DEVELOPMENT OF ADOBE FLASH BASED LEARNING MEDIA TO TRAIN STUDENTS' CRITICAL THINKING SKILL WITH TOPIC OF OPTICAL INSTRUMENT

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ABSTRACT

This research employs a developmental research design with 4D model and tested on grade X senior high school students with one group as the subjects for the pretest and posttest. Learning media and supporting tools in this research, developed as a jigsaw-type cooperative learning model, were expected to be able to train students' critical thinking skills. The students' critical thinking skills improved as represented by the average N-gain score of 0.83 for replication I and 0.88 for replication II, and it was categorized as a high category. This research concluded that Adobe Flash-based physics learning media with the topic of "optical instrument" can be used to train students' critical thinking skill.

Keywords: *Adobe Flash, Adobe Flash-based learning media, optical instrument, critical thinking skills, high school physics*

INTRODUCTION

Critical thinking is thinking sensibly and rationally. This skill involves the ability to think properly and systematically and follow the rules of logic and scientific reasoning (Lau, 2011). Critical thinking is a process for making rational decisions that aim to decide whether to believe or do something (Ennis, 1996). It requires interpretation and evaluation of observation, communication, and other sources of information (Fisher, 2009). Therefore, critical thinking is a process for analyzing or evaluating information obtained through observation, experience, induction process, deduction process, or communication. Additionally, the best learning of critical thinking skills is obtained by teaching on a topic familiar to the student (Slavin, 2006).

Furthermore, according to Ritdamaya and Suhandi, the critical thinking skills of students are relatively low (Ritdamaya & Suhandi, 2015). This is because students have not been familiarized, applied, and trained in critical thinking skills either through process or assessment of learning. It is necessary to construct student-centered learning to train critical thinking skill so that students have chances to construct their knowledge and understanding of physics products. With regards to this, one of the topics in physics lessons that is taught to high school students is about optical instrument. It is to be studied further in this present research to investigate a possibility of improving critical thinking in learning a lesson.

In a student-centered learning process, knowledge can be obtained through some types of media and teamwork-based learning method (Antika, 2014) and one of the cooperative learning models is Jigsaw. Jigsaw can motivate students to learn the material as best they can in a team of experts, so they can help the team of origin to complete a task well. The jigsaw type in the cooperative learning model is designed to enhance students' sense of responsibility for their learning as well as the learning of others. A learning media related to this is then selected for this study.

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Learning media is a tool, method, and technique used in order to more effective communication and interaction between teacher and student in the process of education and learning at school (Hamalik, 1985). One learning media that can make the learning process more attractive is using the computer. It is potential to be a learning tool because it has some advantages, such as be able to show moving objects with sound. Thus, computer media can make learning more attractive. Computers are also able to run programs which are designed to stimulate some experiments that are difficult to be done by students. In presenting teaching materials, the computer can be controlled by the wearer to facilitate in understanding the material he studied (Hana, 2006).

One of the software programs that can be used to make computer-based learning media is Adobe FlashFlash. One of the advantages of Adobe Flash compared to other similar software programs is the size of the final project file that is relatively smaller than other software products. The final project file also has a good quality; however, it does not require high specification hardware. In relation to this, a learning material that is appropriate to be developed using computer-based media is physics materials which are abstract and microscopic (Wiyono, 2015). One of them is optical instrument because, in optical instrument experiments, most students can only observe the final image without observing the rays that construct that image. With computer-based media, students can observe the ray's construction in an optical instrument when an image is formed.

The use of computer-based learning media in physics is expected to be able to train students' critical thinking skills. It is because Adobe Flash-based learning media can improve students' learning motivation (Yusuf, 2015) and through computer-based media, students can uniquely explore physics from the experiment simulation. It is also said that it can be a media to train critical thinking skills (Rasyida, Tapilauw, & Pryandoko, 2015). This statement is corresponding with the results of research from Purnamasari, Samsudin, Suhendi, Kaniawati, and Siahaan (2015) who concluded that students' critical thinking skills increased after the use of the computer multimedia. Similarly, the results of research from Samsudin and Liliawati (2011) concluded that the use of computer animation media further improves students' critical thinking skills. The results of Saade, Morin, and Thomas's research also concluded that media-based learning could contribute positively to improving critical thinking skills (Saade, Morin, & Thomas, 2012). This result is also in accordance with the research conducted by Weay and Masood (2014) that the use of computer-based learning media can improve the ability in reasoning and critical thinking . Also, a research study by Cahyaningsih (2016) also concludes that the application of multimedia based on Macromedia Flash in learning can improve students' critical thinking skills.

