



Development of Socioscientific Issue-Based Interactive E-Modules to Improve Students Critical Thinking Skills on Global Warming Issues

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Abstract: This development research aims to develop and validate interactive e-modules based on socio scientific issues on Global Warming material to improve students' critical thinking skills. This study uses the Research and Development method with 4D design (Define, Design, Develop, Disseminate). The results of construct validation get a score of 85.3 and the feasibility of the material gets a score of 88.2 with the final conclusion "feasible to use with improvement". As well as the Practicality Test from student responses, an average score of 93.25 is in the very high category and the responses from the teachers get a score of 89.8 in the very high category. Based on the pre-test and post-test when the trials were carried out on students, the N-gain value was obtained in the experimental class of 83.91 which means effective and the control class 54.31 which means less effective. Overall, the research findings show that the developed e-module is validated in a very valid category and can improve students' critical thinking skills.

Keywords: interactive e-modules, socio scientific issues, critical thinking skills.

Abstrak: Penelitian pengembangan ini bertujuan untuk mengembangkan dan memvalidasi e-modul interaktif berbasis socioscientific issue pada materi Pemanasan Global untuk meningkatkan kemampuan berpikir kritis siswa. Penelitian ini menggunakan metode Research and Development dengan desain 4D (Define, Desain, Develop, Disseminate). Hasil validasi konstruk mendapatkan skor 85,3 dan kelayakan materi mendapatkan skor 88,2 dengan kesimpulan akhir "layak digunakan dengan perbaikan". Uji Kepraktisan dari respon siswa mendapatkan skor rata-rata 93,25 dengan kategori sangat tinggi dan respon dari para guru mendapatkan skor 89,8 dengan kategori sangat tinggi. Berdasarkan pretest and posttest saat dilakukan uji coba terhadap siswa diperoleh rata-rata nilai N-gain pada kelas eksperimen 0,48 dengan kategori sedang dan kelas kontrol 0,15 dengan kategori rendah. Secara keseluruhan, temuan penelitian menunjukkan bahwa e-modul yang dikembangkan tervalidasi dengan kategori sangat valid dan efektif meningkatkan kemampuan berpikir kritis pada siswa.

Kata kunci: e-modul interaktif, socioscientific issue, keterampilan berpikir kritis.

▪ INTRODUCTION

Through science learning, students are expected to have a scientific attitude, curiosity, logic, critical, analytical, honest, and responsible. It is hoped that these scientific attitudes can emerge after students carry out the scientific method in learning science (BSNP, 2016), so that learning science must be able to instill and cultivate the habit of critical, creative, and independent scientific thinking and behavior which demands the teacher's role that focuses more on activities. students (Rahmasuci, 2018).

A good learning process is learning that is able to develop the skills needed in the 21st century such as the ability to think critically, solve problems, collaborate, and communicate (Kulsum & Nugroho, 2014). This ability can be accommodated through well-prepared learning and media. This ability can be done through well-prepared learning. One of the skills needed to face the demands of the development of the 21st

century is the ability to think critically. The fact is that students have not been optimally trained to develop thinking skills and the quality of science learning is still low. Based on the results of the PISA study (Program for International Student Assessment) In 2019, the State of Indonesia is ranked 72 out of 77 countries with a score of 403. This score is still below the average of 493. According to TIMSS results (Trends in International Mathematics and Science Study) not much different either. Indonesia is a country that has low scientific achievement, which is in 70th place out of 78 countries with an average score of 406 (TIMSS & PIRLS, 2019). This is because science learning which contains various concepts but the learning that is carried out only focuses on textbooks. Lack of adequate teaching materials, makes teachers convey learning with methods that tend to be conventional (Hrin, et al., 2017).

