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Development of Scaffolding-Based Science E-Modules to Improve Junior High School Students' Scientific Reasoning

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Abstract

Scientific Reasoning is a high-level thinking ability to think scientifically, systematically, and logically in the scientific method process. The scientific reasoning of junior high school students is still low in Science learning. In fact, scientific reasoning is an essential component of the cognitive flow of 21st-century skills. This study aimed to describe the validity, practicality, and effectiveness of scaffolding-based Science e-module in improving the scientific reasoning of junior high school students. This study was a developmental study with the ADDIE model. The subjects were 35 7-E students in SMP Negeri 7 Jember with the implementation in the even semester of the 2023/2024 academic year. The data collection techniques used were observation, documentation, validation sheets, implementation observation sheets, tests (pretest and posttest), and questionnaires of student response. Based on the research results, the implementation of a scaffolding-based Science e-module obtained a validation value of 89.8%, which was included in the valid category and can be used in the learning process. The results of the practicality analysis obtained a value of 88%, which was included in the very practical category to be used in the learning process. The effectiveness was obtained from the results of the pretest and posttest with an N-Gain value of 0.73%, which was included in the high category, and the results of student response were 89.4%, which was included in the very good category and effective in improving scientific reasoning of the junior high school students.

Keywords: E-Module; Scaffolding; Scientific Reasoning

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INTRODUCTION

Natural Science is learning that places more emphasis on providing direct experience in developing students' skills and abilities in exploring and understanding the natural environment scientifically (Kanga et al., 2022). The basic concept of science is widely applied in everyday life. In the educational process, science learning has an important role. It can arouse students' enthusiasm and interest in developing science, especially related to the natural environment (Mabsutsah & Yushardi, 2022). The main goal of learning science is to help students recognize scientific concepts, show curiosity, solve problems, and acquire social skills (Kleruk et al., 2021). Science is related to a way to

find out about nature systematically. In addition to mastering a collection of knowledge in the form of facts, concepts, or principles, science is also part of the discovery process. The science learning process emphasizes providing direct experience to develop students' skills so that they can explore and understand the natural environment systematically (Wilujeng, 2017).

Scientific reasoning ability is an essential ability for a student to have. It is defined as a high-level thinking ability to think scientifically or systematically and logically in the scientific method process (Hadi et al., 2021). According to Bogar (2019), the scientific reasoning ability of junior high school students is still very low in science learning. In fact, scientific reasoning ability is an essential component of the cognitive flow of 21st-century skills. In addition, it is also seen as a tool needed to understand science and develop students' conceptual and scientific knowledge (Bogar, 2019).

Electronic modules are modifications of printed modules that can be used in science learning using electronic media such as mobile phones and computers/laptops (Nova et al., 2021). According to Purwanto et al. (2021), the use of e-modules makes learning less boring and more interesting and can improve students' scientific reasoning abilities. Another advantage of this e-module is, it can increase and expand students' knowledge, stimulate thinking, behavior, and further development, and train students in independent learning. In e-modules, there is content such as images and videos; this makes e-modules more interesting than printed. The use of e-modules is still minimal in learning. This can be seen from learning that has yet to raise questions that invite students to reason scientifically (Purwanto et al., 2021).

Students' scientific reasoning can be trained through classroom learning. The learning process in the classroom also depends on the learning media used by the teacher to activate students' scientific reasoning abilities, one of which is a scaffolding-based e-module. The use of scaffolding in e-modules can help students learn independently (Putri et al., 2022). According to Reynolds & Goodwin (2016), there are three principles of scaffolding namely a) the assistance provided must be in accordance with the needs of students, b) how the transfer of teaching responsibilities from teachers to students, and c) the assistance provided will decrease over time. It can be concluded that scaffolding learning provides the assistance/support needed by students in solving a problem by providing freedom and independence in learning according to the student's abilities while also following the appropriate pattern. In meeting the needs of students, especially in science learning, this scaffolding can be used as an e-module arrangement technique (Nova et al., 2021).

Based on the description of the problems above, the researcher conducted a study entitled "Development of Scaffolding-Based Science E-Modules to Improve Junior High School Students' Scientific Reasoning". Scaffolding-based E-Modules are expected to help students understand science lessons and make students more independent and active in the learning process.

