

The use of android-assisted comics to enhance students' critical thinking skill

A E Damayanti¹ and H Kuswanto¹

¹Physics Education, Universitas Negeri Yogyakarta, Sleman, Indonesia

Corresponding author: almiraekad@gmail.com

Abstract. This study aims to determine improvements in students' critical thinking skills through android-based physics comics. This type of research is quantitative research using a one-group pretest-posttest design with a pre-experimental approach. The research sample was determined by purposive sampling as many as 44 students. This research was conducted in two classes experiments: experiment A and experiment B. The media used is an android-based comic about impulse-momentum material. Critical thinking skills of students analyzed by the results of the pretest and posttest. The results of the two classes tested showed an increase in posttest scores. N-gain for the experiment A and the experiment B shows the increase in the value of the pretest and posttest is in the medium category. Thus it was concluded that the Android-based physics comic that was developed could improve students' critical thinking skills.

Keywords : *critical thinking, comic, android*

1. Introduction

The progress of science and technology in the 21st century is very influential in the field of education. The purpose of the 21st century education system requires teachers to make innovation in learning [1]. The 21st century education requires students to have the skills to master concepts to a higher level [2]. One of the skills that can be developed is critical thinking skills [3]. Developing critical thinking skills helps students understand the information conveyed in learning. Critical thinking is a directed and clear process for analyzing, assessing students' thinking, and synthesizing [4], [5]. Critical thinking skills become a major component in learning physics [6].

Physics is one part of natural science [7]. Following the demands of the 2013 curriculum, learning is centered on students. Physics learning in schools should be able to make students to be creative, independent and active [5]. In school, physics material contains a lot of abstract concepts. These abstract concepts that are the cause of understanding of students require high imagination [8]. Learning media that are often used by educators in the delivery of Physics material are still in the form of worksheets, PPT made by educators, textbooks, and learning videos. The learning media used have varied, but more innovative media are needed and can attract the attention of students in the learning process. Physics is more interesting if it is packaged in the form of picture books or comics, where comics can help in visualizing abstract concepts [9].

The development of science today, making comics not only as a medium of entertainment but can be used in education [10]. Comics are loved by all groups, young and old. Comics are the best way to encourage students to think. Comics are now used as an effective method in education especially at the secondary school level [11]. The use of comics with a concise storyline and colorful illustrations will



attract students of all ages [13]. Physics Comics make it easy for students to remember and understand the contents in the story [12]. Physics Comics as a learning media can trigger motivation and enthusiasm for learning because the contents of the story are following the daily environment that will help students compete with the international environment. [13], [14]. Physics learning by using comic media indirectly makes students develop their thinking skills [12]. Currently the communication medium size grip or better known as gadgets to be the most in-demand by Indonesian society. Therefore, printed comics can be packaged in the form of digital or android comics for learning following technological developments.

Digital comics are a form of transformation from printed comics to technology comics in the form of digital electronics [14]. Digital comics can be made in the form of an android application. Comics that are packaged in the form of android allow easy for students to carry anywhere. Android comics also allow paper savings, besides content that can be filled not only with learning material but can be filled with animation, learning videos and tests in large quantities [9]. Digital comics can create a more meaningful learning environment, where the material taught is directly related to the lives of students. Besides, students can play an active role in learning.

The ability to think critically will be easily enhanced if the media has advantages such as attractiveness and makes students happy to read. The use of android comics is expected to improve students' critical thinking skills on impulse-momentum material.

2. Research method

This research is quantitative research using a pretest-posttest design with a pre-experimental approach. This research was conducted at SMA Negeri 1 Kalasan, Yogyakarta. The sample of this research was determined by purposive sampling technique from 44 students. This research was conducted in two classes experiments: experiment A and experiment B.

The media used are android comics on impulse-momentum material. Android comics used have been tested for feasibility by material and media experts. The comic used contains impulse-momentum material and its role in daily life where the plot and narration are based on critical thinking indicators according to the needs of students. Android-based comics consist of comic stories, discussion columns, apperceptions that can encourage students' critical thinking skills and review. Comics are made in the form of android so that they can be accessed more easily wherever and whenever by students.

