



THE DEVELOPMENT OF ALTERNATIVE ENERGY SIMULATION TOOLS TO IMPROVE CRITICAL THINKING SKILLS AT GLOBAL WARMING MATERIALS

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Abstract

This research aims to the characteristics and feasibility of Alternative Energy Simulation (ASEA) Teaching Aids, also to analyze the effectiveness of ASEA props to improve students' critical thinking skills in global warming material. The research method is Research and Development method from Thiagarajan, this research is restricted until Develop phase only. The result of validation got percentage 93.89% for media validation and 95.45% for material validation with each of the criteria was very feasible. For the limited trials, 32 students from VII D SMP N 37 Semarang were given the treatment, with percentage of increasing critical thinking skills 50% moderate and 50% which mean that the Alternative Energy Simulation (ASEA) teaching aid was effective to be used in the science learning process.

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INTRODUCTION

Science learning has experienced many scientific developments along with the changing times. At present learning not only learns the concepts and principles of natural science theoretically, but meaningful processes will have an impact on providing experience and improving students' skills. This process will lead to the discovery and training of students to be able to apply their knowledge in daily life (Hasbi et al., 2015).

Based on observations at SMP Negeri 37 Semarang it is known that the lack of use of teaching aids in learning, teachers assume the transfer of material from books to students is theoretically more efficient. The use of teaching aids takes a long time while the learning material is very much so that most teachers prefer to do learning theoretically. Whereas students' responses regarding theoretical learning make them bored and tend to be difficult to understand the material, especially the terms of science. The results of identification at SMP Negeri 37 Semarang show that learning that is done is not using instructional media, this makes students less interested in learning science and pay less attention to the teacher's explanation.

To support the achievement of learning objectives, you can use the media as a tool to help deliver the material. According to Mardhiah & Akbar (2018) learning media is a vital component in the learning process and the determining factor is the success or failure of a value delivered to students. Positive values in learning can be obtained by the use of media because it can help transfer knowledge from teacher to student and will provide optimal results for student understanding. Learning media teaching aids are a set of concrete objects designed as an intermediary to deliver science material to help understand the concepts or principles of science (Maftuh et al., 2015). According to Nafisah et al. (2018) the use of teaching aids aims to make students interested in learning and is a variation of learning so that teachers can provide better learning services for students. The use of teaching aids will make learning more memorable by using all learners' senses so that they not only memorize but also remember the basic concepts, flow and relationships between concepts.

One of the learning materials that requires a deep understanding of the concept of global warming, in this material there are environmental issues that can be solved by connecting one concept with another concept. Global warming material is a matter-themed problem that can be found in the daily lives of students. To get a good understanding requires good information processing skills and to solve various problems requires good critical thinking skills.

Critical thinking skills are an organized process that allows students to formulate, evaluate and organize their own opinions (Rahayu, 2017). Critical thinking can be had with activities that lead to critical thinking. One aspect that measures students to have good critical thinking skills is activities that hone their creativity (McPeck, 2017). Critical thinking skills can be formed with a problem approach or by observation that directs students to analyze the problem. The existence of problems or issues arouse students to find the right solution, the process of finding solutions will direct students in higher-level thinking and critical thinking.

METHODS

This research uses research and development methods. Data collection was carried out in Semarang 37 Public Middle School with address at Jalan Sroup number 43, Peterongan, South Semarang, Semarang City, Central Java. This developmental research uses the 4D Thiagarajan method referring to Putri & Winarti (2014) which consists of 4 steps which are then modified into 3 steps tailored to the research needs, namely (1) Define, namely needs analysis, literature review, observation and analysis of observations, (2) Design, namely KI and KD analysis, material reference analysis, design of teaching aids and question making, (3) Develop, product development in accordance with design, material validation and media validation by experts, product revision according to expert input until declared feasible and product trial.

This research did not arrive at the Disseminate stage because of time and cost considerations, this research was only limited to product trials, however, the researcher did not rule out further research. This study involved students of class VII D at SMP N 37 Semarang in the even semester of the 2018/2019 school year.

RESULTS AND DISCUSSION

Step 1: Define

Based on the results of observations found that students do not hone critical thinking skills because learning is one-way so that students only accept what is conveyed by the teacher without understanding it first. This is known based on their daily learning in the question and answer session, they tend to quickly forget and imitate the sentences in the textbook indicating they put the memory forward by memorizing rather than understanding the material. The critical thinking skills that are lacking make it difficult for students to understand the material so they are more likely to memorize and copy the contents of the book. Based on observations also found that students prefer learning using the media, it is seen when the learning process using a microscope they are more interested in trying so they can understand the material by observing the process on the media.