By using computer-based media, students are expected to develop their curiosity through experiment simulation so that their critical thinking skills can be developed. Critical thinking skills are necessary to be developed in the learning process because 21 century demands high quality human resources so that they can compete in the global era. Based on that background, the researchers conducted a study entitled *"**Development of Adobe Flash Based Learning Media to Train Students' Critical Thinking Skill with Topic of Optical Instrument**"*.

RESEARCH METHOD

In this study, we use research and development (R&D) method because we want to develop Adobe Flash-based physics learning media with the topic of optical instrument to train critical thinking skills. The developed learning media was complimented with syllabi, lesson plans, students' worksheets, and critical thinking tests. This

R&D research was based on the 4D model that consisted of four steps, i.e., define, design, develop, and disseminate. In this study, the researchers disseminated the results through the writing of this journal article.

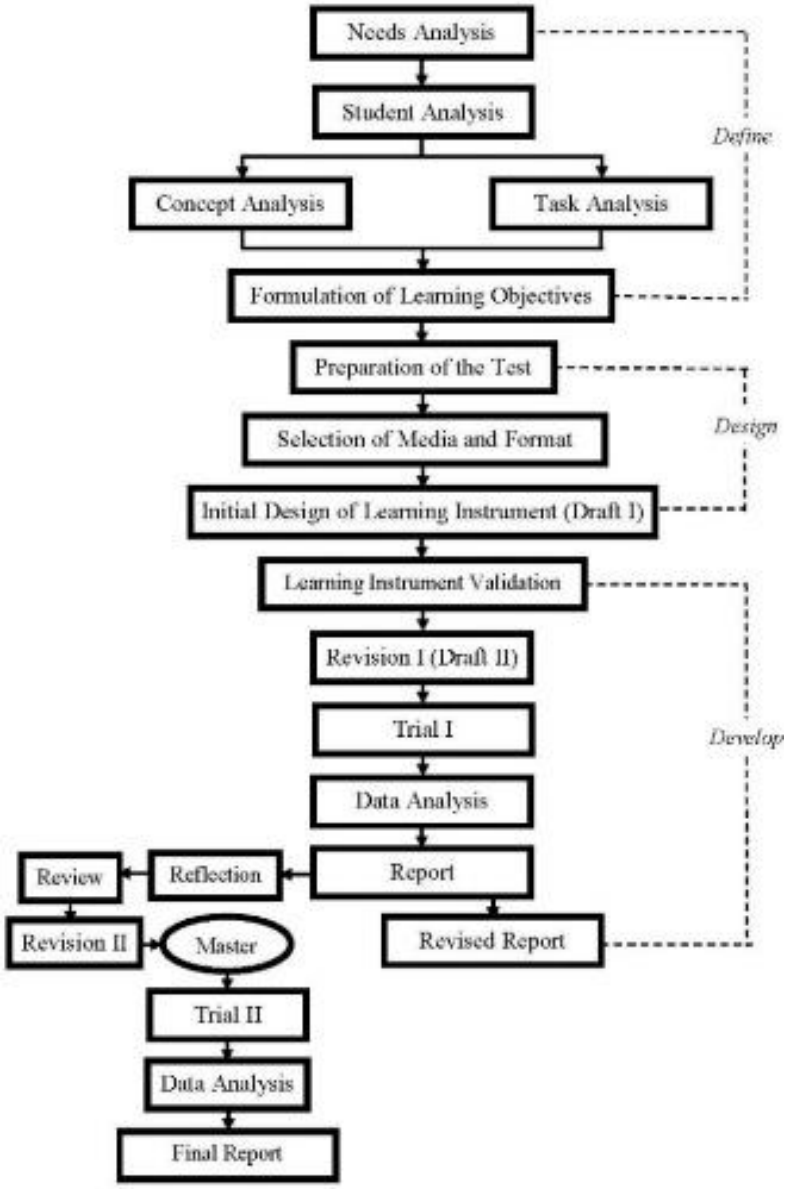

Figure 1. The procedure to develop the learning media tools based on the 4D model

The *defining phase* begins with an analysis of the initial study on the needs of the development of learning media equipped with the syllabus, lesson plan, student worksheet, and evaluation set. An Adobe Flash-based learning media was developed to train the students' critical thinking skills. Student analysis was done by analyzing student characters. Task analysis was the basis for developing learning objectives. It was carried out by detailing the content of teaching materials in the form of an outline of the content of the subject matter which included an understanding of the task in the learning step. It was done by analyzing the operational verbs used in the basic competences and learning outcome indicators of the selected material. The formulation of the learning objectives was based on the Core Competencies and Basic Competencies following the curriculum used, so that the Learning Indicators could be constructed. The indicators were developed into learning objectives specially designed to train

critical thinking skills on optical device material made in the Lesson Plans (two meetings). Conceptual analysis was also done by identifying the main concepts to be taught and organizing them systematically. The result of the concept analysis was a concept map.

