

Development of android-based learning media on light reflection material to improve the critical thinking skill of high school students

N Sholihah¹, I Wilujeng¹ and S Purwanti²

¹Physics Education, Universitas Negeri Yogyakarta, Sleman, Indonesia

²Physics Education, MAN 2 Yogyakarta, Yogyakarta, Indonesia

Corresponding Author: nafiatussholihah.2018@student.uny.ac.id

Abstract. The purpose of this study are 1) to develop physics learning media in light reflection material, 2) to know the improvement of students' critical thinking skill after implementing android-based learning media in their study. Research method used was 4-D namely Define, Design, Develop, and Disseminate. The sample of this research was 20 students of class XI MIPA in MAN 2 Yogyakarta. The technique used for collecting data was tests (pretest and posttest) and non test. The instruments used for collecting data was learning media validation sheets and question sheets. The data analysis technique used a sign test to determine the effect of learning media on critical thinking skills improvement. While the improvement on critical thinking skills using the normalized N-Gain equation. The results of this study was 1) learning media developed was valid, 2) android-based learning media improved students' critical thinking skills as evidenced by the value of sig $0.00 < 0.05$, and 3). There is an improvement on students' critical thinking skills calculated using N-gain equation with a low category namely $g > 0.03$ and a high category which is $0.03 < g < 0.07$.

Keyword: *android, learning media, light reflection, critical thinking*

1. Introduction

Physics very closely related to everyday phenomena. Thus, mastery of concepts, theories, and physical principles are very important to solve the problems of life [1-3]. Additionally, Regulation of Education Ministry No. 21 stated on the content standards that physics lessons related to the way a student learns about natural phenomena and phenomena that occurred around them. Thus, learning physics is emphasized on direct experience to develop students' potential in understanding the surrounding environment. The purpose of learning physics is to create problem solvers [4]. Solving these problems can be done using the main components in physics learning, namely the ability to think at a higher level [5]. By thinking at higher level, student will be helped in solving a problem and being critical for the problems they face [6].

Technology has been developed rapidly and give some impacts to many sectors such as education sector. 21st century learning leads to understand the content, teaching methods and the use of technology. Many teachers have not adapted to the rapid development of technology, whereas today teachers are required to use technology in the learning process. [7]. Based on the signs mentioned above, educators are emphasized to take part by using technology in the learning process as a form of innovation. Teaching with technology can introduce students about the use of technology, create the



learning interactively, and help them to use the technology to enhance their problem solving skills [8], [9]. Furthermore, the learning environment ultimately demands to be more interactive, innovative and effective [10].

The development of technology has created an innovation in various fields such as mobile learning. Mobile learning with android platform is almost owned by everyone from teenagers to adults. Using it as a learning media is very important and has a positive impact on student. The use of technology as a learning tool also greatly affects the effectiveness of learning and improves students' critical thinking skills [11].

In this research, researcher will develop android-based learning media on light reflection material and analyse the improvement of student critical thinking after applying android-based learning media on their study. The above question becomes main question that will be examined in this study.

2. Research method

This was Research and Development that used 4D namely Define, Design, Develop, Dessiminate. Define stage, researcher conducted an analysis of students, curriculum, material, and relationship between media development and critical thinking skills. The relationship matrix was shown in table 1.

Table 1. Matrix of integrated learning media development in critical thinking skills.

| Critical thinking indicators | Material | |
|--------------------------------|---|---|
| | Reflect light | |
| | Convex | Concave |
| Reveal simple explanation | Reveal special light | Reveal special light |
| Improving basic skills | Estimate process of shading refers to media android | Estimate process of shading refers to media android |
| Concluding | Determining the process of shaping a shadow | Determining the process of shaping a shadow |
| Providing further explanation | Explaining the formation of shadows in different object locations | Explaining the formation of shadows in different object location |
| Finding tactics and strategies | Deciding the characteristic of shadows that are formed with different objects locations | Deciding the characteristic of shadows that are formed with different objects locations |

At design stage, researcher began to design learning media accordance with the matrix in table 1. Followed by *develop* which is validating research products and instruments that have been developed. The validation process is carried out by expert lecturers, namely material experts and media experts. The validation results were analyzed quantitatively using the V'Aiken equation to determine the value of content validity. The following is the equation V'Aiken [12]:

$$V = \frac{\sum s}{n(c-1)} \quad (1)$$

With, V is the content validation coefficient of Aiken's V, s is $r - l_0$, r is score given by the validator, c is the highest validity rating score, l_0 the lowest validity rating score. Score obtained from the validation of learning media and test questions were then changed to a qualitative form with 4 criteria according to the range of V'Aiken index in table 2.