Based on the results of observations that have been made, researchers conducted a needs analysis and found problems in the form of critical thinking skills of students that are classified as low. This is known based on observations when the Field Experience Practices (PPL) at SMP Negeri 37 Semarang obtained data of more than 50% of students obtaining scores below the

average indicating their low understanding of the material. Low understanding indicates students are not sharpening their ability to reason and rely on memory of the material by memorization

SMP Negeri 37 Semarang uses the 2013 curriculum system where learning is centered on students (student center). The teacher as a facilitator guides students in learning, the learning media functions to support the teacher's role as a facilitator and helps the teacher's role in transferring material to students. However, the absence of teaching aids makes learning about global warming less than the maximum

Step 2: Design

At the design stage, the design of ASEA teaching aids is made according to the Core Competencies, Basic Competencies and Material Selection based on needs analysis at the previous Define stage. At this stage also made the preparation of tools that will be used in data collection such as syllabus, RPP, LKPD and other research instruments (validation props sheets by media experts, props validation sheets by material experts and questionnaire sheets for students' responses to props). The ASEA design was created by presenting two states of solutions and problems tailored to the critical thinking skills indicators to be achieved. The design of the ASEA props is shown in Figure 1.



Figure 1. Design of Alternative Energy Simulation Props

ASEA is created by presenting two states of solutions and problems tailored to the indicators of critical thinking skills to be achieved. The problem section contains five problems of global warming and the problem section contains five solutions. At this stage the problem concepts and solutions that will be presented in ASEA are

determined such as population density, congestion, factory smoke, deforestation, livestock waste, Bioenergy B20, Biogas, Wind / Wind Power Plant (PLTB), solar cells and greening. At the design stage Anwas (2014) also designs products that will be developed in his research.

Phase 3: Develop

At this stage production of props is carried out in accordance with the design that has been made. Props are made in wooden suitcases to make it easier to carry props. Miniatures in ASEA are made from paper-based materials that are shaped and colored in such a way that they resemble their original forms such as miniature houses, cars, factories, cow sheds, highways and windmills for nuclear power plants. Whereas other miniatures such as fallen trees are made from plant roots as stems and dishwashing sponges as leaves, the base of the soil in the problem section is made of pulp formed to resemble the contours of the soil.

After the production phase is validated by media experts and material experts. At this stage the researcher produced the teaching aids from the designs that had been made, the ASEA visual aid that was developed was validated from 2 aspects namely the media aspect and the material aspect. Each aspect was validated by 3 validators,

validators from media experts consisted of 2 lecturers from the Science Department of Integrated Mathematics and Natural Sciences UNNES and 1 Science Subject teacher at SMP N 37 Semarang. The material validator consisted of 2 lecturers from the Natural Sciences Faculty of Integrated Mathematics and Natural Sciences UNNES and 1 teacher of Natural Sciences in SMP N 37 Semarang.

Data Recapitulation of Validation Results by Media Specialists

Validation of ASEA props by media experts was carried out twice after the production period, the first validation was still revised in the form of suggestions and input on ASEA products which was then revised. The product is then validated again until it is declared feasible to use research data. The recapitulation of the results of the validation of the feasibility assessment of the Alternative Energy Simulation Props (ASEA) in terms of media is presented in Table 1.

Table 1. Recapitulation of Validation Results for Alternative Energy Simulation (ASEA) validation by media experts

No	Validator	Agency	Before revision	After revision
1	Expert 1	Integrated Science Lecturer of FMIPA UNNES	68,33% (Decent)	90% (Very decent)
2	Expert 2	Integrated Science Lecturer of FMIPA UNNES	78,3% (Decent)	91,67% (Very decent)
3	Expert 3	Natural Science Teachers at SMP N 37 Semarang	75% (Decent)	100% (Very decent)
Mean			73,89% (Decent)	93,89% (Very decent)

Based on Table 1 it can be concluded that the ASEA props are very suitable for use in data collection. The results of the validation of the

ASEA visual aids by media experts were analyzed in every aspect to determine the achievements of each aspect. As stated in Figure 2.

