JPPIPA 9(12) (2023)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Effectiveness of Science E-Module Using Argument-Driven Inquiry Models to Improve Students' Generic Science, Critical Thinking and Scientific Argumentation Abilities

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Received: October 14, 2023
Revised: November 27, 2023
Accepted: December 20, 2023
Published: December 31, 2023

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DOI: 10.29303/jppipa.v9i12.6279

Abstract: This research aims to determine the effectiveness of e-module teaching materials with the Argument-Driven Inquiry model to improve students' generic science, critical thinking and scientific argumentation abilities. The development model design used is 4D which consists of the define, design, develop and disseminate stages. The e-module which was declared valid was then carried out on a limited scale trial on 27 students. Analysis of increasing generic skills in science, critical thinking and scientific argumentation using the n-Gain (g) test. The research results show that there is an increase in ability after the e-module is implemented into learning. The n-Gain value for generic science abilities is 68.70, critical thinking 62.25 and scientific argumentation 67.11. The n-Gain value for each variable is in the medium category so that the Argument-Driven Inquiry based science e-module is quite effective for use in science learning

Keywords: Critical thinking; Effectiveness; E-module; Generic science; Scientific argumentation

Introduction

Science is a scientific subject studied to understand nature comprehensively (Songsil et al., 2019). In science, scientific concepts and theories are obtained based on experimental activities carried out on the basis of the scientific process (Susilawati et al., 2020). To gain a deeper understanding of the natural environment, processes inquiry (investigation) is considered important to be implemented in learning. By using the process inquiry, thinking, working and communication skills can be developed (Lismawati et al., 2021; Marudut et al., 2020). These abilities can be developed if there are adequate teaching materials, one of which is e-modules.

E-module is a type of teaching material that is prepared as ICT-based teaching material. E-modules as one of the innovations in learning can help students to learn independently, besides that they can be used as evaluation material so that it can make it easier for teachers and students to learn (Katauhi et al., 2022; Serevina et al., 2022). This teaching material is arranged systematically following the systematic arrangement of modules, the difference lies in the form of physical packaging only. The quality of learning will increase if the learning tools are of good quality (Arizona et al., 2023).

E-Modules have the advantage of being able to stand alone, meaning that students are able to learn on their own without depending on other parties so that they can improve the quality of learning (Marnah et al., 2022). As an innovation in learning, e-modules are effective in improving students' abilities (Laili et al., 2019; Wahyuni et al., 2020). E-Modules should be facilitated by an appropriate learning model. One of learning model that can be used is Argument-Driven Inquiry (ADI). The ADI model can help students

How to Cite:
Sukarso, A. A., Syuzita, A., & Susilawati. (2023). Effectiveness of Science E-Module Using Argument-Driven Inquiry Models to Improve Students' Generic Science, Critical Thinking and Scientific Argumentation Abilities. *Jurnal Penelitian Pendidikan IPA*, *9*(12), 11576–11581. https://doi.org/10.29303/jppipa.v9i12.6279

develop generic science skills, critical thinking and scientific argumentation (Salsabila et al., 2019; Siahaan et al., 2019). So that e-modules facilitated by the ADI model can be used as a solution to improve students' abilities.

Based on observations made at one school in West Lombok, the learning resources used only depend on textbooks so that learning seems monotonous, activities that support learning such as practicums are rarely carried out so that students' abilities have not been trained optimally. By looking at the conditions of learning in schools, learning innovation is really needed to develop and train students' abilities. Students' learning resources need to be facilitated optimally. One learning resource that can be used is e-module. The use of modules or e-modules in learning has never been used. Apart from that, the observation results indicate that the learning model used in learning is not yet able to support students' generic science, critical thinking and scientific argumentation abilities, the learning model used is not implemented optimally, there are still learning steps that have not been carried out due to time constraints.

E-modules as an innovation in learning activities can be integrated with learning models that are adapted to the characteristics of the learning content. In developing e-modules, there are many software that can be used, one of which is 3D Pageflip Professional (Putra & Mufit, 2022). This research aims to determine the effectiveness of the developed Argument-Driven Inquiry-based Science E-module in improving students' generic science, critical thinking and scientific argumentation abilities.

Method

This research is research and development that will produce a product in the form of an E-Module with an Argument-Driven Inquiry model using 3D Pageflip Professional software. This research uses a 4D development design which consists of four stages as shown in Figure 1 (Sugiyono, 2014).

