that has been developed in linear program material. The data were collected on students of XI grade selected by the purposive sample. This research uses quantitative descriptive approach. Data collection is done through observation of learning, test, and questionnaire of student learning interest after using educational comic. The results showed that educational comic could improve students mathematical understanding ability with N-gain value = 0.48 including high-quality improvement. Students interested in the following learning using educational comic media of 77% with high interest criteria. So educational comic media has been appropriate in its development because it can improve students mathematical understanding ability and student interest in learning.

1. Introduction
An effective learning is an effort to give a good explanation to the students so they can understand what they learn and how to use or apply it in daily. Comprehension is different from memorization, that is learning process which only gives knowledge in the form of the theories then saves it piles on the memory. The process of memorizing is ineffective learning. This is because in the learning process doesn’t give meaning and understanding to the students. The ability of understanding is the basic capital for students to be able for more interactive with the concepts that have been taught before the concepts are implemented or developed in accordance with the needs of the problems faced [1]. Similarly, Mathematical understanding is a key to solve mathematical problems as well as in real life problems [2]. In Indonesia, students’ understanding about the linear program material is still low. This statement is supported by data based on the results of Senior High School (Science Stream) National Examination in 2015/2016. The results of the examination show that students’ absorption in solving daily problems which are related to the linear program is only 52.70% [3].

Based on preliminary observation conducted by the students of XI Grade in SMA Negeri 8 Kota Cirebon, student’s mathematical comprehension in the linear program still needs to be improved. For example, when they were given a question that measures the ability of mathematical comprehension such as A yacht has 96 passenger seats. The ticket price for the business class is Rp 200,000.00 and economy class is Rp 150,000.00. Maximum carryable by every business class passenger is 60 kg and the economy class passenger is 40 kg. A yacht can carry goods up to 1800 kg. In order for the revenue
from ticket sales to reach a maximum when the yacht is full, please determine the number of seat economy class passengers! (Work on the algorithm).

Some students are unable to solve the problem clearly. They have difficulties in the initial steps of completion, so students are confused in the next step of settlement. Most students simply write answers like the figure 1.

![Figure 1](image)

**Figure 1.** The results of students answer who are less able to solve problems have difficulties in the initial steps of completion so that students are confused in doing the next settlement step.

The indicators of conceptual understanding in this research are in line with the 2013 curriculum including: presenting concepts in various forms of mathematical representation, clarifying objects based on whether fulfilled or not the requirements are forming the concepts, developing necessary and sufficient requirements from the concept, and applying the concept logically [4]. From the 28 students who worked on the test on linear program materials, only 4 students were complete in answering.

A linear program is one of the lessons in mathematics that contains many mathematical problems. Students often encounter problems in solving problems with linear program material marked with errors. In a training study conducted by the researchers, there are some difficulties faced by students in completing the linear program. First, determine the variable that is students understand the problem and transfer the information to a variable. Second, organize the information into the table means the students understand the purpose of creating a table. Third, determine the constraint function that is students determine the sign of inequality, understand the domain and do not equate the unit. Fourth, determine the objective function that is students write the form of the objective function and difficulty determining the coefficient. Fifth, determine the feasible area means students determine the line of an equation, determine the area of inequality settlement and determine the area of settlement system inequality. Sixth, determine the test point and check whether the test point is the optimum point that students understand the test point, determine the intersection of two lines and draw conclusions.

One of the alternatives assumed to improve student’s mathematical comprehension is by applying teaching materials that contain the problem of understanding the concept of linear program material. This teaching material is mathematical comic. Comic media can also be used as a teaching and learning media in the education field if the comic media can be designed in accordance with the needs of students and appropriated to the lesson that will be presented by the teacher. Comics books are a gateway to richer literature and the exploration of new, innovative, and rather even, untried ideas [5]. Comic media serves as a messenger of learning messages packed as interesting as possible for more meaningful learning. Meaningful learning will provide more experience and have more value for students in understanding the concept and meaning of learning. The use of comics that is oriented on real-life and character that is familiar to the students to have more value if used in learning [6].
Several studies have shown that comic media have a positive impact on learning, such as comic media effectively used in learning by students X-1 Pharmacy class with classic mastery reach 86% and student activity is 91.4% [7]. From other research results obtained that the comic can replace the student worksheet, connecting the abstract into concrete and through an interesting storyline can prevent student’s boredom [8].

