



How to Stimulate Student's Critical Thinking Skill on Learning Electrical Conversion Energy?

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Article Info

Article history:

Received: November 9th, 2020

Accepted: April 24th, 2021

Published: April 30th, 2021

Keywords:

Critical Thinking Skills;

Guided Inquiry;

Student Worksheet.

ABSTRACT

One alternative for students to actively participate in education is to teach material through a practicum with a thermal-electric energy conversion tool equipped with Student Worksheet (SW). This matter shows that SW is a crucial subject to develop. This research aims to develop SW to stimulate students' critical thinking skills in the heat-electric energy conversion material. The research design used is ADDIE. The validity test instrument measures the validity of the SW by the expert and the small group test. The validity test results and the small group test show that the developed SW is valid and able to stimulate critical thinking skills so that the resulting SW is suitable to be used as an alternative moderate in learning material for thermal-electric energy conversion.

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INTRODUCTION

In the industrial revolution era 4.0, education prioritizes higher-order thinking skills (Ciffolilli & Muscio, 2018), including critical thinking, problem-solving, creativity, innovation, collaborative, and communication skills (Supandi & Senam, 2019). 21st-century learning requires students to solve problems through the knowledge they acquire and provide opportunities for students to make decisions based on facts obtained from the scientific process in solving problems (Hadma, 2017). The expected state of education is not only teacher-centered but student-centered (Sodikin, 2015).

One model of student-centered education is guided inquiry (Erlinda, 2016). According to Agustini and Suyatna (2018), this model can improve conceptual understanding and learning motivation because students are actively involved in carrying out investigations or practicum. One of the exciting physics materials for teaching using

a practicum model is alternative energy material (heat-electric energy conversion). Alternative energy material is one solution to limited electrical energy (Ependi et al., 2016). The physics material relates a lot to the concept of natural phenomena or the environment to stimulate students' knowledge (Jayanti et al., 2016).

The provision of heat-electric energy conversion material with the practical method uses a guided inquiry model that can improve scientific behavior in maximizing critical thinking skills, where students carry out learning by carrying out observations, experiences, reasoning, or communication to decide so that they can provide rational and correct conclusions sourced from experiments (Purnamawati et al., 2017). Seeing the current state of learning, students still lack critical thinking skills.

Another effort that has an active function in supporting the learning process is to sort out the appropriate learning media for students (Hartini et al., 2017). One of the

media or learning resources that can be used as a support and help students in education to take place efficiently and effectively is the Student Worksheet (SW) (Fhadhila et al., 2018). A student worksheet is an activity sheet in the form of instructions and steps that support the learning activity process so that students, both individually and in groups, can build their knowledge (Latifah, 2016).

Based on the results of the distribution of online questionnaires filled out by some of the XII IPA class high school students in Bandar Lampung, it is known that the teaching material that is still widely used in the heat-electric energy conversion material is physics textbooks. This is following the results of a needs analysis questionnaire filled out by 29 students of class XII IPA, if 100% of students reported that the learning media that was often used were printed books, 27,6% used SW, 44,8% with videos/ films, 6,9% with flash animation / Java, 27,6% with practicum kits and 34.5% with props. The number of respondents who stated that printed books were the media that was often used in explaining the material on the conversion of thermal-electric energy, some students were not able to master the material, so that 100% of students stated that they needed the development of an SW that could guide the implementation of experimental activities.

The problem with the problem is that students do not appropriately implement the teaching materials and media used in describing the heat-electric energy conversion material, even though the heat-electric energy conversion material is class XII material so that it is often missed by the teacher to be taught. Teachers as facilitators and mediators are required to develop teaching materials that follow the provisions of the curriculum, which aims to make the teaching materials suitable with the existing conditions and conditions. (Putri, 2017).

Based on the existing cases, no one has developed learning media regarding guided inquiry-based heat-electric energy conversion material to facilitate students in

studying thermal-electric energy conversion material, so the authors innovated to conduct research entitled Development of Guided Inquiry-Based Worksheets for Thermal Energy Conversion Materials - Electricity to Stimulate Students' Critical Thinking Skills.