The *design stage* is done to design the initial form of learning media, along with supporting devices. The results include the Adobe Flash-based learning media and supporting documentation such as , syllabus, lesson plan (LP) , student worksheet, and critical thinking skills test.

The *development stage* is done to produce a learning media, along with supporting tools that have been revised based on input from experts. From the design results, a step of validating the Adobe Flash learning media along with supporting tools and field test is completed. The study was conducted in 2017 with the sample subjects as many as 26 students of class X MIA 1 (Replication I) and 27 students of class X MIA 2 (Replication II) in a private senior high school in Surabaya.

Variables related to the feasibility of developing learning media along with supporting tools include (1) validity of the media and supporting tools covering validity of Adobe Flash-based learning media, syllabus, lesson plan, student worksheet, and critical thinking skill test; (2) practicality of the instructional media along with the supporting tools include the implementation of lesson plan and constraints during the learning process along with the solution, and (3) effectiveness of the instructional media along with the supporting tools that include critical thinking skills and student responses to the learning media development.

Trial of instructional media along with its supporting device was done by using one group pretest and posttest design (Suparno, 2010) that is one group observed/measured not only at the end of treatment (posttest) but also before (pretest) which can be described as follows:

U_1	X	U_2

with

U_1 = Pretest to know the critical thinking skills of students before the learning takes place.

X = Provision of treatment by using the learning media and its supporting devices.

U_2 = Posttest to know the critical thinking skills of students after the learning takes place.

In this research, the data collection process was conducted to obtain data about the validity, practicality, and effectiveness of the instructional media and its supporting documents. The validity of instructional media, syllabus, lesson plan, student worksheet, and test of critical thinking skills were obtained using the learning sheet validation instrument. Implementation and constraints during the learning process were obtained from the observation sheet. Critical thinking skills were derived from pretest and posttest results. The student response questionnaire instrument was administered to obtain the students' responses.

Data validation of the instructional media, along with its supporting device, was obtained from the calculation of average assessment by two validators on the developed media and its supporting devices. Interpretation of data validation results can be seen in Table 1 below.

Table 1. Criteria Categorization of Learning Device Validation

Interval Score	Assessment Category	**Explanation**
$3.6 \leq P \leq 4$	Very valid	Can be used without revision
$2.6 \leq P \leq 3.5$	Valid	Can be used with a few revision
$1.6 \leq P \leq 2.5$	Less valid	Can be used with many revisions
$1 \leq P \leq 1.5$	not valid	Cannot be used

(Ratumanan & Laurens, 2006)

Practical data of instructional media along with its supporting device was obtained from the data of LP implementation, which was the calculation of average assessment by two observers who made the observations during the learning process. Interpretation of data results of the implementation of LP can be seen in Table 2 below.

Table 2. Criteria for Categorization of the Implementation of Learning Devices

Interval Score	Assessment Category
$3.6 \leq P \leq 4$	Very good
$2.6 \leq P \leq 3.5$	Good
$1.6 \leq P \leq 2.5$	Poor
$1 \leq P \leq 1.5$	Very Poor

Adapted from (Ratumanan & Laurens, 2006)

Analysis of learning implementation constraints is completed using qualitative descriptive analysis that the observers and researchers provide to record the constraints that occured during the implementation of teaching and learning activities in the classroom and the solution of the constraints.

The data of learning media effectiveness along with its tools, were obtained from the questionnaire analysis to know the student's responses to instructional media developed. The questionnaire used a Likert scale. The questionnaire answers were later analyzed using frequency distribution by calculating the mean ideal and standard deviation.

$$\text{Mean Ideal} = \frac{(\text{Jav} \times \text{nt}) + (\text{Jav} \times \text{nr})}{2} \quad (1)$$

$$\text{SD Ideal} = \frac{(\text{Jav} \times \text{nt}) - (\text{Jav} \times \text{nr})}{6} \quad (2)$$

With

Jav = the number of valid item

nt = highest score

nr = lowest score

The results are categorized into three and are shown in Table 3.

