Students' Critical Thinking Ability through Guided Inquiry-based Digital Student Worksheet

Ade Yeti Nuryantini, Fitri Sulastri and Ea Cahya Septia Mahen
Program Studi Pendidikan Fisika UIN Sunan Gunung Djati Bandung
Jalan A.H. Nasution No 105 Bandung Jawa Barat Indonesia

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Abstract: The 21st century science learning requires students to be proficient in technology. Students are required to have various skills such as creative thinking, innovative thinking, critical thinking, and problem solving. In reality, students' critical thinking skills are still lacking and teachers have not utilized teaching materials in the form of digital student worksheet to train the students. This guided inquiry-based digital student worksheet development research aims to find out the implementation of the learning process using digital student worksheet, and the improvement of students' critical thinking skills on sound wave material after using guided inquiry-based digital student worksheet. The method used is a development research with ADDIE (Analysis, Design, Development, Implementation, Evaluation) models. The product research subjects were 33 students. The results of the study are the implementation of the learning process using guided inquiry-based digital student worksheet is in the very good category, and the usage of guided inquiry-based digital student worksheet on sound wave material can improve students' critical thinking skills with a moderate increase in average.

1 INTRODUCTION

Various efforts continue to be made to improve the quality of education in Indonesia, especially in the field of science, in order to produce the scientific skills potential of students, who are able to advance Indonesia. The demand of science learning in the 21st century is to prepare students with various skills and abilities such as creative , innovative and critical thinking, and problem solving (Zubaidah, 2016).

Along with the development of the times, the development of science and technology in the 21st century is growing rapidly. An increasingly sophisticated technology can be used to support the learning process. Some familiar information and communication technologies (ICTs) are mobile phones and laptops. Smartphones and laptops are useful for finding and accessing various information needed by students.

The results of interviews with physics teachers and students in high schools revealed that the method most often used by teachers in learning process was the lecture method. Teachers are the more active one in each learning process so that the learning is considered as teacher-centered learning. This results in students being less active in learning process such as being less active in asking questions. According to the teacher's explanation, active students tend to ask repeated and similar questions eventhough asking activity is one of the things that can train students' critical thinking skills (Ningsih & Bambang, 2012). Therefore, it can be concluded that students' critical thinking skills are still insufficient. The results of interviews regarding the use of teaching materials such as student worksheet also have not been oriented towards achieving students' critical thinking skills. Consequently, it is necessary to develop student worksheet in order to train students' critical thinking skills. Student worksheet is developed in the form of digital in order to utilize ICT in the learning process because schools already have computer laboratory that can be used in physics learning. Most students also own a laptop.

Student worksheet is sheets containing a series of activities that must be carried out by students (Prastowo, 2011, p. 203). Student worksheet has several functions: (1) to increase student activity, (2) to make it easier for students to understand the material. (3) as teaching material for students to practice, (4) to facilitate the teacher in carrying out

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the teaching materials (Prastowo, 2011, pp. 205–206)

In this study, the developed student worksheet followed the guided inquiry learning stage. The guided inquiry stage consists of orientation, problem formulation, proposing hypotheses, collecting data, testing hypotheses, and making conclusions (Putra, 2013, pp. 101–104). The results of previous studies reveals that inquiry-based learning can help students understand scientific concepts (Apedoe, Walker, & Reeves, 2006, p. 419)

Inquiry is a learning process that maximally involves all students' abilities to search and investigate systematically, critically, and logically so that students are able to find their own knowledge, attitudes, and skills as a form of behavior change (Hanafiah & Suhana, 2009, p. 77). Hence, the teacher must be proficient in creating learning processes that maximally involve the ability of students.

Inquiry-based learning builds new knowledge by planning investigations based on previous learners' knowledge, investigating and drawing conclusions based on data (Lehtinen, 2017). The benefits of inquiry activities are: (1) making fun activities in learning the basics of physics, (2) increasing motivation to find different natural phenomena, (3) creating a positive attitude towards physics (Ropeková & Kires, n.d.).

One of inquiry learning levels is guided inquiry. Guided inquiry learning requires students to play an active role in the learning process and help students develop the skills they need (Hale & Mullen, 2009). In addition, guided inquiry learning is also used to improve learning, and emphasize attitudes and skills in addition to knowledge. Students are divided into several groups to conduct investigation activity which is designed to help them build their own knowledge. Learning with guided inquiry also has the potential for education in computer science (Kussmaul & College, 2012). Inquiry-based learning can be used by utilizing ICT (Kellow, n.d.)