METHODS

Research and Development (R&D) is a method used to create new products or develop and perfect existing products. This development research refers to the Analyze, Design, Develop, Implement, and Evaluate (ADDIE) model. The data collection technique used in the research measures the validity, practicality, and effectiveness of scaffolding based on a science e-module. The data in this research was processed in the form of descriptive analysis data obtained through the results of observations, documentation, validation sheets, implementation observation sheets, tests (pretest and posttest), and questionnaires of student response.

RESULTS AND DISCUSSION

This research refers to the ADDIE model. The stages in the research are analyze, design, develop, implement, and evaluate. This development research was conducted to obtain a valid, practical, and effective e-module product. The research stages using the ADDIE model are explained as follows.

Analyze

At this stage, the researcher conducted an observation to obtain information related to initial data from the school. In addition to observation, together with the science teacher, the researcher also interviewed at the school. The results of the observation and interview related to technology, namely electronic media, are rarely used in learning, especially in science subjects. Teachers only use printed teaching materials in the learning process, such as textbooks, LKS, and printed modules if available. This makes students bored and less interested in learning, so they do not understand the material taught by the teacher. The author determined SMP Negeri 7 Jember as the place of research because e-modules have never been used in the learning process and students' scientific reasoning is included in the low category. This can be seen from the teaching materials used, which are still printed teaching materials. In addition, the results of an interview with one of the science teachers at the school stated that students' scientific reasoning was not optimal because students were too lazy to learn to think.

Design

This stage is carried out by designing the product based on the results of the previous stage, namely analysis. Researchers design a product, namely a scaffolding-based science e-module on ecology and biodiversity material to produce a valid, practical, and effective product. This stage begins with designing the product on the website, namely Canva. The design is in the form of materials, practical activities, scaffolding-based worksheets, and practice questions to train students' scientific reasoning that can be accessed online.



Figure 1. E-module cover

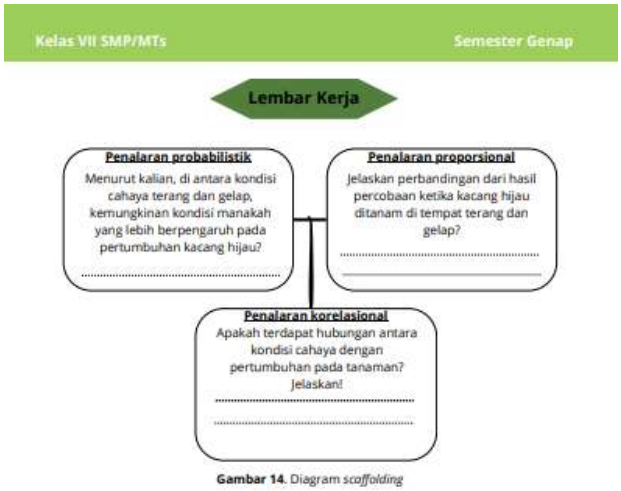


Figure 2. Scaffolding diagram-based worksheet

Develop

The e-module resulting from the design stage will be developed and validated by three validators. The validation results will be analyzed in each aspect of the assessment, and then the module will be adjusted to the interval of its validity level.

Table 1. Results of the validity test of the scaffolding-based science e-module

No	Assessment Aspects	Interval Score			Percentage (%)	Category
		V1	V2	V3		
1.	Content Aspect	95	100	85	93.3%	Very Valid
2.	Material Aspect	86.6	96.6	90	91.1%	Very Valid
3.	Presentation Feasibility Aspect	100	100	86.6	95.5%	Very Valid
4.	Aspects of Language Usage	60	90	90	80%	Quite Valid
5.	Design Aspects	84	100	84	89.3%	Valid
	Average Score	**85.1**	**97.3**	**87.1**	**89.8%**	**Valid**

Based on the validation results obtained from 3 validators with all aspects, 89.8% of them are included in the valid category. So, it can be concluded that the scaffolding-based science e-module can be used in the science learning process.

Implement

The valid scaffolding-based science e-module will be tested on students, namely in learning activities. The research subjects in this development test were 35 students of class VII E of SMP Negeri 7 Jember. Data on the implementation of learning in the use of scaffolding-based science e-modules to improve students' scientific reasoning will be used as the results of the development test. The data were obtained from 3 observers, namely students who conducted assessments during learning activities in the classroom.