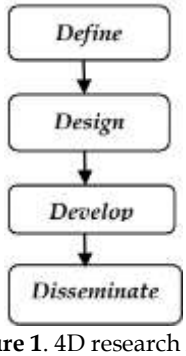

Figure 1. 4D research flow

In this research, the 4D model was simplified to the development stage, namely a limited scale test to see the effectiveness of the product (Doyan et al., 2020). The limited scale is carried out in class VIII with the number of students being 27. Before the science e-module is given in learning activities, students are given a preliminary test and a final test. This test was carried out to see the extent of students' knowledge before and after the science e-module was applied in learning. The tests given can be used as a reference to determine the increase in students' generic science skills, critical thinking and scientific argumentation. The test is given in the form of a description of 7 questions, each question includes three indicators of the abilities to be improved. Quantitative data obtained from a limited scale is then processed using tests N-gain (equation 1) to see the increase in students' abilities, (Doyan et al., 2020). The n-gain value consists of three categories, namely high (n-gain>70), medium (70>n-gain>30), and low (n-gain <30) (Hake, 1999)

$$N - \text{gain} = \frac{Posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \times 100\% \qquad (1)$$

Result and Discussion

This research is development research which produces a product in the form of science E-module teaching materials based on the Argument-Driven Inquiry learning model assisted by 3D Pageflip Professional software to improve students' generic science, critical thinking and scientific argumentation abilities. This e-module was developed to be used as a learning resource for Junior High School students.

This research was conducted to test the effectiveness of the product being developed, namely E-module. The effectiveness of the product is tested by analyzing the cognitive domain of students consisting of pre-test, post-test and n-Gain (Susilawati et al., 2022). Pre-test activities are carried out before the science e-module is implemented into learning, while post-test activities are carried out after the science e-module is implemented into learning. The results of students' ability test activities are analyzed using the N-gain equation to see the improvement in test results and show whether learning using Argument-Driven Inquiry based science e-modules has been effective.

Based on the pre-test and post-test activities, it can be seen in table 1 that there is an average difference in each desired ability variable. There was an increase in students' abilities after the science e-module was used by students in learning. Students basically already have generic science abilities, but the lack of opportunities to practice these abilities means students cannot develop them. Generic science abilities are basic abilities

possessed by students that need to be trained, developed and improved continuously so that students can develop high-level thinking skills well (Mashami Azizah & Khaeruman, 2020). Critical thinking and scientific argumentation skills are also experienced an increase of 51.50 and 51.69 where the increase in ability is in the medium category. The increase in generic science skills, critical thinking and scientific argumentation shows that the Argument-Driven Inquiry-based science e-module is quite effective in supporting learning activities. The pre-test and post-test results for each indicator for each ability can be seen in the following image.

Table 1. Pretest and Posttest Scores in the Tested Class

Data	Generic Science		Critical Thinking		Scientific Argumentation	
	Pre test	Posttest	Pretest	Posttest	Pretest	Posttest
Amount of Students	27	27	27	27	27	27
The highest Score	43.52	86.11	22.53	92.59	48.28	88.36
The Lowest Score	7.41	62.04	11.11	52.78	3.97	55.82
Score Average	19.89	73.61	16.17	67.67	21.06	72.75
N-Gain Score (%)		68.70		62.25		67.11

Figure 2 shows that the average generic science ability during the pre-test and post-test has increased. Based on the picture, it can be seen that students' generic science abilities increase with a fairly high range of scores on the GS-2 and GS-3 indicators, namely indirect observation and awareness of scale, followed by GS-4, namely symbolic language, GS-1, namely direct observation. Then GS-9 builds new concepts and GS-7 mathematical modeling. GS-5 and GS-8, namely logical inference and cause and effect laws, have the same improvement value and GS-6, namely logical framework. The highest improvement value was 82.27 in indirect observation ability and awareness of scale. Meanwhile, the indicator with a lower increase value is 56.69 in the logical framework capability. Each indicator of generic science ability experienced a significant increase after using e-modules in learning with an average N-Gain of 68.70 in the moderate and quite effective category.

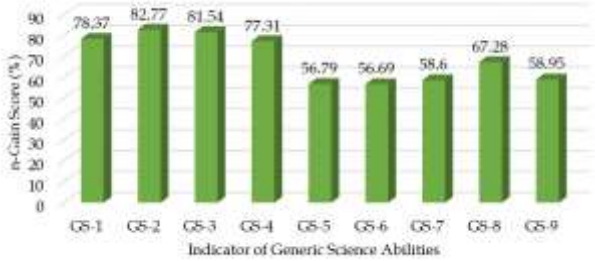

Figure 2. Improvement data per indicator of students' generic science abilities

This is in line with Mashami Azizah et al. (2020) the average generic science ability of students after studying PBL-based interactive multimedia reached 74.50 in the medium category. The development of CTL-based interactive e-modules can improve students' generic science abilities (Nurvitasari et al., 2022).