Analysis of pre-learning ability is done before the android comic media is used by giving a pre-test at the beginning of learning. Pretest contains five questions of critical thinking. Android comics are applied during learning where 11 discussion groups are formed which consist of two people in each group. Critical thinking skills have been formed from the beginning of learning. Before starting the core learning phase students are given apperception through videos contained in the android comic feature. Then a few questions will arise about the video to start a small discussion. Comics that contain plot and story based on indicators of critical thinking will be used in the core activities as material to answer questions in the discussion column. End of learning activities are presentations, questions and answers between students and teachers act as facilitators, learning at this stage as a form of climax of the range of learning in shaping students' critical thinking skills.

Analysis of abilities after learning is done by giving a posttest. Posttest contains five items of critical thinking. Indicators of critical thinking can be seen in table 1 which was adopted from summarizing the analysis of several studies.

Table 1. Indicators of critical thinking skills.

Indicator	Discussion	Activity
Analyzing the facts	Students analyze the facts in the daily life of the material impulse	Students can analyze the facts about impulse material by view videos on android-based physics comics in apperception activities
Formulate the main problem	Students formulate the main problems related to the momentum of the material	Students can connect subject matter with material displayed in Android-based physics comics
Evaluate the logical argument	Students evaluate logical arguments about the concepts of momentum and impulse	Students can evaluate the arguments presented by other groups and compare with the arguments that have been discussed by the group
Make conclusions	Students make conclusions about the material momentum and impulse	Students can conclude the results of learning and discussion conducted

Analysis of the influence of the use of android comics is used by calculating the n-gain to see an increase in students' critical thinking skills. Here is the n-gain formula [13]:

$$N - \text{gain} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}} \quad (1)$$

Where n-gain is gain or increase, S_{posttest} is the sum of the posttest scores, S_{pretest} is the number of pretest scores and the maximum is the maximum (ideal) score. N-gain obtained will be clarified if $g > 0.7$ then the result of N-gain is in the high category, if $0.7 > g \geq 0.3$ then the n-gain generated is in the medium category, and if $g \leq 0.3$ then the resulting n-gain is in the low category.

3. Results and Discussion

The results of this study include an increase in critical thinking skills in learning using Android-based physics comics. Comics are used with storylines that are made according to indicators of critical thinking skills. Instrument questions to measure critical thinking skills of learners are prepared based on the indicators of critical thinking skills. Each instrument is structured to meet the indicators of critical thinking. In the learning process, students as the center of learning and teachers only as facilitators. This helps train students' thinking skills. In accordance with previous research statements that the role of teachers is very important, because in this case educators do not teach, but support and intervene students to learn. Thus students will learn to respect and respect each other in class. Besides that, it encourages students to develop their own concepts to show various forms of knowledge they have mastered [15]. The application of critical thinking skills indicators in comics can be seen in figure 1 and figure 2.



Figure 1. Android-based physics comic.

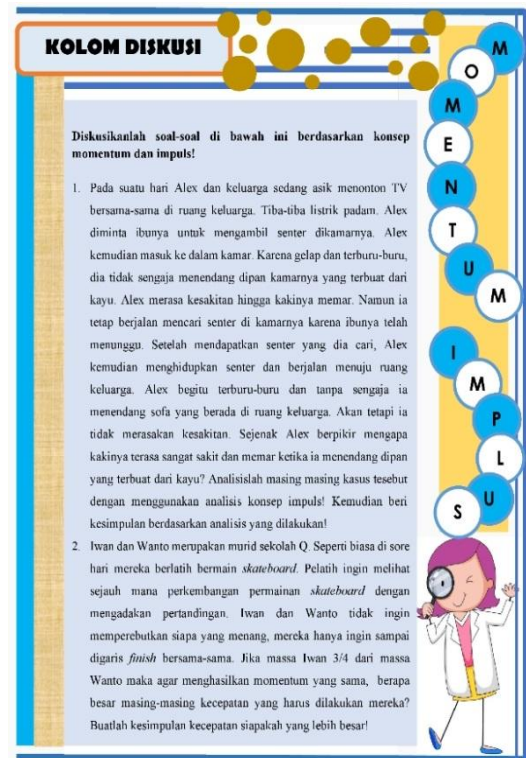


Figure 2. Problem critical thinking.