METHODS

This research is research and development research. The research refers to the ADDIE model, which includes five steps, namely:

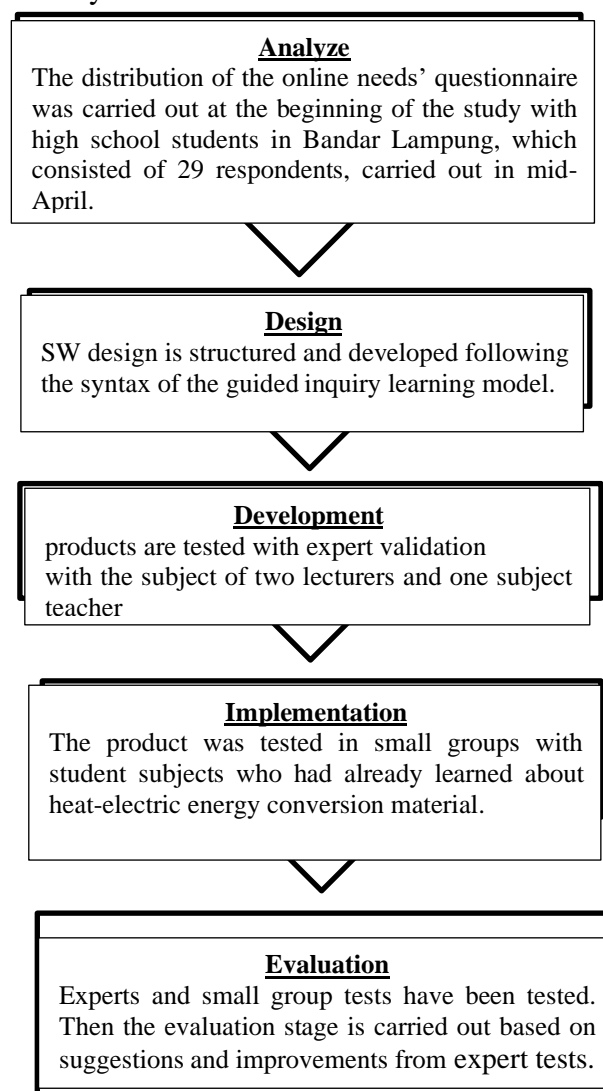


Figure 1. ADDIE Steps (Branch, 2009)

This study uses data analysis techniques by analyzing the results of the validity test scale and the assessment of the achievement of the developed SW critical thinking skills indicators. The validity test is used to obtain

information on the validity of the developed SW, which is obtained from assessments by material experts and design experts (Hutama, 2016). The material and design expert test scale analysis has four choices of answer scores according to the content of the problem. The score of the assessment criteria for each answer choice refers to the assessment score, that is:

Table 1. Assessment Expert Test Score

Score	Criteria
3,26 – 4,00	Very Valid
2,51 – 3,25	Valid
1,76 – 2,50	Less Valid
1,01 – 1,75	Invalid

(Suyanto, 2009)

Validators and small group tests carried out analyses of students' critical thinking skills. The aspect of critical thinking skills indicators in the SW according to the grading grid and small group test assessments was carried out based on an assessment rubric (Ennis, 1985). The results of the assessment of the validator test used the calculation of formulas and criteria such as the material and design expert test, while the results of the small group test were analyzed using the formula:

$$NP = \frac{\sum}{SM} \times 100\% \quad (1)$$

Information:

NP = Percent value sought

\sum = Total assessment score

SM = Maximum score

(Trianto, 2010)

The percent value obtained is matched with the criteria for assessing critical thinking skills, that is:

Table 2. Critical Thinking Skills Assessment

Percentage	Criteria
81 - 100	Excellent
61 – 80	High
41 – 60	Moderate
21 – 40	Low
0 – 20	Poor

(Ratumanan, T.G. & Laurens, 2003)

RESULTS AND DISCUSSION

The product produced from this development research is guided inquiry-based student worksheets on the material of electric thermal energy conversion, which can be seen in Figure 2. The developed SW is made to stimulate students' critical thinking skills in the learning process.