Table 2. Validity criteria.

| Validity result | Validity criteria |
|--------------------|-------------------|
| $0.8 < V \leq 1$ | Very Adequate |
| $0.6 < V \leq 0.8$ | Adequate |
| $0.4 < V \leq 0.6$ | Less Adequate |
| $0.2 < V \leq 0.4$ | Inadequate |

Assessment of learning media was analyzed by calculating the average score obtained from media and material experts. Average score of each component was calculated using the following equation:

$$\bar{X} = \frac{\sum X}{n} \quad (2)$$

With, \bar{X} the average score rating, $\sum X$ is total score of each component and n is number of validator/assessor.

Table 3. Assesment criteria of android-based learning media.

| Score | Category |
|--|----------------|
| $X > \bar{X}_i + 1.8sb_i$ | Very good |
| $\bar{X}_i + 0.6sb_i < X \leq \bar{X}_i + 1.8sb_i$ | Good |
| $\bar{X}_i - 0.6sb_i < X \leq \bar{X}_i + 0.6sb_i$ | Good enough |
| $\bar{X}_i - 1.8sb_i < X \leq \bar{X}_i - 0.6sb_i$ | Less good |
| $X \leq \bar{X}_i - 1.8sb_i$ | Very less good |

The last stage is disseminate, at this stage a limited and extensive trial of the product was carried out. A trial was conducted to find out whether there was an improvement in students' critical thinking skills or not. This research was conducted in Yogyakarta Indonesia. The subjects of this study were students of class XI MIPA in the 2018/2019 school year with a total of 40 children. Data collection techniques using tests and non test. Research instrument used was multiple choice question sheet to measure students' critical thinking skills and learning media validation sheet. Technical data analysis using descriptive and quantitative analysis. The influence of learning media on increasing the value of critical thinking skills was tested using non-parametric statistics, namely the *sign test* with the help of SPSS. So we get the frequency of increase and decrease in value. Similarly, to determine the average results pretest and posttest using descriptive analysis. As for knowing the average improvement in critical thinking skills can be calculated using the normalized gain equation (N-Gain) [13]:

$$N - \text{gain} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maximum}} - S_{\text{pretest}}} \quad (3)$$

With, S_{posttest} is score of posttest, S_{pretest} is score of pretest and S_{maximum} is maximum score achieved by students. The categorization criteria at the N-Gain level is shown in table 4.

Table 4. N-gain level criteria.

| Limit | Categori |
|-----------------------|----------|
| $g > 0.7$ | High |
| $0.3 \leq g \leq 0.7$ | Medium |
| $g < 0.3$ | Low |

3. Result and Discussion

V'Aiken calculation results stated that the learning media and research instrument were valid. The validity levels of both of them fell into the high category is shown in table 5.

Table 5. The results of data collection instrument validity.

| No. | Data collection instruments | V'aiken coefficient | Explanation |
|-----|------------------------------------|---------------------|-----------------------|
| 1 | Assessment of learning instruments | 1 | Valid (very adequate) |
| 2 | Task assessment sheet | 1 | Valid (very adequate) |

Assesment result of learning media by media and material experts are presented in table 6.

Table 6. Results of android-based learning media assessment.

| No. | Aspect | Assessment results | Explanation |
|-----|------------------------|--------------------|-------------|
| 1. | Media expert | | |
| | Program operation | 2.85 | Very good |
| | Navigation | 2.92 | Very good |
| | Learning media display | 2.88 | Very good |
| 2. | Material expert | | |
| | Learning competency | 3.00 | Very good |
| | Material | 2.96 | Very good |
| | Task | 2.84 | Very good |
| | Average score | 2.90 | Very good |

Table 6 shows that the average score of media assessment by media and material experts were 2.90 with a very good category. The assessment shows that learning media was feasible to be implemented in learning namely small-scale learning in limited trials and large-scale learning in large trials. The display of android-based learning media developed on the light reflectance material is presented in figure 1.

**Figure 1.** Android-based learning media display.

The initial display of the media was designed to facilitate students in operating the system. Starting from the title of the material being studied, class units, menu of learning competency, material, pictures (containing simulations), practice questions, and application of concepts shown on the video. The media were then tested on students as treatment in improving critical thinking skills [14].

Obtaining statistics on students' critical thinking skills through the results of the pretest and posttest scores to find out the average value, that was, before and after treatment given. The following is SPSS calculation data in table 7.