Critical thinking questions are used in the guided inquiry process to guide students in understanding the concepts learned (Irham, Mawardi, & Oktavia, 2017)

Therefore, this study aims to produce digital student worksheet which is designed using guided inquiry stages to improve students' critical thinking skills in sound waves material in XI grade.

2 RESEARCH METHOD

This study uses development research method with ADDIE (Analysis, Design, Development, Implementation and Evaluation) approach developed by Robert Maribe Branch (Sugiyono, 2017). The selection of ADDIE model was done because this model has stages that are easily understood and implemented to grow the development products similar to student worksheet. The study was conducted by analyzing the curriculum used in the school where the research was conducted, namely the 2013 2017-revised curriculum and sound wave material in class XI. After that, a product design was made in the form of digital student worksheet that can be used to train students' critical thinking skills. Then the design was compiled and packaged using microsoft power point software to produce learning media that can be applied in physics learning on the sound waves material. To find out the improvement of students' critical thinking skills, a pretest was taken before digital student worksheet was applied and a posttest was also conducted after the students were being treated by using the digital student worksheet. In addition, observations were made regarding the implementation of the learning process using digital student worksheet which was assessed using an observation sheet.

3 RESULTS AND DISCUSSIONS

3.1 Results

3.1.1 Analysis

The results of the analysis of teaching materials in the form of student worksheet used in schools show that it has not been oriented to students' critical thinking skills. In addition, schools also have not utilized ICT in the learning process.

Analysis related to the material chosen was sound waves. Material selection is based on previous research where students experienced misconceptions related to sound wave material in the form of sound wave propagation (Hasanah, Tri Anita Nur, Choirul Huda, 2017). Therefore, the sound wave material needs to be visualized so that students easily understand the material.

The curriculum used in the school was the 2013, 2017-revised curriculum. The curriculum analysis was done by analyzing core competence (KI/*kompetensi inti*) and base competence (KD/*kompetensi dasar*) on sound wave material that

was used as a reference in the development of guided inquiry-based digital student worksheet.

3.1.2 Design

At this stage the student worksheet framework was designed using guided inquiry stages, formulating learning objectives, formulating the material to be discussed in the first, second, and third meetings as outlined in a lesson plan. Then the preparation of research instruments was arranged in the form of validation sheets to determine the feasibility of digital student worksheet, observation sheets to determine the implementation of the learning process, and tests of critical thinking skills to determine the improvement of students' critical thinking skills after using digital student worksheet.

3.1.3 Development

At this stage the media was made based on the results of previous designs using Microsoft power point and packaged as interesting as possible by loading images, animations and videos. After the digital student worksheet was finished, validation was carried out by material experts, media experts, and physics teachers to find out the feasibility of digital student worksheet. Validation results from material experts, media and high school physics teachers are presented in Table 1.

Table 1: Validation results from material expert, media expert, and physics teacher.

No	Experts	Score	Category
1.	Material	4,00	Very good
2.	Media	3,17	Good
3.	Physics Teacher	3,80	Very Good
Average		3,66	Very good

The results above shows that guided inquiry-based digital student worksheetthat has been developed is worthy of use with a very good category.

3.1.4 Implementation

The fourth stage is implementation. At this stage, the implementation of digital student worksheet was carried out on students three times. The results of student worksheet fulfillment students are presented in Figure 1.

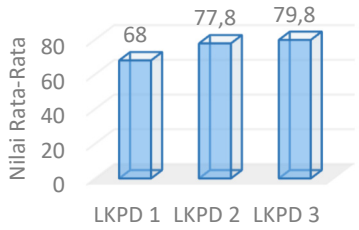

Figure 1. Graph of digital student worksheet fulfillment.

The average value has increased, so we can see the achievement of the learning process using guided inquiry-based digital student worksheet at each meeting.

Observations regarding the implementation of the learning process using digital student worksheet are presented in Table 2.

Table 2: Percentage the learning process implementation.

Meeting	Activities		
	Teacher	Students	Total
1	80%	80%	80%
2	100%	100%	100%
3	97,5%	92,5%	95%

During the implementation phase, pretest and posttest were also conducted to determine the improvement of students' critical thinking skills. The results of pretest and posttest are presented in Figure 2.

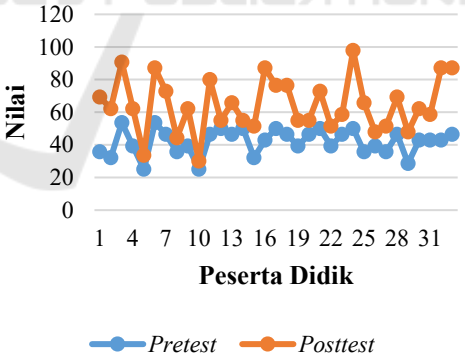

Figure 2. Comparison of students' pretest and postest scores.

