

Learning optics with android- assisted comics: the impacts on students critical thinking

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Abstract. The purpose of this study is to improve students' critical thinking skills with the assisted of android comics learning media on optical material. The study was conducted at SMA Negeri 1 Kalasan, Yogyakarta with a data sample of 27 students. The study was conducted using the type of pre-experimental research. The data is taken using a cluster random sampling technique and the research design is one group pretest-posttest design. The test used is a critical thinking ability test in the form of essays in optical material, and it's validated by expert judgment. Test data were analyzed using n-gain analysis, the results of the analysis showed that the increase in students' critical thinking skills is in the average value of N-gain included in the moderate and high categories. Students who get the moderate category have an N-gain value of 0.53 with a percentage of many students at 44%. Meanwhile, students who get the high category have an N-gain value of 0.79 with the percentage of many students at 56%. This shows that android comics learning media is effectively used to improve students' critical thinking skills.

Keywords: *comics, effectiveness, critical thinking*

1. Introduction

The development of skills to deal with complex challenges needs to be done in the 21st century. The skills that need to be developed are high-level thinking, one of which is critical thinking ability [1]. The ability to think critically is an ability to evaluate statements, explain thoughts, and produce a decision to accept or reject the statements [2]. Critical thinking processes include considering an outcome from the point of view and reconstructing a thought to be better [3].

Part of critical thinking is also the ability to analyze information to determine the relevance of information in the interpretation of a problem [4]. Students will be able to make a solution that is faced with critical thinking skills [5]. An effort to apply this ability as early as possible to students also needs to be done because this ability can only be obtained through various processes [6]. With good processes and abilities, students can make rational decisions well [7]. However, students' critical thinking skills are still relatively low so they need to be improved [8]. This improvement can be done by integrating indicators of critical thinking skills into learning [9], [10].

Alignment between technological developments and human resources needs to be done in the Industrial Revolution 4.0 [11]. Efforts that can be made in this regard are digital literacy [12]. The leading media that applies digital literacy in the world of education and adds knowledge in comics [13].

The comic is a picture story that is not moving [14]. Comics contains elements of entertainment that encourage students to be able to think critically [10]. Comics as learning media are able to encourage



creative and critical ideas of students in understanding learning with fun [15]. Comics containing grooves and images are packaged attractively to make it easier to understand [16], [17]. Comics are also able to become superior learning tools [13]. Comics tend to be widely read by students because they contain an interesting set of illustrated stories, besides comics, also have an educational source that can stimulate students' activeness, creativity, and critical thinking [18].

The current development of comics is not only in the form of print but also in the digital form. Digital comics can be used in various applications, one of which is an android application. Android-based comics can be accessed easily anywhere and anytime, making it easier for students to learn [19].

Android comics have sections that can improve critical thinking skills, including images and narration. The narrative contains a story line that refers to indicators of critical thinking. Thus it is expected that the use of Android comics can improve students' critical thinking skills.

2. Research method

The type of this research is pre-experimental research. The study was conducted at SMA Negeri 1 Kalasan, Yogyakarta with a data sample of 27 students. The data is taken using a cluster random sampling technique and the research design is one group pretest-posttest design. Android comics contain material, narration, and flow that refers to critical thinking indicators applied to improve students' critical thinking skills. Android comic media used have passed the validity test with valid results.

The test is conducted at the beginning of learning (pretest) and at the end of learning (posttest) to see the value of increasing its ability to use N-gain. Indicators of critical thinking abilities are applied in the delivery of materials, the process of learning activities, and the test instruments are tested, while the details can be seen in table 1.

Table 1. Discussions and activities based on critical thinking skills

Indicator	Discussion	Activity
Analyzing facts	Learners analyze facts about the eyes and the camera in everyday life.	Learners can analyze the facts about the eyes and the camera from the video given the apresept activities on comic android
Formulate the main problem	Learners formulate the main problems relating to the material of optical devices namely eyes and cameras	Learners can connect the main problems in the material displayed in android comics.
Evaluate logical arguments	Learners evaluate logical arguments about the eye and the camera as optical devices.	Learners can evaluate the arguments presented by other groups and compare with the arguments that have been discussed in their respective groups
Make conclusions	Learners make conclusion of material on tools optics that covers the eyes and camera	Learners can conclude the results of learning and discussion conducted.

Table 1 explains the discussion and activities of each indicator. Starting from indicators collecting facts, formulating problems, evaluating arguments, until the indicators make conclusions have a description of the discussion and their respective activities.

Increased ability is measured by using the N-gain written in equation 1.

$$\text{standart gain (g)} = \frac{\bar{x}_{\text{Posttest}} - \bar{x}_{\text{pretest}}}{x - x_{\text{pretest}}} \quad (1)$$

The results of the calculation of increasing critical thinking ability from equation 1 are classified as in table 2 below.