Table 3. Criteria of Students' Response Questionnaire Data

Interval Score	**Category**

	X >	(M + 1.8 SD)	Excellent
(M + 0.6 SD)	< X ≤	(M + 1.8 SD)	Good
(M – 0.6 SD)	< X ≤	(M + 0.6 SD)	Fair
(M – 1.8 SD)	< X ≤	(M – 0.6 SD)	Poor
	X ≤	(M – 1.8 SD)	Very Poor

(Sukarjo, 2006)

Analysis of students' critical thinking skills was obtained based on the pretest, and posttest results. N-gain analysis was used to show the difference between students' critical thinking skills before the learning process and after the learning process. The equation to calculate the gain score (g) was

$$g = \frac{\text{posttest score} - \text{pretest score}}{\text{maximum score} - \text{pretest score}} \quad (3)$$

The interpretation of gain value (*g*) is as shown in Table 4.

Table 4. The criteria of Normalized Gain

N-Gain Score			Criteria of Normalized Gain
	g	> 0.7	High
0.3 <	g	≤ 0.7	Medium
	g	≤ 0.3	Low

(Hake, 2012)

RESULTS AND DISCUSSION

Validation Result of Media and Its Supporting Learning Tools

In this study, the researchers used Adobe Flash-based learning media to train students' critical thinking skills. Three experts validate the media. The average score from the three validators is 3.51, which means that the learning media can be categorized as valid and that it can be used in the next research steps.

The supporting learning toolsets that have been developed include syllabi, lesson plan, students' worksheet, and evaluation set of critical thinking skills. The syllabus developed by the researchers employed the principles of relevance, systematic, consistency, adequacy, actualization and context, flexibility, and comprehensiveness (Akbar, 2013). In this study, the syllabus was developed based on the jigsaw type in the cooperative learning model. Two experts validated the syllabi. The average score from the two validators was 3.56, meaning that the syllabi can be categorized as valid. It indicated that the syllabi could be used in the research steps that follow.

Preparation of lesson plan was done in a systematic and detailed that contains Core Competencies, Basic Competencies, indicators, learning objectives, methods, materials, media, and learning steps. The development of lesson plan conducted by researchers was in accordance with the principles of lesson plan development by adjusting the content of the syllabus. The lesson plan developed by researchers consisted of 2 meetings, and it was validated by two experts. The two validators gave an average score of 3.38, meaning that the lesson plan could be categorized as valid and showed that the lesson plan can be used for the next research steps.

A worksheet is a learning tool that complements or supports the implementation of the lesson plan. The worksheet developed by the researchers was said to be valid based on validation results by experts so that it could be used in the teaching and learning activities. The students' worksheet developed by the researcher was used to train students' critical thinking skills provided by using a jigsaw type cooperative learning model. The students' worksheet was also validated by the two experts. The average score from the two validators was 3.74. It means that the worksheet was valid and could be used for the next research steps.

The critical thinking skill test is a collection of questions used to measure students' critical thinking skills in solving optical devices. In this research, the researcher gave a subjective test in the form of description test, which aims to measure the extent of critical thinking skill seen from the student's answers. This test is used to obtain data about students' critical thinking skills. Validation of critical thinking skills assesses two aspects, namely content validation, and language validation and writing. The average pretest validation score provided by two validators was 3.4 for content validation and 3.2 for validation of language and writing and included in a valid category, whereas the mean posttest validation score provided by the validator was 3.3 for content validation and 3.1 for validation language and writing and were included in a valid category. It means that the critical thinking skill evaluation set was valid and could be used for the next research step.

Practicality Result of Media and Its Supporting Learning Tools

Implementation of a lesson plan includes three parts, namely implementation of teaching and learning activities, classroom atmosphere, and time management. Data on the implementation of lesson plan at the time of learning using jigsaw type cooperative learning model to train students' critical skills in replication class I and replication II was obtained from the average observation by two observers.

For replication class I, the result was 3.75 for meetings 1 and 3.64 for meeting 2 and was included in the very good category, while for replication class II, obtained 3.75 for meetings 1 and 3.64 for meeting 2 and included in the very good category. Implementation of all components in the LP shows that Adobe Flash-based learning media and supporting tools developed show that learning activities that use Adobe Flash-based learning media and its supporting devices with jigsaw type cooperative learning method take place well.

The Use of Media and Its Supporting Learning Tools Set in the Learning Activity

The trial was conducted to 53 students of a class of senior high school students grade X. In the testing phase, the students were asked to provide written input on the media developed through a given questionnaire.

The data obtained from the experiment are summarized, and a frequency distribution was obtained so that the following results were obtained.

$$\text{Mean Ideal} = \frac{(\text{Jav} \times \text{nt}) + (\text{Jav} \times \text{nr})}{2}$$
$$= \frac{(10 \times 4) + (10 \times 1)}{2}$$
$$= 25$$

$$\text{SD Ideal} = \frac{(\text{Jav} \times \text{nt}) - (\text{Jav} \times \text{nr})}{6}$$
$$= \frac{(10 \times 4) - (10 \times 1)}{6}$$
$$= 5$$

The result of student response analysis toward instructional media is summarized in table 5.