Figure 2. Product's Cover

Initial validation test data were obtained using material expert test instruments in terms of content feasibility, language feasibility, and presentation quality, shown in Table 3.

Table 3. Material Expert Test Results

No	Material Expert Test Assessment Aspects	Average Examiner Score	Qualitative Statement
1	Content	3,60	Very Valid
2	Language	3,46	Very Valid
3	Serving	3,42	Very Valid
Average Score of Material Expert Test		3,49	Very Valid

Based on Table 3, it is known that the average score of the material expert's test results from the aspects of the feasibility of content, language, and quality of presentation in SW is very valid, with an average number of 3.49.

After obtaining the material expert validation test, the design expert test in terms of the cover and content assessment aspects can be seen in Table 4.

Table 4. Design Expert Test Results

No	Design Expert Test Assessment Aspects	Average Examiner Score	Qualitative Statement
1	on cover	3,61	Very Valid
2	on content	3,42	Very Valid
Design Expert Test Score Average		3,5	Very Valid

Based on Table 4, it is known that the average value of the design expert's test results from the design aspects on the cover and content of the SW is very valid, with an average number of 3.5.

Furthermore, experts' assessment of the stimulus analysis of critical thinking skills is tested by following the indicators of critical thinking skills assessment, which can be seen in Table 5.

Table 5. Expert Test Results for Critical Thinking Skills

Assessment Aspects	Average Examiner Score	Qualitative Statement
Suitability Indicator of Critical Thinking Skills in LKPD	3,57	Very Valid
	3,57	Very Valid
	3,71	Very Valid
Average Expert Test Score	3,61	Very Valid

Based on Table 5, it can be seen that the results of the expert test on the suitability aspect of the indicators of critical thinking skills at SW are very valid, with an average number of 3.61.

A small group test carried out the last assessment by distributing SW to small groups to work on, and the results can be seen in Table 6.

Table 6. Small-Group Test Results

No	Assessment Aspects	Indicator	Percentage Average	Category
1	Provide a Simple Explanation	Focusing questions:		
		a. Identifying or formulating problems	100%	Excellent
		b. identifying or formulating criteria to consider possible answers	89,95%	Excellent
		c. Identifying and dealing with an inaccuracy	79,9%	High
2	Build Basic Skills	Considering whether the source can be trusted or not	76,6%	High
3	Conclude	Concluding according to facts	73,3%	High
4	Provide further explanation	Identifying assumptions	79,9%	High
5	Set Strategy and Tactics	Defining an action and interacting with other people	73,3%	High
Average			78,6 %	High

Based on Table 6, it can be seen that the results of the small group test on SW with an average number of 78.6% with a high qualitative statement, this indicates that the suitability of indicators of critical thinking skills in SW is suitable to stimulate students' critical thinking skills.

The guided inquiry learning model supports the implementation of scientific activities in learning through stages, namely problem orientation, formulating problems, hypotheses, collecting data, analyzing data, concluding (Abdurrahman et al., 2018). Relevant research regarding the guided

inquiry learning model was carried out by Lastriningsih (2017). The Guided inquiry learning model can condition students to think critically from observations made to bring up a conclusion to find concepts themselves scientifically.

The initial stage of this research was carried out based on a need's analysis found in the field. A needs analysis was carried out by distributing questionnaires online to all high school students in Bandar Lampung who had received learning materials about alternative energy. The results of the student need analysis showed that the printed book is a moderate that is often used in explaining the heat-electric energy conversion material. There are 60% of students who are unable to understand the material. Based on the student needs analysis questionnaire results, students need independent learning media such as guided inquiry-based SW on heat-electric energy conversion material, which can stimulate critical thinking skills to support the learning process.

