

Android physics comics to train the mathematical representation ability on momentum and impulse of senior high school students

A N W Priyadi¹, H Kuswanto¹ and Sumarna²

¹ Physics Education, Universitas Negeri Yogyakarta, Sleman, Indonesia

² Physics Education, SMAN 1 Kalasan, Sleman, Indonesia

Corresponding author: ahmadnuwisnu@gmail.com

Abstract. The purpose of this study is to train students' mathematical representation abilities using the android physics comics of momentum and impulses. This research is an experimental research. This research was conducted in the 2nd semester of April 2019. Performed in the semester II on April 2019. Using 2 classes, namely X MIA 3 as comic modelling class with 22 students and X MIA 1 as comic implementation class with 24 students. The data collection instrument was in the form of a mathematical representation ability test that was tested before and after learning. Data analysis used the n-gain test to find out the increase in students' mathematical representation ability. The results of the n-gain analysis show that the comic modelling class is mostly in the medium category, while the implementation comic class is mostly in the high category. Based on the results of the analysis it can be concluded that learning using the android physics comic's application can improve the mathematical representation ability of students on the momentum and impulses.

Keywords: *physics, comic, android, momentum and impulses*

1. Introduction

In the era of the industrial 4.0 students are required to have critical thinking skills and problem solving, communication and collaboration, creativity and innovation. Then it is necessary to train students to have high-level thinking skills. Innovation in learning is very important, in order to support and practice the ability to confront industrial 4.0.

One form of practicing problem solving can be done through the ability of representation [1]. Display representation of students shows their ability to interpret physical phenomena, both verbally, mathematically, symbols and images [2], [3]. In learning physics the ability of representation is needed to support problem solving.

Mathematical representation is the most commonly used problems solving found in physics learning [3], [4]. But, students have difficulty in using mathematical representation capabilities. Students have difficulty especially when determining the equation that will be used on the problems raised [5]. Mathematical representation is a way of combining mathematical symbols and structures in physics using numbers, variables, and operating equations [6]. So that, important to train the mathematical representation ability of students.

Physics subject that gets a low percentage in answering correctly in the national exam 2018 is momentum and impulse that is equal to 40.91%. Based on the indicator of the questions tested on the



subject is a test of mathematical representation ability, which determines the speed of the boat when the passenger jumps from the boat and determines the speed of the billiard ball after colliding the two balls move to form an angle. So that, it is necessary to train and improve the ability of mathematical representation on the momentum and impulse.

Based on observations in SMA 1 Kalasan Sleman, the mathematical representation ability of students still needs to be improved, because students often forget to determine mathematical equations that will be used to problems solving in physics. The use of android in learning physics is used several times, but it is necessary for other innovations to support learning. The use of android physics in learning is still rare, because the use is limited to finding improve knowledge on the internet through the smartphone of each students. So that, education in the industrial 4.0 must always innovate including the use of learning media.

Learning media is one of the important aspects in assisting teachers in conveying information messages from the material to be delivered. One of the interesting media and little to develop in learning physics is comics. Comics have many advantages including using complex interactions between text and images, which provide the potential to convey concepts and motivate students' involvement effectively [7], not only containing material but also ordinary conversations between characters to avoid boredom [8], flexible, and characters are not always human [9]. Comics as learning media for students must be made according to the target age, related to daily life and there is humor [10]. Characters in comics do not have to be human, they can use local characters or inanimate objects. Communication through comics is very effective in conveying messages because it is an embodiment of objects, ideas, or information displayed in two dimensions. So there is a need for research into the use of comic media in delivering material momentum and impulses in learning physics.

If comics are used in learning, then the scientific content that will be conveyed must reach the reader. Therefore, in making comics as a teaching medium, teachers should adjust to the achievements of the basic competencies that will be achieved by students, in this case is to train students' mathematical representation abilities. Research [11] comics are effective in improving students' analytical abilities in dealing with problems. Analytical ability can support the ability to problems solving in this case is a mathematical representation, so students are easy to solve these problems.

Digital comics began to develop in the community, as well as many who use them. The distribution of comics not only with paper but can also use the internet can even be combined with digital technology. Looking at the rapid development of technology in the industrial 4.0, it can be utilized in support the distribution of comics. One technology that is widely used by students is a smartphone with Android operating system. Learning to use a smartphone can be accessed by students anytime, anywhere, and more flexible and saves time [12]. Android-based physics learning media have not been developed in line with the development of the internet and technology [13]. Android-based learning media can support the learning process of physics [14]. Android-assisted physics comics are very possible to be developed and used in learning. So that, it is necessary to develop physics comics with Android.

The comics developed are displayed conversations that guide students to improve their mathematical representation abilities. The comics developed can be used on an Android system. Contain of comics is momentum and impulse, and practice questions are used for students' discussion media.

2. Research methode

The type of research used is experimental research. The study used one group pretest and posttest design.

Table 1. One group pretest and posttest design.