The results of the n-gain test based on Figure 3 for the developed electronic module show that there is an increase in each indicator of students' critical thinking abilities. The CT-1 indicator, namely basic decisions, has a fairly high increase value compared to other indicators, namely 91.51, in contrast to the CT-5 ability indicator, namely reasoning and integration, which has a quite low increase value compared to the other indicators, namely 45.18. The CT-2, CT-3 and CT-4 indicators, namely basic clarification, inference and further explanation, also experienced quite significant improvements. After using the science e-module, students' critical thinking abilities on average increased by 62.25 which is in the moderate category so that the e-module is quite effective in learning.

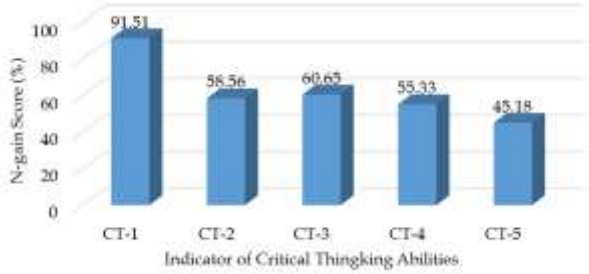

Figure 3. Improvement data per indicator of students' critical thinking abilities

The application of science learning media in the form of flipbooks can make it easier for teachers to convey material in science subjects and easier for students to understand the science material itself (Jannah & Atmojo, 2022). Contextually based flipbook science learning media is a development of e-books as an alternative used in learning which is proven to improve critical thinking skills in science learning (Aprilia, 2021). Other research states that students' critical thinking abilities increase after learning using modular-assisted

e-modules with splash screen displays (Rismayanti et al., 2022).

Students' scientific argumentation abilities after learning using e-modules have increased. The increase in scientific argumentation skills can be seen based on the n-gain score obtained through the pre-test and post-test which can be seen in Figure 4.

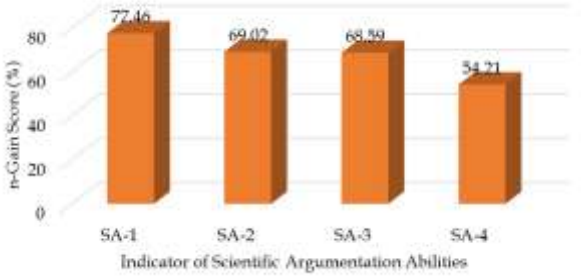

Figure 4. Improvement data per indicator of students' scientific argumentation abilities

The SA-1 indicator, namely claims, has a fairly high increase value compared to other indicators, namely 77.46, in contrast to the SA-4 capability indicator, namely backing, which has a quite low increase value compared to other indicators, namely 54.21. The SA-2 and SA-3 indicators, namely data and warrants, also experienced a significant increase. After using the science e-module, students' scientific argumentation abilities on average increased by 67.11 which is in the moderate category so that the e-module is quite effective in learning. This is in line with research (Rismayanti et al., 2022) which found that there was an increase in scientific argumentation skills after being given learning through argument mapping-based student worksheets by 62% in the quite effective category.

The development of a science e-module facilitated by the argument-driven inquiry model has been tested to see the effectiveness of the e-module in improving students' generic science skills, critical thinking and scientific argumentation. The ADI learning model is effective in training generic science skills so that students are able to solve problems based on their abilities (Belga, 2022; Siahaan et al., 2019). The ADI learning model is also able to facilitate students to develop students' critical thinking and scientific argumentation skills, by arguing, students are able to develop their ideas (Ayuningtyas et al., 2019; Fadilah et al., 2020). Students must have generic science abilities to be able to think at a higher level, one of which is critical thinking. When students use their critical thinking skills, it will influence their generic science abilities (Izetbigovic et al., 2019; Noviandayati & Shofiyah, 2021). Foundational argumentation skills in critical thinking, through argumentation students can develop their ideas (Hardini & Alberida, 2022; Karlina & Alberida, 2021).

Conclusion

The Argument-Driven Inquiry based e-module assisted by 3D Pageflip Professional which was developed meets the n-gain score criteria in the medium category. Thus, it can be concluded that the electronic module based on Argument-Driven Inquiry assisted by 3D Pageflip professional is quite effective for use in science learning activities in schools.

Acknowledgements
We would like to thank all parties who have contributed to the research.

Authors Contribution
The author's contributions include A.S: collecting data, analyzing data, writing original drafts, and S. and A.A.S: focus on methodology, and review of writing.

Funding
This research was funded by Ristekdikti Master's Thesis Research 0557/E5.5/AL.04/2023.

Conflicts of Interest
The authors of this article declare no conflicts of interest.

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