There are various types of teaching materials used by science teachers. Based on the results of a survey of thirty science teachers in the form of a needs analysis questionnaire based on interactive E-Module development Socio Scientific Issue In several public and private junior high schools in Lampung province, 80% of the teaching materials used are printed modules and 20% are electronic modules. Then 12% of the teaching materials were made by themselves, 48% downloaded on the internet, and 32% copied from textbooks. The percentage of these teaching materials can improve critical thinking skills is 44% based on the survey results. This is due to various reasons, including teaching materials that are not yet innovative, students who are less independent, and limited teaching time, especially during a pandemic. Print teaching materials containing Global Warming material are not many and not interactive. So it is assumed not to be able to train students' critical thinking skills optimally.

To overcome these problems, it is necessary to develop teaching materials that can overcome problems during the learning process. One of them is with modules and the use of current information technology. Technological development electronic module (e-module) encouraging the combination of print technology with smartphone technology in activities. Study teach. paper module presentation can be transformed into electronic form, so that the emergence E-module. Thus, the electronic module can be interpreted as a form of independent learning material that is structured into learning units to achieve learning objectives, which are displayed in electronic format, in which each teaching and learning activity is connected with links as navigation which makes students more active with the program, equipped with video tutorial displays, and audio to enrich the learning experience.

Based on research conducted by Suryadie (2014), electronic modules are innovative media that can increase students' interest in learning. A learning process in order to be able to improve the achievement of learning outcomes needs to be supported by learning guide right. This is because the face-to-face time in front of the class is very limited when compared to the volume of material that must be completed. Therefore, it is needed learning guide capable of activating students in learning. Between learning guide which allows for the improvement of student learning outcomes and prioritizes students' active independence are electronic modules.

Various kinds of Global Warming material modules have been integrated into the learning model. One of them is integrated into learning Socio Scientific issue (SSI). Learning Socio Scientific issue (SSI) is learning that displays social issues related to

science (Zeidler, 2005). SSI is used in science education in order to organize scientific literacy which emphasizes the application of scientific and moral reasoning to deal with phenomena that occur in society. According to Zeidler (2005), SSI learning has several benefits, namely, (1) fostering awareness or scientific literacy in students so that they can apply evidence-based scientific knowledge in everyday life, (2) forming social awareness where students can reflect on the results of their reasoning, (3) encouraging argumentation skills in the process of thinking and scientific reasoning towards a phenomenon that exists in society, and (4) improving critical thinking skills which include analyzing, making conclusions, providing explanations, evaluating, interpreting, and doing self-regulation.

Socio-scientific issues (SSI) is something new for Indonesia, so SSI-based teaching materials are hard to find. The results of the study showed that the five books analyzed did not meet the percentage of SSI-based learning stages (Rostikawati and Permanasari, 2016). Socio Scientific issues take problems / issues / information / news that are in the community environment and stimulate students to debate and solve a problem. SSI gives students a role to think like scientists in solving social issues that exist in society (Anagun & Ozden, 2010). The involvement of social aspects in SSI provides an opportunity for conflicts to arise between scientific reasoning and social perspectives, which in learning has great potential for the development of students' moral reasoning and thinking skills in the context of solving problems related to related issues (Subiantoro, et al., 2013).

One of the materials currently being debated is environmental challenges, namely climate change and global warming. Global warming is a phenomenon that can be studied and solved through science. The impact of global warming is melting polar ice. If the ice continues to melt, the islands along the coast are threatened with sinking. This event is proof that global warming is a phenomenon that needs to be taught using social issues that occur. This statement is supported by research results (Rostikawati & Permanasari, 2016).

Through based learning Socio Scientific Issue can improve students' critical thinking skills, arguments, and scientific literacy through discussing socio-science issues (Tal & Kedmi, 2006; Sadler, 2011; Andryani, 2016;). In research (Kartika, 2019) teaching materials based on Socio Scientific Issues are quite effective in increasing students' scientific literacy skills. Supported by other research (Laksono & Yuni, 2022) that SSI-based teaching materials can improve students' higher-order thinking skills. Critical thinking skills can help people deal with their daily problems, especially problems related to science (Santika, et al., 2018).