The results of increasing students' critical thinking skills use the gain test. There are three things about N-gain that are above 0.0 and less than 0.3 with low criteria. N-gain is more than equal to 0.3 and less than 0.7 with medium criteria and N-gain with value more than or equal to 0.7 and less than 1.0 with high criteria. Learning outcomes on cognitive tests aim to measure the increase in students' critical thinking skills on momentum and impulse material using Physics comics based on android. Data were selected by purposive sampling for 22 students in each class. To find out the increase in learning outcomes can be seen in figure 3.

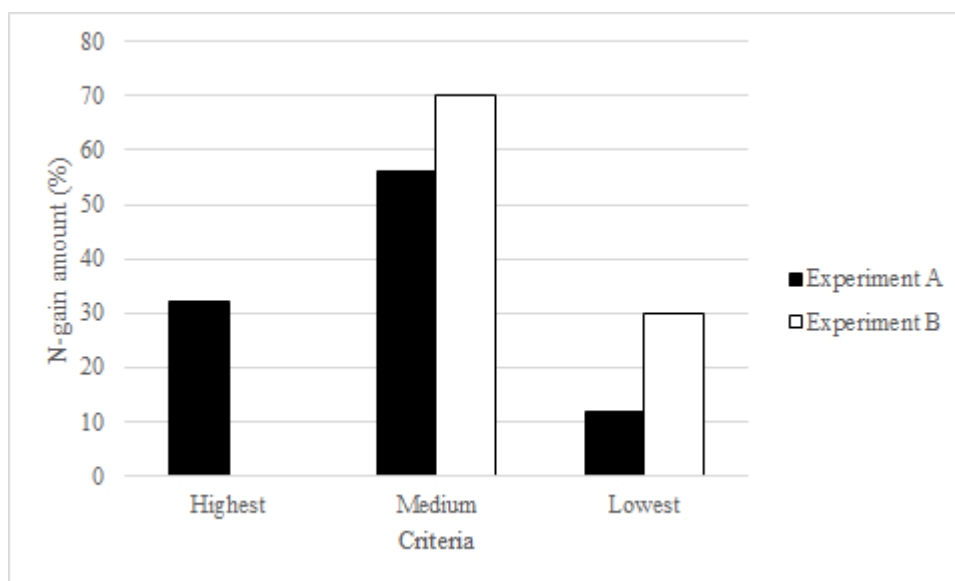


Figure 3. Achievement of the N-gain class experiment A and experiment B comics android.

Figure 3 shows the results of the achievement of the N-gain class samples and class implementation are categorized into three categories: high, medium and less. . The percentage of gain scores in the high category in experiment A is 32% and 0% in experiment B. The percentage gain score in the medium category is 56% in experiment A and 70% in experiment B. The percentage score obtained by the low category is 12% in experiment A and 30% in experiment B. From the results of each N-gain score, an increase in learning outcomes can be seen through the average gain of the total pretest and posttest in table 2.

Table 2. Data from the analysis of learning outcomes.

	Experiment A		Experiment B	
	Pretest	Posttest	Pretest	Posttest
Lowest	0	25	6.3	25
Highest	81.25	100	43.8	62.5
Amount	712.5	1200	431.3	931.3
Average	32.4	54.5	20	42

Table 2 is a data analysis learning outcome. The learning achievement test is carried out twice. Pretest at the beginning of the meeting was held before the use of android comics and the posttest at the end of the meeting was held after the use of android comics. Experiment A for the lowest pretest results of 0 and the highest results of 81.25 with a total of 712.5. Improved student learning outcomes can be seen from the results of the post-test which increased significantly with the lowest results 25 and the highest results 100. The number of posttest results for the experiment A is 1200. The average results of the pretest of the test class are 32.4 and the posttest is 54.0. The difference between the two assessments is 21.6. This shows an increase in students' critical thinking skills with an increase of 21.6. The experiment B for the lowest pretest results was 6.3 and the highest results were 43.8 with a total of 431.3. Improved student learning outcomes can be seen from the results of the posttest which increased significantly with the lowest results of 25 and the highest results of 62.5. The number of posttest results for the experiment A is 931.3. In the experiment B, the average pretest results were 20.0 and the average posttest results were 42.0. The difference between the two ability tests is 22.0, which means there is an increase in critical thinking skills between the results of the pretest and posttest with an increase of 22.0. This shows the influence of the use of Android-based physics comics on learning outcomes that measure the level of critical thinking skills. The statement was also supported by previous research that the discussion method using the concept of cartoons to develop students' critical thinking skills was very effective. Learners are freely asked to express their thoughts through open questions and discuss them in groups. Besides colorful cartoons, encouraging active participation for students in learning can play a role in the development of critical thinking [4]. Improved learning outcomes can also be seen from the gain values shown in table 3.