2. Method
This research used experimental research with a quasi-experimental method where the research subject is not grouped randomly, but accept the condition of the subject as it is. The study was conducted by implementing mathematical comic on linear program material. The learning process is done in class XI IA 3 SMA Negeri 8 Cirebon and involves 24 students in the classroom. This research includes three stages of preliminary research, research and final stages of research. The research design used in this research is one group pretest-posttest design, that is by comparing between pretest score and posttest score. In this method, before the observer gives the treatment firstly, the observance are given pretest (preliminary test) and at the end of the learning, the observance is given a posttest (final test). The instrument of data collection used in the research is questionnaire of student interest, interview, and mathematical comprehension test. At the stage of implementation is given experimental treatment with comic implementation to see how much students understanding of the application of teaching materials, that is by measuring the improvement that occurred before and after learning is calculated by the formula gain index (normalized gain) as follows [9].

\[ N - gain = \frac{Skor\ posttest - Skor\ pretest}{SMI - Skor\ pretest} \]  

Table 1 is the following criteria for N-gain value:

| N - gain value | Criteria |
|----------------|----------|
| \( N - gain \geq 0,70 \) | High |
| \( 0,30 < N - gain < 0,70 \) | Medium |
| \( N - gain \leq 0,30 \) | Low |

Questionnaire of student interest is aimed to know the student’s interest in learning process using educational comic media. The data is transformed by aposteriori, it means the positive statements with strongly agree categories given the highest score, but negative statements with strongly disagree categories were scored lowest.

Here is the formula used by the researcher [9]:

\[ P = \frac{f}{N} \times 100\% \]

Where:

- \( P \) = Percentage of answers
- \( f \) = Frequency of answers
- \( N \) = Maximum number of scores
The criteria of student interest are presented in table 2 below.

**Table 2. Criteria for student’s interest.**

| Percentage of score interest | Criteria  |
|------------------------------|-----------|
| 76% - 100%                   | High      |
| 56% - 75%                    | Medium    |
| 0% - 55%                     | Low       |

3. Result and discussion

3.1. Implementation of mathematical comic

The mathematical comic on linear program material that has been developed in the previous stages using the ADDIE (Design, Development, Implementation, and Evaluation) learning design. Valid criteria obtained from the results of the assessment by media experts [10]. Based on the result of the validation assessment by the six experts was found that educational comic media to improve the ability of mathematical comprehension linear program material has a valid validity level, with 86.7% percentage. This indicates that the educational comic is suitable for use in the learning process in the classroom that will be applied at the implementation stage without any improvement figure 2.

![Figure 2](image-source)

**Figure 2.** The lesson in the image introduces the symbols of equation and mathematical inequalities.
This implementation step is the stage of delivering learning materials that are conducted in the classroom. Before the researcher has done a teaching and learning process in the classroom, there are some things that are prepared as syllabus, lesson plan, and educational comic media as a resource of the teaching and learning activity. The learning process is done in class XI IA 3 SMA Negeri 8 Cirebon and involves 24 students in the classroom. Implementation stage is done during 2 meetings in the classroom. For each meeting, the learning takes place for the duration of 90 minutes (2 hours lesson). Students who will follow the learning are given a test to know the student's ability from the beginning. Furthermore, after students follow the learning process using comic math media, students are given posttest to determine the student's final ability. In addition, to be given the test, students are also given a questionnaire of student interest to find out student's interest in the learning that has been done. The test and questionnaire are given to the students are the ways to evaluate the educational comic media that has been developed by the researcher.

3.2. Improvement the ability of student mathematical comprehension
The improvement of student’s mathematical comprehension is obtained from the result of pretest and posttest values. Explanation of student’s initial skills is shown in the following table 3.

| Ideal Score | X_min | X_max | Average | Std.deviation |
|-------------|-------|-------|---------|---------------|
| 100         | 3     | 35    | 16,13   | 8,804         |

Based on the table above, the pretest average of class XI IA 3 SMA Negeri 8 Kota Cirebon is still low. The test that was done by the students have detailed scores of each question are on a variety of scores. Quite a few students who almost get the maximum score on the matter of the indicators classify the objects based on whether fulfilled or not the requirements that form a concept and presents the concept in various mathematical representations itself. But on the questions of a linear program that contains the indicators to develop the necessary terms and conditions quite a concept and apply the concept algorithm, there are still students who get the minimum score. Based on the results of interviews conducted by a researcher with one of the mathematics teachers in SMA Negeri 8 Cirebon obtained information that there are still many students who see mathematics is a difficult lesson. The difficulties of students in learning linear program material are the number of steps in solving the problem on linear course material that requires students to thoroughly do it. This is in line with teacher’s difficulties in teaching linear programming material because many students are still unable to clear the question if it is different from the previous question. While the learning media of linear program uses PowerPoint software. Learning media in the form of print media used by teachers only book packages from government and Students Sheet book from school. Next, the student's final test information is displayed in the following table 4.

| Ideal Score | X_min | X_max | Average | Std.deviation |
|-------------|-------|-------|---------|---------------|
| 100         | 46    | 65    | 56,54   | 6,06          |

Based on the table above, it is known there was an improvement in the average score in the posttest stage (final test) if compared with the average pretest score (preliminary test). The average increase in the ability of mathematical comprehension is obtained after the learning using mathematical comic media.