▪ **METHOD**

Participant

This study uses a 4D research and development design (Define, Design, Develop, Disseminate) (Thiagarajan, 1974). This research was conducted in February 2023. Located at MTS Nur El-Ihsan Katibung South Lampung, 30 students in class VII A and 30 students in class VII B were studied. Class VII A was the experimental group and class VII B was the control group.

Research Design and Procedures

This research was conducted to produce a product, namely teaching materials in the form of interactive e-Modules based on scientific social issues on Global Warming material. This research consists of five stages, namely needs analysis, instrument design, instrument development, implementation, and evaluation. The stages are as follows.

First, the analysis stage, at the analysis stage the researcher analyzed the teacher's needs for teaching materials in the form of e-modules based on socio scientific issues on global warming material to improve students' critical thinking skills. In addition, a literature study was also carried out by reviewing literature and research results relevant to development research, namely literature studies on interactive e-Modules, scientific social issues, global warming, and critical thinking skills. Second, the design stage, the design stage carried out by the researcher includes, compiling a structural framework for e-Module teaching materials, formulating learning objectives, and compiling construction criteria (selection of media and format selection). Third, the development stage, namely the stage of preparing teaching materials, product development in the form of e-Modules is carried out according to the design that has been prepared. The e-module developed at this stage is a product that can already be implemented. The developed e-module is also equipped with information about social issues around it with additions hyperlik to the youtube site as well as news as in the following figure.



Figure 1. hyperlik to the youtube

Fourth, the implementation stage, the application of science learning using the developed electronic module. Fifth, the evaluation stage, the evaluation phase is carried out in the analysis, design, development and implementation stages. Evaluation is carried out to determine product quality and the results are used as feedback for product improvement. Evaluation is also carried out to determine the level of students' critical thinking skills. There are 4 indicators of critical thinking skills observed including 1) providing simple explanations, 2) building basic skills, 3) concluding, and 4) providing further explanations (Ennis, 2011).

Instrument

There are three instruments used in this study. First, the expert validation instrument is in the form of an assessment of the validity of the suitability of the content and construction. The data collection technique uses a validation questionnaire instrument. The two limited trial instruments were carried out through questionnaires on the responses of teachers and students to the e-modules resulting from the development.

The three test instruments are to determine students' critical thinking skills. This test is used when pretest and posttest in the form of 2 essay questions and 13 reasoned plural choices.

Data Analysis Technique

Product validation test is known by using the validation sheet instrument. At this stage a validation test is carried out to determine the validity of the module. The e-module validation carried out in this development research consisted of content/material validation and construct/design validation. E-module validation is carried out using an assessment instrument using the Guttman scale which is filled in by the validator by providing suggestions for improvements to the developed e-module in order to obtain an expert or professional assessment. Answers are made with the highest score of 1 (one) for yes answers and the lowest 0 (zero) for no answers (Sugiyono, 2013). The results obtained are calculated as a percentage by dividing the score obtained by the maximum score, and multiplied by 100%. Then the results obtained are interpreted, 81-100% very valid, 61-80% valid, 41-60% quite valid, 21-40% less valid, and 0-20% invalid (Ridwan, 2010). After the validation test was declared valid by the validator, a practicality test was carried out using a teacher and student response questionnaire. This effectiveness test was conducted to review three aspects, namely attractiveness, usefulness and readability of interactive e-modules. After the interactive e-module was declared practical, field trials were then carried out to see the effectiveness of the interactive e-module's influence on students' critical thinking skills. The effectiveness of the use of e-modules is seen from the achievements in the form of student pretest and posttest scores.

▪ RESULT AND DISCUSSION

The module has the characteristics of Self Instruction (can be used for independent learning), Self Contained (learning materials carefully arranged), Stand Alone (not dependent on teaching materials or other media), Adaptive (adjusting to developments in science and technology), and User Friendly (easy to use) (Daryanto, 2013). Inside the e-module there are audio, audio visual, and multimedia as learning media which can be accessed using a personal computer or laptop by students. Text, photos, graphic art, sound, animation, and video that are integrated into multimedia are elements that can be used in electronic learning media (Laksana, et al., 2019).