Table 3. Data pretest-posttest gain.

	Class	
	Experiment A	Experiment B
Lowest	0.1	0.1
Highest	1	0.5
Amount	7.8	6.2
Gain	0.4	0.3
Category	Moderate	Moderate

Student learning outcomes test data for the experiment A obtained the lowest results of 0.1 and the highest of 1 with a total of 7.8. In the experiment A, the average gain value is known to be 0.4 with moderate criteria. The gain value indicates an increase in students' critical thinking skills in the medium

category. Student learning outcomes test data for the experiment B obtained the lowest results of 0.1 and the highest results of 0.5 with a total of 6.2. The experiment B is an average gain value of 0.3 with a medium category. Thus it was concluded that the Android-based physics comic that was developed could improve students' critical thinking skills. Improved test results can be seen in figure 4.

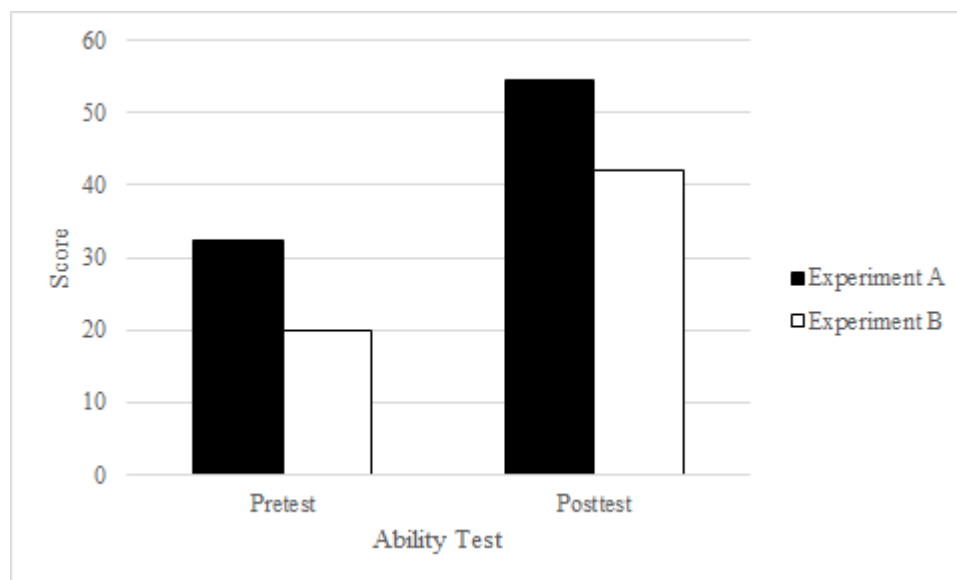


Figure 4. Pretest-posttest diagram.

Figure 4 shows that the average gain increases in each class. Learning outcomes of students before using an Android-based Physics comic until after using an Android-based Physics comic showed an increase. This is supported by statements stating the use of interesting teaching materials with characters integrated in the form of comics makes students interested in learning. Learning using comic media can improve students' understanding [15]. The ability of an Android-based Physics comic in presenting impulse-momentum material is very helpful for students in learning. The concepts of impulse-momentum material can be conveyed well to students using Android-based physics comics. Simple language and attractive appearance make students can understand impulse-momentum material more easily. This is consistent with previous research that science comics become a tool to facilitate the delivery of science learning to students in a fun way. Previous research emphasizes that science comics can improve students' critical thinking skills [12]. Comics can be used as learning media that can interpret knowledge and apply science strongly because in learning that uses comic media will be more interesting and stimulating. The resulting learning outcomes increased significantly.

4. Conclusions

The application of Android-based physics comics gets a positive response from students. Comics can be used to improve students' critical thinking skills. Good verbal packaging with narration and directed flow makes comics more interesting. The results of the two classes tested showed an increase in posttest scores. N-gain for the experiment A and experiment B shows the increase in the value of the pretest and posttest in the medium category. Thus it was concluded that the Android-based physics comic that was developed could improve students' critical thinking skills.

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