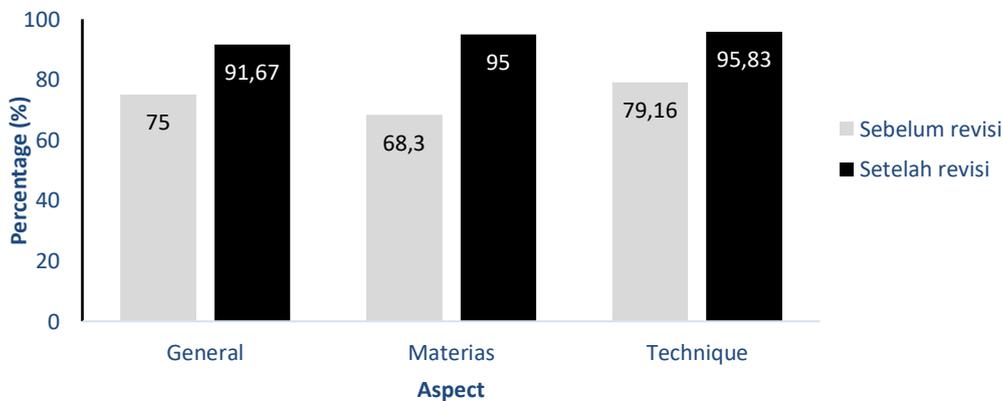


Figure 2. Recapitulation of Props Validation Results for Each Aspect by Media Experts Before and After Revision

Data Recapitulation of Validation Results by Material Experts

The validation of the ASEA trainer is then carried out by material experts twice after the production period, the first validation gets advice and input on the ASEA product which is then

repaired. The product is then validated again until it is declared appropriate to be used for research data collection. Recapitulation of the results of the validation of the feasibility assessment of the Alternative Energy Simulation Props (ASEA) in terms of the material presented in Table 2.

Table 2. Recapitulation of Validation Results for Alternative Energy Simulation (ASEA) validation by material experts

No	Validator	Instansi	Before revision	After revision
1	Expert 1	Integrated Science Lecturer of FMIPA UNNES	84,09% (Very decent)	90,09% (Very decent)
2	Expert 2	Integrated Science Lecturer of FMIPA UNNES	84,09% (Very decent)	95,45% (Very decent)
3	Expert 3	Natural Science Teachers at SMP N 37 Semarang	75% (Decent)	100% (Very decent)
Mean			81,06% (Very decent)	95,45% (Very decent)

Based on Table 2. it can be concluded that the ASEA props are very suitable for use in data collection. The results of the validation of ASEA

teaching aids by material experts were analyzed in every aspect to determine the achievement of each aspect. As stated in Figure 3.

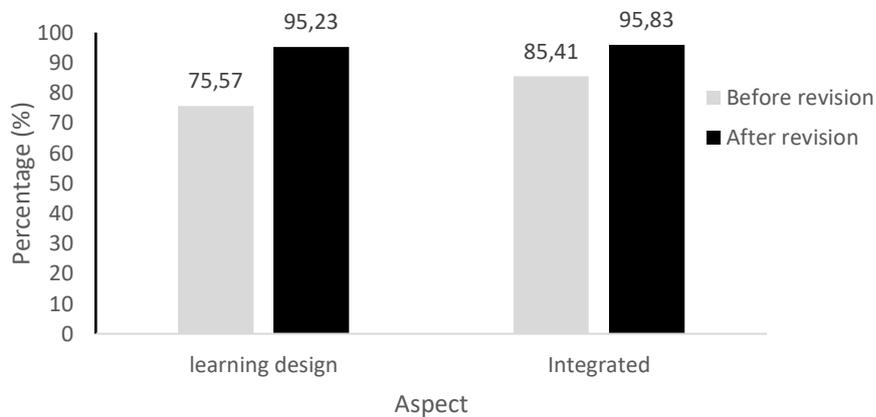


Figure 3. Recapitulation of Props Validation Results for Each Aspect by Material Experts Before and After Revision

Students' Critical Thinking Skills

Indicators of critical thinking skills used in this study refer to Ennis (2011), of the 12 indicators presented only 7 cognitive domain indicators used in this study because the limitation of the problem of this study only measures the increase in critical thinking skills in the cognitive domain. The seven indicators are (1) analyzing arguments, (2) reducing and considering the results of deduction, (3) inducing and considering the results of induction, (4) making and determining the results of consideration, (5) defining terms and considering terms in three dimensions, (6) identifying assumptions, and (7) determining assumptions.

Critical thinking skills of students are measured using multiple choice question instruments that have been adapted to the Core Competencies, Basic Competencies and indicators of critical thinking skills referring to indicators of critical thinking skills. Students' critical thinking skills are analyzed from the pre-test and post-test scores. Improved students' critical thinking skills demonstrate the effectiveness of ASEA teaching aids for use in learning. Acquisition of students' pretest and posttest scores can be seen in Figure 2 as follows.