The results above show that there was an increase between the pretest and posttest scores. Increasing students' critical thinking skills is calculated using n-gain. The results of n-gain analysis are shown in Table 3.

Table 3: Improvement Interpretation Critical Thinking Skills.

Notes	Pretest	Posttest	N-Gain
Average	41	65	0,41
Interpreation			Moderate

The results of the n-gain analysis of each critical thinking skills indicator which consists of formulating a question, identifying conclusions, finding differences, giving reasons, hypothesizing, applying concepts, identifying assumptions with unstated reasons are presented in Table 4

Table 4. N-gain for each critical thinking skills indicator.

Results	critical thinking skills indicator						
	1	2	3	4	5	6	7
Pre	86	64	3	58	61	4	11
Post	95	77	42	70	64	23	52
N-Gain	0,6	0,3	0,4	0,3	0,1	0,2	0,5

3.1.5 Evaluation

The evaluation phase was carried out at each stage. Researchers make improvements to the digital critical thinking skills that has been made. The improvements made are as follows.

Table 5. Evaluation on the digital student worksheet made.

No	Input	Action
1.	The student worksheet presented is too rigid	Adding pictures, animations and videos so that student worksheet is not too rigid
2.	The scope of the material is not just a concept, but must be mathematical also.	Make improvements in the form of adding material and making a formula for getting an equation.
3.	In digital student worksheet, practice questions were added	Adding practice questions to digital student worksheet
4.	The next and previous buttons should be deleted	Deleting next and previous button

3.2 Discussions

3.2.1 Validities'

The validity of guided inquiry-based digital student worksheet data was obtained from two expert lecturers (material experts and media experts) and one high school physics teacher.

Based on table 1, it is obtained the results of validity by material experts with very good categories. While the results of validity by media experts obtained validity with good categories. The results of validity by high school physics teachers are also very good.

3.2.2 Implementation

Table 2 shows that the implementation of the learning process using digital student worksheet at the first meeting as a whole is 80% in the good category. In addition, the observer commented on several stages that were not carried out in the learning process because researchers were not able to pay attention to the time and material presented. Besides, the cause of the lack of maximal use of time allocation with learning material is that it was students' first time in using digital student worksheet, so that the implementation of the learning process is not optimal.

In the second meeting, the overall implementation of the learning process using digital student worksheet was 100% (very good).

At the third meeting, the implementation of the overall learning process using digital student worksheet was 95%. Some stages were not carried out because there was less discussion between one student and the others.

The results of previous research on the development of physics student worksheet showed that the results of the implementation of learning using student worksheet was quite well so that it can be said that student worksheet can be used practically in learning (Nissa & Sukardiyono, 2017). Other research also found that student worksheet can accommodate guided inquiry learning steps, namely orientation, formulating problems, making hypotheses, conducting experiments, analyzing data, drawing conclusions, communicating results, and developing new problems, judging from the learning achievement which was 100% achieved (Hujatulatif, Roektiningroem, & Maryanto, 2017).

3.2.3 Improvement of Critical Thinking Skills

Increased students' critical thinking skills were analyzed using n-gain. N-gain is 0.41. According to Hake (1999:1) in (Thohir, Wasis, & WW, 2013) the score range $0.3 < g < 0.7$ is in the medium category, so that the improvement of students' critical thinking skills based on the research that has been done is in

the medium category. It can be concluded that after applying guided inquiry-based digital student worksheet there is an increase in students' critical thinking skills. This is in accordance with the results of research conducted by previous researchers that the use of guided inquiry-based student worksheet can optimize the ability of critical thinking of students with good categories (Damayanti, Ngazizah, & Setyadi K, 2013).

The results of n-gain analysis on each indicator of critical thinking skills presented in Table 4 show that the lowest n-gain is the indicator hypothesizing, while the highest n-gain is the indicator focusing on the question. Based on the results of the students' answers to the hypothesized indicator, students experienced a slight misconception in expressing the hypothesis so that the n-gain indicator of hypothesizing is the lowest compared to other indicators. Based on the results of research, students are difficult to make hypothesis so that they get the lowest score in hypothesizing, and this is because students lack of knowledge before learning begins. They are also not used to independent learning, whereas students are accustomed to relying on teachers in learning (Rosnaeni, Muslimin, & Saehana, 2018).

4 CONCLUSION

Guided inquiry-based digital student worksheet was developed with the steps of ADDIE (Analysis, Design, Development, Implementation, Evaluation). The implementation of guided inquiry-based digital student worksheet was implemented very well. There was an increase in students' critical thinking with moderate category after using guided inquiry-based digital student worksheet.

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