Table 2. N-gain value classification table

Score (g)	classification
$g \geq 0,7$	High
$0,7 \geq g \geq 0,3$	Moderate
$g < 0,3$	Low

Table 2 explains the classification of acquisition value increases. There are three different classifications in the table, namely the classification of high, moderate and low increase.

3. Results and Discussion

Android comics before being implemented have been developed by media developers. Android comics that are valid with the results of the validity of the material and media experts are selected and used for learning. Android-based comics with the application of optical devices in everyday life are selected as comics that are in accordance with the material in progress. Comic content that leads to narration and plot based on the development of students' critical thinking abilities. The chosen comic form can be observed in figure 1.

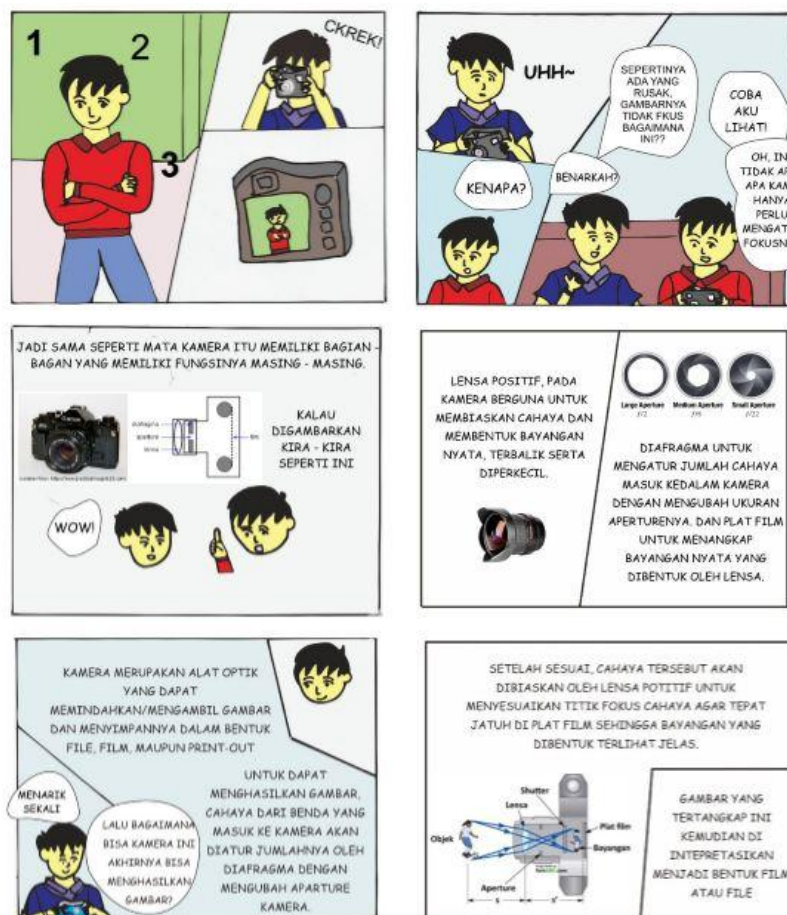
**Figure 1.** Android comics contain indicators of critical thinking



Figure 2. Android comics contain indicators of critical thinking

Android comics are applied with the help of discovery learning models. Students are divided into groups with 4 - 5 members each. After being divided into groups, the comics that have been shared are discussed. Each group was given one Student Worksheet (LKPD) which contained 5 critical thinking questions about the material contained in the android comics. LKPD is used as a discussion tool for the final discussion of material in android comics. Discussions and questions and answers are conducted at the end of learning to evaluate the breadth of students' critical thinking after using the android comic media in learning.

Measurement of the results of the application of learning media to improve students' critical thinking skills is done by giving 4 items that represent 4 indicators of students' critical thinking abilities. The test begins with a pretest to see the students' initial abilities and ends with a posttest to test the students' final abilities after the media is applied. The results of increasing students' critical thinking skills on each indicator are measured using N-gain. As for the data obtained, the results are shown in table 3.

Table 3. Table of N-gain values per indicator

Indicator	N-gain	category
1	0.56	Moderate
2	0.65	Moderate
3	0.58	Moderate
4	0.82	High

Table 3 shows that there was an improvement in the way students thought about each indicator. In indicator 1, which is an indicator of the ability of students to identify and analyze parts of the eye and the camera and its description. From this indicator, the N-gain value of 0.56 is recorded in the moderate category. Something similar happens p there is an indicator 2 which is an indicator of the abilities of students in formulating daily events simulations based on the function of each part of the eye, and

indicator 3 which is an indicator of the abilities of students in explaining the workings of the eye and its shadow formation. In both of these indicators, there was an increasing inability in the moderate category, with N-gain values respectively of 0.65 and 0.58. These results prove the existence of a critical thinking mindset that develops in students