The improvement of student’s mathematical comprehension using educational comic media developed by researchers is analyzed through two stages, namely the analysis phase of improvement of each indicator and the overall analysis phase. Before performing the analysis using Normalized Gain Test (N-gain), the data is tested for normality first. pretest normality test results with a
significance value of 0.163 and posttest normality test results with a significance value of 0.110. It shows that the value of significance on pretest and posttest is greater than the significant level of $\alpha$.

An improvement analysis of each indicator of student’s mathematical comprehension is conducted to find out the value and N-gain interpretation of each indicator of mathematical comprehension capability contained in educational comic media. The results of the improvement analysis of each indicator show that students have increased the ability of mathematical comprehension after learning using educational comic media. This is shown from the N-gain value of each indicator testing. This is an improvement analysis of mathematical understanding on each indicator as Table 5.

| Indicators | N-gain | Criteria |
|------------|--------|----------|
| Indicator 1 | 0.77   | High     |
| Indicator 2 | 0.68   | Medium   |
| Indicator 3 | 0.41   | Medium   |
| Indicator 4 | 0.32   | Medium   |

The next stage is the analysis of the overall indicators measured. This analysis is done by making an average of the total scores obtained by students during pretest and posttest. The average of the pretest and posttest scores used in determining the N-gain value. Based on the results of the calculation with N-gain formula, we obtained the value of $N_{gain} = 0.48$, with medium quality improvement.

3.3. Student interest in learning using comic education media
The result of data calculation of students interest in educational comic media aims to know the interest of students in learning using educational comic media that has been developed by the researcher. The main factor that can determine the degree of student learning activeness is student interest in learning [11]. So knowing the interest of students in learning can show how students activeness in learning.

$$P_{combine} = \frac{\sum P_t}{n} = \frac{1835\%}{24\%} = 77\%$$

Based on the results of the calculation, obtained for $P_{combine} = 77\%$. Criteria score of student interest, the calculation obtained that $P_{combine} = 77\%$ included in the high criteria.

4. Conclusion
Educational comic media developed by the researcher has been in accordance with the aim is to improve students' mathematical comprehension of linear program material. Improving students' mathematical comprehension skills uses the educational comic media with medium quality improvement. The benefits of instructional media such as educational comic are to improve the quality of student learning outcomes and students interest in learning mathematics. There is an improvement of interest from the students towards learning conducted using comic media. This is indicated by interactive movement when students follow the learning in the classroom. Students are more active and have an interest because learning using educational comic is a new way of learning for students. Students always feel curious and not saturated in the teaching and learning activity.

Acknowledgments
Grateful to the Mathematics Education Department of Universitas Swadaya Gunung Jati Cirebon who have given support to the writing of this manuscript.
References

[1] Firdausi N, Prabawa H W and Sutarno H 2017 Improve Student Understanding Ability Through Gamification in Instructional Media Based Explicit Instruction in *Journal of Physics: Conference Series* 812 1

[2] Amam A, Fatimah A T, Hartono W and Effendi A 2017 Mathematical Understanding of the Underprivileged Students through GeoGebra in *Journal of Physics: Conference Series* 895 (1)

[3] Utomo Kusmayadi T and Pramudya I 2018 High profile students’ growth of mathematical understanding in solving linear programming problems *J. Phys. Conf. Ser.* 1008 p. 012070

[4] Hendriana H, Rohaeti E and Sumarmo U 2017 *Hard Skills dan Soft Skills Matematik Siswa* (Bandung : PT Refika Aditama)

[5] M J Vulte 2013 *Comic Books and Other Hoks: 21th Century Education* (Bloomington: Author House)

[6] Kurniawati A A, Wahyuni S and Putra P D A 2017 Utilizing of comic and jember’s local wisdom as integrated science learning materials *Int. J. Soc. Sci. Humanit.* 7 1 p. 47–50

[7] Yulian V N 2018 Developing Teaching Materials Using Comic Media to Enhance Students’ Mathematical Communication *IOP Conf. Ser. Mater. Sci. Eng.* 335 p. 012110

[8] Widyastuti P D, Mardiyan M and Saputro D R S, Sep. 2017 An Instructional Media using Comics on the Systems of Linear Equation *J. Phys. Conf. Ser.* 895 p. 012039

[9] Lestari K E and Yudhanegara M R 2015 *Penelitian Pendidikan Matematika* (Bandung : PT. Refika Aditama)

[10] Adhitama I, Sujadi I and Pramudya I 2018 Discover the pythagorean theorem using interactive multimedia learning *J. Phys. Conf. Ser.* 1008 p. 012066

[11] Aritonang K T 2008 Minat dan Motivasi dalam Meningkatkan hasil Belajar Siswa *Jurnal Pendidikan Penabur* 10 11-21