Pretest	treatment	Posttest
01	X	02

2.1. Sampling

The sampling technique used is cluster random sampling. This research was carried out at SMA N 1 Kalasan, Sleman, Yogyakarta. The classes used are class X MIA 1 and X MIA 3. X MIA 3 as comic

modelling class and X MIA 1 as comic implementation class. In this study there was no control class, because this study used a one group pretest and posttest research design. Modelling comic class be taught by students, and implementation class be taught by physics teachers. The modelling comic class is used as a pilot class before the physics teacher learns in the implementation class. The physics teacher looks at learning in the modeling class, then applies the learning to the implementation class. Both classes use the same media, models, and lesson plan.

2.1.1. Data analysis technique. Collection data using pretest and posttest. The data obtained in the form of a score of students' mathematical representation ability on the subject momentum and impulses. To find out the increase in students' mathematical representation ability after the students are given treatment using comic, an analysis using n-gain test. The n-gain calculation refers to the following equation.

$$(g) = \frac{s_f - s_i}{\text{score maximum} - s_i} \quad (1)$$

(g) is the gain score, s_f is the score of posttest, and s_i is the score of pretest. Gain score (g) is converted to qualitative data using conversion rules according to Hake (1998) as listed in table 2.

Table 2. Conversion of n-gain to qualitative data three scale.

Interval gain score (g)	Criteria
$(g) \geq 0,7$	High
$0,3 \leq (g) < 0,7$	Medium
$(g) < 0,3$	Low

3. Results and Discussion

3.1 Result and data analysis

The study was conducted in the high school comic modelling class amount 22 students and the implementation of comic amount 24 students. The purpose of this study was to train mathematical representation abilities with android comic media.



(a)



(b)



(c)



(d)

Figure 1. Dialogues in comics that practice mathematical representation.

Figure 1 shows a dialogue between characters in a comic that reflects indicators of mathematical representation. Indicator of mathematical representation of synthesis results from experts in this study is that students are able to write problems into mathematical equations and are able to operate mathematical equations. The dialogue in the comics is based on the development of existing indicators, so that it is expected to be able to train and improve students' mathematical representation abilities. Mathematical representation indicators are developed in the form of dialogue between figures based on daily problems related to the momentum and impulse. Other than that, developed student worksheet such as figure 2.

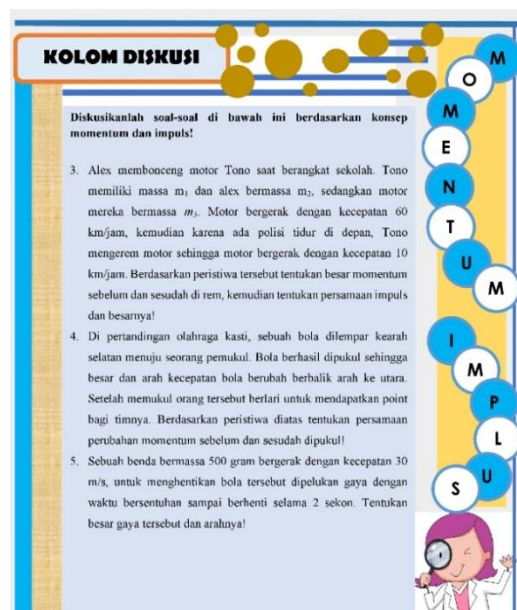


Figure 2. Student worksheet mathematical representation.

Figure 2 shows student worksheet, which aims to train students to solve problems in the form of everyday problems. The existence of dialogue and practice questions in the student worksheet, it is expected that the mathematical representation ability of students can increase.

Table 3. Pretest and posttest mathematical representation ability results.

Class	Pretest			Posttest		
	Score max	Score min	Average	Score max	Score min	Average
Modelling comic	65.4	19.2	46.5	100	46.2	74.4
Implementation comic	65.4	3.8	21.6	96.2	42.3	70.4

Table 3 shows the average pretest and posttest results of both classes. The average class result of the comic modelling class pretest was 46.5 while the implementation class comic was 21.63. This pretest is conducted to determine the initial ability level of students who will be treated. The treatment in the form of learning physics using android physics comics.

The average class of posttest results in the modelling comic class is 74.4, and the implementation class comic is 70.4. This posttest is conducted to determine the mathematical representation ability of students after being given treatment.

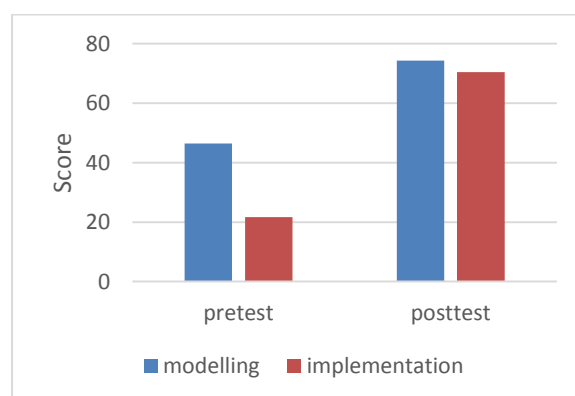


Figure 3. Graph of the average score of a mathematical representation ability.