Table 5. Summary of distribution of questionnaire scores on the developed media

Category	Score Interval	Frequency	Percentage
Excellent	X > 34	31	58.49%
Good	28 < X ≤ 34	22	41.51%
Fair	22 < X ≤ 28		
Poor	16 < X ≤ 22		
Very Poor	X ≤ 16		
Total		**53**	**100%**

Students' responses to the developed learning media showed that 58.49% of the students stated that this learning media was excellent, while 41.51% of students said that this media was good. Overall, the students agreed that this learning media was good. However, based on the students' comments, some of them said that small revisions were needed to improve the legibility of menu and font.

In addition to feedback on the media developed, the students were also given a questionnaire to identify their responses in learning using the jigsaw type cooperative learning model that had been implemented.

The data obtained from the experiment were summarized, and a frequency distribution was obtained so that the following results were obtained

$$\text{Mean Ideal} = \frac{(\text{Jav} \times \text{nt}) + (\text{Jav} \times \text{nr})}{2}$$
$$= \frac{(8 \times 4) + (8 \times 1)}{2}$$
$$= 20$$

$$\text{SD Ideal} = \frac{(\text{Jav} \times \text{nt}) - (\text{Jav} \times \text{nr})}{6}$$
$$= \frac{(8 \times 4) - (8 \times 1)}{6}$$
$$= 4$$

The results of the student response analysis of the learning are summarized in table 6.

Table 6. Summary of distribution of questionnaire scores on the lesson learned on 53 high school students Kartika Wijaya Class X

Category	Score Interval	Frequency	Percentage
Excellent	X > 27.2	29	54.72%
Good	22.4 < X ≤ 27.2	24	45.28%

Fair	$17.6 < X \leq 22.4$		
Poor	$12.8 < X \leq 17.6$		
Very Poor	$X \leq 12.8$		
Total		**53**	**100%**

Table 6 shows that 54.72% stated that this learning was excellent, and 45.28% stated that this learning was good. In general, students responded positively to the learning with the jigsaw type cooperative learning model and Adobe Flash aided instruction media developed.

For replication I, N-gain analysis showed that 22 students had a high criterion of N-gain, while four students had a medium criteria of N-gain. The average gain score (g) was 0.83 and categorized as high criteria N-gain. Summary of the results of students' critical thinking skills for each class of replication I can be seen in Table 7.

Table 7. Summary of the Students' Critical Thinking Skills in Replication I

No	Indicator observed	Number of Problem	Pretest	Posttest	Gain	Category
1	Focusing on the question	1a	5.77	99.04	0.99	High
2	Answering the question	1b	80.77	100.00	1.00	High
3	Analyzing Arguments	2	21.15	77.88	0.72	High
		3	8.65	76.92	0.75	High
4	Making a conclusion	4	0.00	82.69	0.83	High
5	Taking a decision in action	5	0.00	75.96	0.76	High

For replication II, the N-gain analysis showed that 24 students had a high criterion of N-gain, while three students had a medium criterion of N-gain. The average gain score (g) was 0.88 and categorized as high criteria N-gain. Summary of the results of students' critical thinking skills for each class in replication II can be seen in Table 8.

Table 8. Summary of Students' Critical Thinking Skills in Replication II

No	Indicator observed	Number of Problem	Pretest	Posttest	Gain	Category
1	Focusing on the question	1a	3.70	99.07	0.99	High
2	Answering the question	1b	78.70	100.00	1.00	High
3	Analyzing Arguments	2	22.22	84.26	0.80	High
		3	11.11	85.19	0.83	High
4	Making a conclusion	4	0.00	88.89	0.89	High
5	Taking a decision in action	5	0.00	82.41	0.82	High

This average of N-gain score also shows that students' critical thinking skills improve relatively well. It can be interpreted that the developed Adobe Flash-based learning media can train critical thinking skills with good results because the media has a complete set of content and may satisfy the necessity of explaining the optical

instrument material such as animation and simulation. This result also agrees with the previous research studies which showed that the use of computer-based learning media could improve reasoning and critical thinking skills (Cahyaningsih, 2016 and Weay & Masood, 2014)

CONCLUSION

The Adobe Flash-based physics learning media of optical instrument with its supporting learning tools set is feasible to improve students' critical thinking skills in the learning process because it satisfies validity, practicality, and effectiveness criteria. Teaching optical instrument is recommended to use jigsaw-based learning media that have been developed because they have met the eligibility requirements and can help to improve students' critical thinking skill.

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