Table 7. Results of descriptive statistical analysis.

| | N | Minimum | Maximum | Mean | Std. Deviation |
|--------------------|----|---------|---------|-------|----------------|
| Pretest | 20 | 20 | 50 | 36.50 | 8.127 |
| Posttest | 20 | 40 | 80 | 57.50 | 10.699 |
| Valid N (listwise) | 20 | | | | |

Table 7 states that the average pretest value of students is 36.50 with a minimum value of 20 and a maximum value of 50, while the average value of posttest 57.50 with a minimum value of 40 and a maximum value of 80. The average value of students increases by 21 points after being treated. After analyzing descriptively, a sign test was tested to determine whether there was an influence of the use of instructional media in improving students' critical thinking skills. The following are the results of sign test in tables 8 and 9.

Table 8. Sign test frequency.

| | | N |
|------------------|----------------------|----|
| Prottest-Pretest | Negative Differences | 0 |
| | Positive Differences | 20 |
| | Ties ^c | 0 |
| | Total | 20 |

Tabel 9. Analysis results of sign test.

| | Posttest-Pretest |
|---|-------------------|
| Exact Sign (2-tailed) | .000 ^b |
| ^a Sign Test | |
| ^b Binomial Distribution Used | |

Table 8 states that overall students have increased their critical thinking skills in terms of the results of the pretest and posttest. Wardani, Lindawati, and Kusuma [15] revealed that Android-based learning media improved critical thinking skill of students. This statement was also supported by research conducted by Shabrina and Kuswanto [17]. While the results of *sign* test analysis in Table 9 can be concluded by using a significance level (α) of 5%, it can be concluded that the null hypothesis is rejected as indicated by the sig value. = 0.00 < 0.05 (α), it can be stated that there is an influence of learning media on improving students' critical thinking skills. Obtaining statistical data on the results of critical thinking skills tests before and after using android-based learning media can be seen in Table 10.

Table 10. Pretest and posttest score.

| Range of Score | 20-30 | 31-40 | 41-50 | 51-60 | 61-70 | 71-80 |
|----------------|-------|-------|-------|-------|-------|-------|
| Pretest | 9 | 8 | 3 | | | |
| Posttest | | | 1 | 15 | 2 | 2 |

Students' critical thinking skills increased after being treated using android-based learning media can be calculated using the normalized N-Gain equation with the results as shown in figure 2.

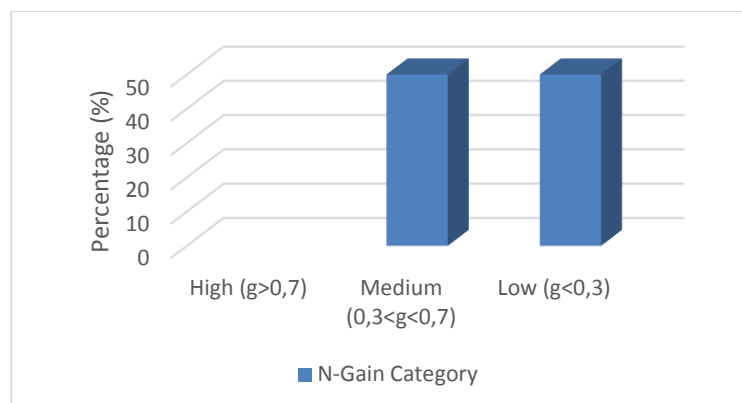
**Figure 2.** The improvement of critical thinking skill using N-gain.

Figure 2 shows the critical thinking skills of students in class XI MIPA 3 MAN 2 Yogyakarta after learning using the Android-based learning media is higher than learning without using that media [16]. thus it can be concluded that an increase in the value of students' critical thinking skills with the category $g > 0.3$ by 50% (low) and $0.3 > g > 0.7$ by 50% (medium). There was no improvement in high category. This was caused by several factors including limited learning time so students are less than optimal in absorbing and understanding the material that has been delivered by the instructor. The same factor also explained by Wardani, Lindawati and Kusuma in their research [15]. From the explanation

above shows there was a relationship between critical thinking skills and android-based learning media. This was because students were accustomed to accessing or operating Android so that learning in digital form can be easily adjusted. As for other things that affect the improvement of students' critical thinking skills learning is done by using problem based learning in which students were required to find solutions from the problems they faced.

4. Conclusion

Android-based learning media developed were valid and feasible based on material and media expert judgment with the aspects mentioned above. Learning was carried out using this learning media, especially in the light reflection material on concave and convex mirrors which was able to improve students' critical thinking skills. There was also the influence of learning media with critical thinking skills as evidenced by the results of statistical tests using the sign test.

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