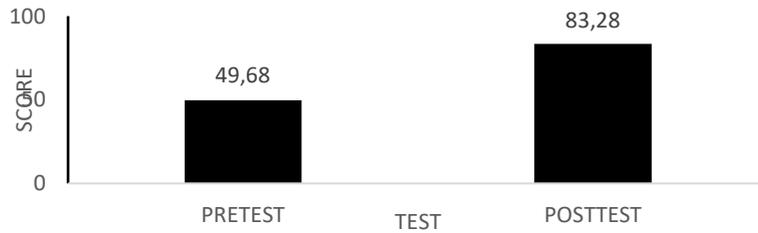


Figure 4. The students' pretest and posttest scores

While the results of the n-gain criteria for students' critical thinking skills as a whole can be seen in Figure 5.

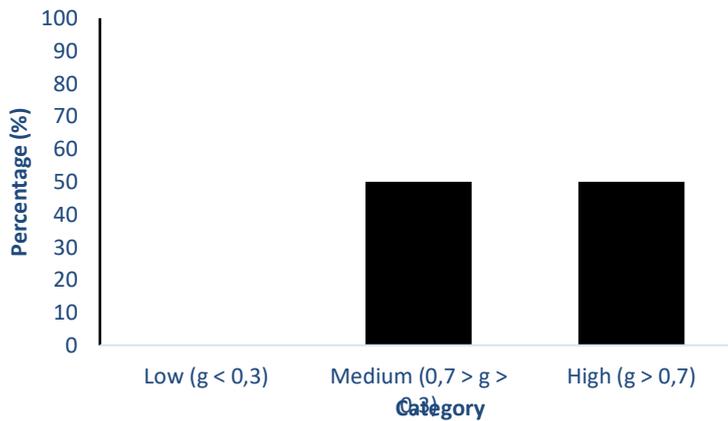


Figure 5. Results of the N-Gain Criteria for Students' Critical Thinking Skills

Overall, based on the analysis of pretest and posttest data, students' critical thinking skills experienced an average increase with an N-gain score of 0.699 in the medium category. Based on the N-Gain score results specifications, the results obtained 50% of students get an N-gain score of $0.7 > g > 0.3$ in the medium category and 50% of students get an N-gain score of $g > 0.7$ in the high category. This is because the Alternative Energy Simulation (ASEA) teaching aid is able to hone students' critical thinking skills in terms of analysis, identification, definition of problem understanding in three dimensions (cause, impact and solution), determination of actions and consideration of the results of actions. In line with the findings Hartati (2010) states learning using teaching aids actively involves students in the discovery of concepts so as to stimulate students to think critically.

Questionnaire Student responses to ASEA

Questionnaire responses of students given after implementation to see the assessment of students against the developed ASEA. Student assessment of ASEA is used to determine students' responses to ASEA in the form of criticisms and suggestions that can be material for further improvement of ASEA. This 32-piece questionnaire was obtained from the response of class 7D which was used as a research sample. The following is a recapitulation of the results of the questionnaire responses of students to ASEA presented in Figure 6.

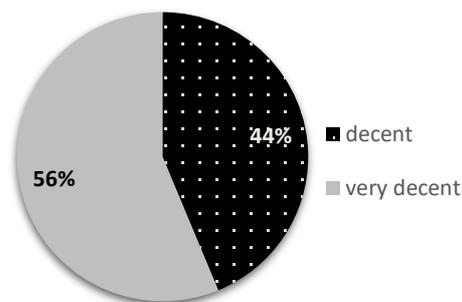


Figure 6. Results of the Questionnaire

Recapitulation of Student Responses to ASEA

The feasibility of ASEA teaching aids according to students' views is presented in Figure 2 by giving questionnaire sheets of students' responses to ASEA. Obtained results 56% of students think ASEA teaching aids are suitable for use in learning and the remaining 44% think very feasible. Student questionnaire responses sheet to ASEA is used to determine students' responses to the product being developed. The students' response is very important for the next stage of product development because students become the object of research using ASEA teaching aids in learning.

CONCLUSION

Based on the results of the study concluded that the Alternative Energy Simulation Props (ASEA) has the characteristics of content, material, concepts and physical that have been adapted to global warming material and can support students' critical thinking skills.

The feasibility of the ASEA teaching aid has been tested in terms of media and material by each of the 3 experts. Based on the results of the feasibility test of ASEA props by media experts and material experts, it was concluded that the ASEA props were very suitable to be used for research data collection.

In addition, ASEA teaching aids are effective in supporting students' critical thinking skills shown by an increase in the pretest and posttest scores after being measured using questions with an N-gain score of 0.669 in the medium category.

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