Measurement of the ability to remember critical thinking reaches its peak on indicator 5, which is an indicator of students' ability to deduce the similarity of the parts of the eye and their work processes. On this indicator showed an increased ability to reach the category of high-value N-gain of 0.82. This increase occurs because students can infer material from the results of the application of media in learning. This is evidenced by the activeness of students during the discussion, questions and answers not only take place between students and teachers but also between students and students so that their enthusiasm for finding out becomes higher and being. These results can be seen in the development of the increase in Figure 2

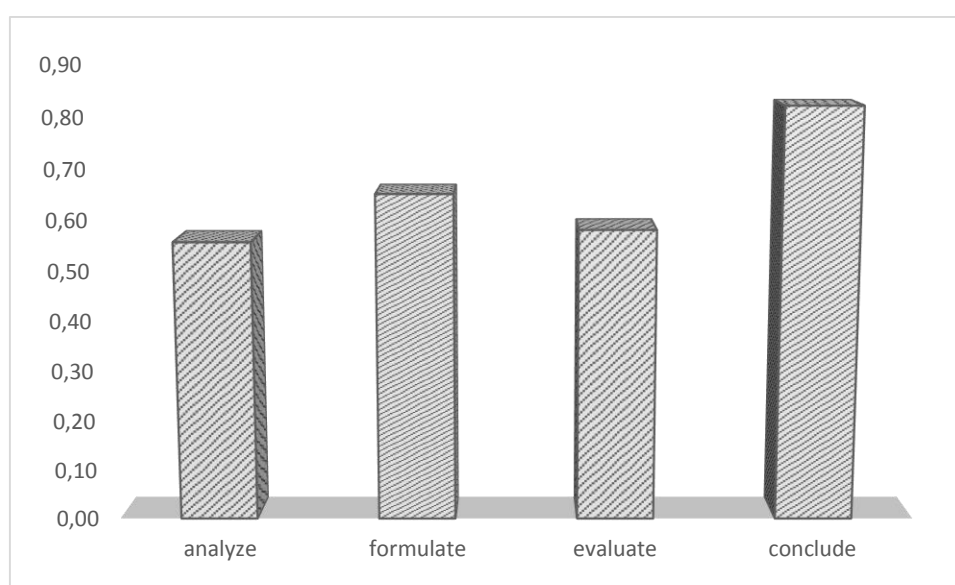


Figure 3. Diagram of the value of N-gin per indicator

The development of an increase in indicators can be observed in Figure 2. In Figure 2 an increase in the ability to think critically has the greatest increase in the indicator of summing up a problem.

The results of the improvement of each indicator are averaged to include. The average overall increase can be seen in table 4.

Table 4. Diagram of the value of N-gain per indicator

category	N-gain
low	0
medium	0.53
high	0.79

Figure 3 explains how students' critical thinking skills develop in the moderate and high categories with an average N-gain value of 0.53 and 0.79, respectively. The percentage results of many students who have reached the classification can be observed in Figure 4.

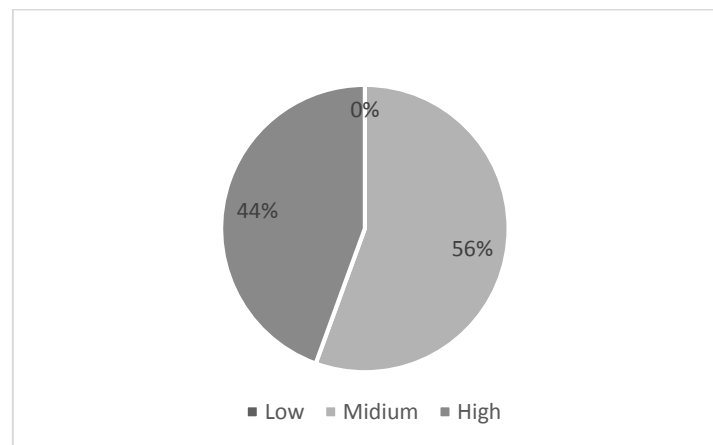


Figure 4. The results of the percentage value of N-gain

The results of this percentage indicate that many students who have reached the moderate category have reached 44% with a total of 12 students. Whereas for many students who have reached 56% high classification with 15 students.

Critical thinking is an important skill in real life [4]. Android comics can be used in improving understanding of concepts [19], learning outcomes [20], mapping cooperatively [15], creative thinking [12], and critical thinking with different results [10]. Comics can be used to divert students' attention to be more focused on learning, due to the fact that comics contain a series of images with certain grooves that can be understood even if there is no narration in them [10]. Android comic media based on data obtained, is proven capable of being applied in learning to improve students' critical thinking skills.

4. Conclusion

The application of android comic-based learning media with narratives and grooves is arranged in such a way that they are suitable and can be adapted to ongoing learning material can be used as one of the media that increases students' critical thinking abilities. The ability to think critically can be seen from the increase through the N-gain of each indicator. Increased ability on each indicator is the basis of the magnitude of the increase in the ability to think critically the average student as a whole is in the moderate and high categories.

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