Figure 3 shows the results of comparison of pretest and posttest mathematical representation ability of students in the modelling class and the implementation class. The figure shows the difference between pretest and posttest results. The difference can be seen an increase before and after learning to use physics assisted comics with android. The increase occurred in both classes. To find out the category of increase in the results mathematical representation ability, an n-gain test analysis was performed.

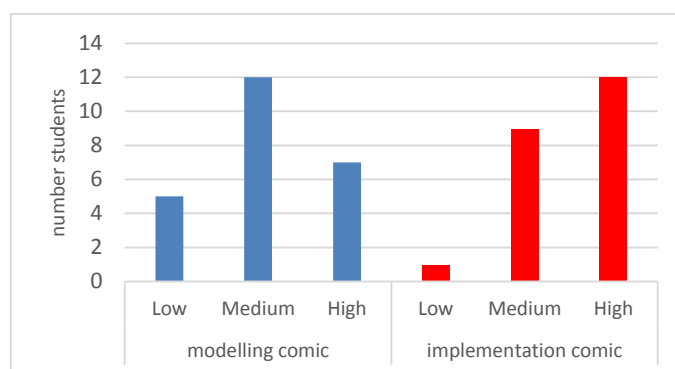


Figure 4. Graphic achievement of the number of students in the N-gain test category.

Figure 4 shows the results of the n-gain test analysis of the mathematical representation capabilities of the two classes. In the comic modelling class most of the increase in test results is in the medium category. In the high category were 7 students and the low category were 5 students. In the implementation comic class most of the increases in the high category were 12 students, 9 students in the medium category, and 1 student in the low category.

3.2 Discussion

Physics learning in schools examines physical phenomena that occur in nature. In the study, analytical skills are needed to solve the problems that arise. A form of problem solving that is often used is the ability of mathematical representation. The ability of mathematical representation makes it easier to solve physics problems in class [5].

Practicing students' mathematical representation abilities requires an interactive and familiar media with students. So that in this study using the android comic application media to train the mathematical representation ability. Indicator of mathematical representation ability is displayed in the form of dialogue in comics. Dialogue in comics discusses of momentum and impulse related to the lives of students. Dialogue not only contains material, but daily conversation to avoid boredom [9].

Comic media that are used in the form of an android application. The contents of the application in the form of the apperception videos, comics, and student worksheet. The apperception video is used as a teacher's apperception media before delivering learning. Comics describe daily events that are close to students, namely stories that take place in school settings related to the material momentum and impulses. The story is then based on an indicator of mathematical representation ability. Therefore, when students read stories they will practice their mathematical representation abilities. The student worksheet was created with the aim of training the representation of mathematical representation of students in real terms with a challenge. Comic media is used in one learning.

The results of this study are pretest scores and posttest scores in the modelling class comic and implementation class comic. Pretests are conducted to determine the level of mathematical representation ability of early students. The pretest results of both classes obtained low scores under the criteria minimum score. Then given the same treatment with different teachers. The results of the mathematical representation ability of the two classes tend to get an average in the category which is quite good, seen from the posttest score of the mathematical representation ability. The score of the mathematical representation ability of the comic modelling class is higher than that of the implementation comic class. This is in accordance with the research [15] physics comic media used can train the understanding of physics concepts and [16] can improve student learning outcomes in science. Understanding these concepts can support the ability to solve problems, one of which is the ability of mathematical representation.

In the modelling comic class the improvement of mathematical representation ability mostly tends to be in the medium category. The implementation comic class improvement is mostly in the high category. Based on results the use of android physics comics was successful in practicing the mathematical representation ability as seen from the increase in n-gain results. The implementation comic class taught by the teacher with the same lesson plan as the modelling comic class got a higher increase. This is because the comic implementation class pretest scores tend to be lower than the comic modelling class, so the increment will tend to be greater for the implementation comic class.

Viewed on the student answer sheet, there is an increase in student answers related to mathematical representation ability. Mathematical representation is a way of combining mathematical symbols and structures using numbers, variables, and operating equations [6]. This can be seen on the student answer sheet at the pretest, students tend to directly write down the equation and the final answer. So that, most of the students are trapped in the units used that have not been converted into SI units, so the answers become wrong. Other that, students are confused in determining the equation to be used, so it tends to be directly answered the final answer. While on the posttest answer sheet, students tend to follow the flow more mathematical representation indicators, making it easier to solve problems and look more systematic.

In the class, students are very enthusiastic in using physics comic's application media. This is because the use of physics comic's applications in physics learning has never been done before in class. Learning using the physics comic's android application is effectively seen from the achievement of the implementation of learning in accordance with the lesson plan that has been made, as well as increasing the mathematical representation ability of students in the medium and high categories.

4. Conclusion

This article contains about the use of android comics that are used to practice the mathematical representation ability of students. Based on the results of the analysis it can be concluded that the use of android physics comics can train and improve students' mathematical representation abilities on momentum and impulse.

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