Based on the results of the needs analysis, the next stage in product design. The product design developed includes a front cover, a foreword, a table of contents, a list of tables, a list of pictures, an introduction (cover ownership, core competencies, essential competencies, indicators, activity objectives, and content summaries), learning activities (activities based on guided inquiry syntax and questions evaluation), glossary, bibliography, and back cover. According to Andriyatin, R., Rosidin, U., dan Suane, (2016). SW must be designed to present learning starting from apperception to evaluation activities to be used for learning as a whole. Scientific activities designed on SW products are expected to help students understand the concept of the material more deeply and stimulate students' critical thinking skills.

The next step is the development, where at this step, the product is tested for validity. Product validity has consisted of design and content expert tests. Expert testing is carried out using a rating scale instrument consisting

of a statement and four answer choices. The statements on the instrument refer to previous research conducted by Anggraini, Wahyuni, & Lesmono (2016), which states that high worksheets have several conditions, including layout, sentence structure, and illustration images. Questions on expert test instruments are also based on research conducted by Nurliawaty et al., (2017), which states that high worksheets need to pay attention to the aspects of material presentation and appearance. Based on these two previous studies, the researcher classified the aspects of the material expert test consisting of content feasibility, language feasibility, and presentation quality. The design expert's test aspects include the design on the cover and the design on the content section.

The expert test results showed that the average score for the material expert test was 3.49 with a very valid qualitative statement. The material in SW is very valid, which is following the aspects of the feasibility of content, language, and quality of presentation. The average design expert test score is 3.5, which is categorized as very valid. A very valid SW design is following the cover design and content. The expert test results already contain suggestions for improvement from the experts used to improve the SW. Based on the results of expert testing, it can be concluded that SW based on Guided Inquiry on the material of Heat-Electric Energy Conversion is very valid to be used as an alternative moderate in learning.

Analysis of the assessment of students' critical thinking skills seen from the expert test assessment whether the SW has included indicators of critical thinking or not and seen from the small group test assessment. The average result of the expert test score was 3.61. The results of the expert test assessment show that the SW based on Guided Inquiry to stimulate critical thinking skills is very valid. This shows that the SW developed is compatible with indicators of critical thinking skills with guided inquiry syntax.

Small group test assessment activities are carried out at the implementation stage. The results of the small group test showed the assessment of critical thinking skills with an average of 78.6%, which was categorized as high. This was adjusted to the student assessment rubric developed based on indicators of critical thinking skills so that SW could be said to stimulate students' critical thinking skills.

The last stage of the ADDIE development model is the evaluation stage. This stage aims to make the SW development valid and suitable for use in learning. Based on the material expert test and design expert test and the critical thinking skills assessment carried out. The validator provides suggestions for improvements to the product being developed so that SW improvements are held, which refer to suggestions and improvements provided by the validator so that the product results are as needed. Furthermore, after the product has been repaired according to the advice of the validator, the prototype results are obtained, which are the final products in development research.

The developed SW has several advantages and disadvantages. The advantages of the developed SW are that it presents pictures of phenomena and orientation of problems related to everyday life, experiments and is equipped with evaluation questions related to practicum results. The weakness of this SW is that it costs more to print SW because of its very colorful presentation.

CONCLUSION AND SUGGESTION

Based on the results of the validity test and small group test, it was found that the student worksheet based on guided inquiry on the material of heat-electric energy conversion to stimulate students' critical thinking skills developed was declared valid. The developed SW could stimulate students' critical thinking skills so that SW, which has been developed, can be recommended as an alternative media in learning materials for electric-thermal energy conversion.

Based on the research, the authors suggest the development of a guided inquiry-based electronic-Student Worksheet (e-SW) on heat-electric energy conversion material, which is expected to facilitate students and follow technological developments and considerable group test research should be carried out to determine the effectiveness of guided inquiry-based SW that has been developed because of development research. This is only up to a limited small group test related to the Covid-19 Pandemic.

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