The results of the development research that will be described include the results of the literature study, the results of the initial field trials and the results of the field trials. In developing e-module products, validation data from experts is needed to assess the feasibility of e-modules for use in learning in a broad scope and test questions are used to measure students' critical thinking abilities. This e-module has been carried out construct validation and material feasibility validation. Each validation sheet contains 17 indicators and statement items used. All indicators have been met, but there are 5 indicators that need improvement in construct validation and 4 indicators that need improvement in content validation.

Material feasibility validation matters that need to be improved, including all phenomena presented are phenomena that exist in Indonesia, social issues need to be sharpened, and the e-module needs to be equipped with a graph of temperature rise as a function of time. Whereas in construct validation the things that need to be improved

include the preface adding a little explanation of the contents of the e-module, displaying the table of contents with direct hyperlinks to the related page, writing the full name of the bibliography et al., and using letters in the e-module that do not use type decorative letters. These suggestions for improvement have been improved so that the e-module is feasible to use. The developed e-module has been validated both in terms of content and construct. E-modules developed are in accordance with Rochmad's view (2012: 13) that in a development result (product) is declared valid if the product developed is in accordance with adequate theory both in terms of material and all components of learning products that are related to each other consistently (construct validity).

In this development research, students and teachers were asked to provide responses regarding interactive e-modules based on Socio-Scientific Issues on Global Warming material. The purpose of soliciting student responses is to find out the attractiveness, usefulness and readability of the interactive e-module being developed. Teacher response instruments were given to 3 science teachers. While the student response instrument was distributed to 30 students who were in the experimental class.

Based on the calculation of the results of the questionnaire obtained, it is known that the average overall result of the student response questionnaire to IPS-based interactive e-modules is 93.25% with very high criteria. Then the average results of the teacher's response questionnaire to the interactive e-module on the three aspects obtained an average of 89.8% with very high criteria. Based on the average results of these assessments, it can be concluded that the learning media in the form of interactive E-modules based on Socio Scientific Issues to improve Students' Critical Thinking Ability on Global Warming material that has been developed is practical and feasible to use and carry out field trials. This is in accordance with the statement of Yamasari (2010) that the e-module is said to be practical in practice, that is, the percentage of student responses and teacher responses to the media is in the positive category.

Field trials are the final stage in this development research. This trial was carried out by applying learning using interactive e-modules based on Socio Scientific Issues to improve students' critical thinking skills in Global Warming material. The field trial phase was carried out with two classes of MTs Nur El-Ihsan students, namely class VII A as the experimental class and class VII B as the control class. Field trials are conducted to determine the effectiveness of the products that have been developed. The effectiveness of the use of e-modules can be seen from student activities and assessment of critical thinking skills in the form of student pretest and posttest scores. Critical thinking ability test instruments are given to students before and after learning activities are carried out using interactive e-modules based on socio-scientific issues to improve students' critical thinking skills on global warming material.

The results of the average pretest and posttest scores of students in the control and experimental classes showed that the average control group at the time of the pretest was 42, as well as the experimental group which had an average pretest of 42. After learning using interactive e-modules based on Socio- Scientific Issue's average score in the experimental group experienced a significant increase from initially 42 to 55. In contrast, the control group experienced only one score increase from initially having an average of 42 to 43 at the time of the posttest. It can be concluded that in the experimental class the average score of the critical thinking ability test increased.

Furthermore, based on the average pretest-posttest results, the n-gain calculation for each critical thinking indicator is performed as shown in the following figure.

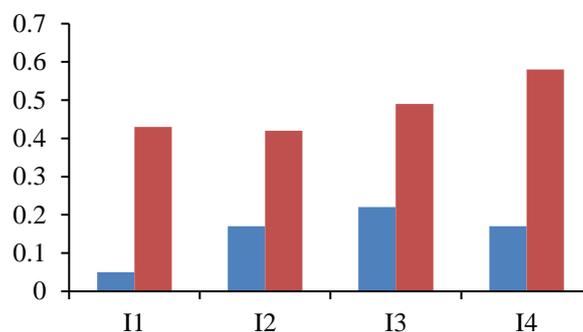


Figure 1. N-gain results. control and experimental group was indicated by blue and red colors

Based on the n-gain average results per indicator of critical thinking, that for the first indicator, namely giving a simple explanation to the control class, 0.05 is included in the low category and the experimental class is 0.43, which is included in the medium category. The second indicator is building basic skills, in the control class of 0.17 including the low category and the experimental class of 0.42 including the medium category. The third indicator is concluding, in the control class of 0.22 including the low category and the experimental class of 0.49 including the medium category. The fourth indicator is to provide further explanation, in the control class 0.17 is in the low category and the experimental class is 0.58 in the medium category. Therefore it can be said that the n-gain in the control class is in the low category and the experimental class is in the medium category. If we calculate the average n-gain for the control and experimental classes, we get an n-gain for the control class of 0.15 in the low category and 0.48 for the experimental class in the medium category.

The first indicator of critical thinking is giving simple explanations, students are able to focus on questions so they can consider possible answers. The second indicator is building basic skills, students are able to consider the suitability of sources and are able to give reasons. The third indicator is concluding, students are able to state common things and draw conclusions based on what has been observed. The fourth indicator is providing further explanation, students are able to define terms and consider a definition. It can be stated that in the experimental class the average student has achieved this ability.

The effect of using interactive e-modules based on socio scientific issues on students' critical thinking skills is stated based on the results of the effect size test. Based on calculations based on (Hake, 2002) it was found that the effect size in the control class was 0.16 in the low category and the experimental class was 1.13 in the high category. This means that the use of interactive e-modules based on Socio Scientific Issues has a significant effect on increasing the critical thinking skills of the experimental group.

The use of e-modules makes learning fun, interesting and interactive, so students will be motivated to study economics. This was conveyed by Suarsana that e-modules

can be accessed using a computer/mobile phone and are more interactive because they can display images, video, audio (Suarsana & Mahayukti, 2013). In line with the statement above, Abidin and Walida explained in their research that e-modules are teaching materials that can make it easier for students to learn independently, because e-modules are arranged in a complete, clear and attractive manner (Abidin & Walida, 2017). Whereas learning without using e-modules makes learning less interesting and not interactive so students are less motivated to learn.

The developed e-module can be used anywhere, making it more practical to carry anywhere. In addition, the learning process no longer only depends on the instructor as the only source of information (Mulyadi & Wahyuni, 2016). The developed e-module is equipped with concrete social issues through hyperlinks that lead to YouTube and electronic news so that the social issues regarding global warming that are presented can be a stimulant for students' critical thinking skills. This is in accordance with Mazfufah's research, (2017) that the application of socio scientific issues in learning will direct students to develop solutions from various aspects of life. Meanwhile, Zeidler (2009) added that socio-scientific issues are open-ended so that they allow students to think critically about these issues together with other people who have different views. The use of socio scientific issues in learning that is packaged in e-modules can train students' critical thinking skills to solve various problems that exist in their daily lives.

▪ CONCLUSION

Based on the research results, the interactive E-module based on socio-scientific issues developed on global warming material to improve the critical thinking skills of junior high school students was declared valid. This can be seen from the expert validation assessment of the suitability aspects of the material and constructs. The practicality of learning using interactive e-modules based on socio-scientific issues in warm-up material is stated to be practical and effective in terms of the acquisition of the teacher's assessment of 83.3% in the very high category and the student's assessment of 91.88 in the very high category. This result is also supported by the acquisition of the e-module trial based on the calculation of the average N-gain value of the experimental class for each indicator of critical thinking which is in the moderate category.

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