Table 2. Results of the practicality test of the e-module

No	Aspects observed	Presentation of the 2nd Meeting					Percentage (%)
		1	2	3	4	5	
1	Students can access scaffolding-based e-modules	100	100	91.6	91.6	91.6	95%
2	Students understand the material and/or carry out experiments in the e-module to obtain information.	91.6	83.3	83.3	83.3	91.6	87%
3	Students work on exercises and discuss how to process the information they obtain.	91.6	91.6	83.3	83.3	91.6	88%
4	Students answer questions related to probabilistic reasoning, proportional reasoning, and correlational reasoning in scaffolding-based e-modules.	75	75	83.3	75	83.3	78%
5	Students write and explain the results of their observations in the e-module.	83.3	91.6	91.6	100	91.6	92%
	Average	88.3	88.3	86.6	86.6	90	88%
				Category			**Very Practical**

Based on Table 2, the practicality of learning using scaffolding-based science e-modules is determined. The average percentage of all meetings is 88%, which is categorized as very practical. So, the e-module can be said to be very practical to use and implement.

Evaluate

This stage is carried out by assessing the quality of the product both before and after the implementation stage. There are formative and summative evaluations. Formative evaluation is an evaluation carried out during the development implementation process, while summative evaluation is an evaluation carried out to determine the success of the development implementation; this evaluation is carried out at the end of the study. The level of success can be measured by knowing the increase in students' scientific reasoning in using scaffolding-based science e-modules during learning. This can also determine the level of effectiveness of the product that has been developed. In addition to the results of increasing students' scientific reasoning, effectiveness can also be measured from student response questionnaires regarding the use of e-modules.

The effectiveness of a developed product can be seen through the results of tests conducted after using it. This test includes a test before using the e-module (pretest) and a test after using the e-module (posttest), which is conducted to determine the increase in students' scientific reasoning when using the scaffolding-based science e-module in learning.

Table 3. The Results of n-gain scientific reasoning

Component	Class VII E		N Gain	Category
	Pretest	*Posttest*		
Number of Students	35	35		
Lowest Value	12.5	71	0.669	Currently
The highest score	62.5	96	0.893	Tall
Average Value	**37.5**	**83.5**	**0.736**	**Tall**

Based on the analysis results in Table 3, the average percentage of the N-gain value was obtained at 0.736, which is categorized as high. The average result of the pretest value obtained by students was 37.5, while after learning using the e-module or the posttest value, it increased to 83.5. So, the N-gain value obtained shows an increase in students' scientific reasoning when learning using the scaffolding-based science e-module. The use of the e-module is effective and can be applied as a science teaching material on ecology and biodiversity materials to improve students' scientific reasoning.

Table 4. N-gain results based on scientific reasoning indicators

Indicator	Pretest Average	Posttest Average	*N-gain*	Category
Correlational Reasoning	54.4	85.5	0.682	Currently
Proportional Reasoning	21.4	80.5	0.752	Tall
Probabilistic Reasoning	41.9	88.0	0.794	Tall

Based on the N-gain results in Table 4 show that there is an increase in the average value of each indicator of students' scientific reasoning. The highest increase in value in the scientific reasoning indicator is shown by the probabilistic reasoning indicator, which is 0.794 with a high category. The lowest increase in value is shown by the correlational reasoning indicator, which is 0.682 with a medium category. This study is also supported by student response questionnaire data filled out by class VII E, totaling 35 students.

Table 5. Student response questionnaire results

Aspects observed	Percentage (%)	Category
Interest	89.6	Very good
Material	86.2	Very good
Language	92.3	Very good
Average	**89.4**	**Very good**

Based on the results of the student response questionnaire analysis in Table 5, the average percentage was 89.4%, with a very good category. Both of the observed aspects, namely interest, material, and language, can motivate students in learning activities on ecology and biodiversity materials using scaffolding-based science e-modules. The product can be said to be good and effective for improving students' scientific reasoning.

CONCLUSION

Based on the research results on the development of scaffolding-based science e-modules, the validation value obtained was 89.8% which is included in the valid category and can be used in learning. The results of the practicality analysis obtained a value of 88%, which is included in the very

practical category for use in learning. Effectiveness was obtained from the results of the pretest-posttest with an N-Gain value of 0.73%, which is included in the high category, and the results The student response was 89.4%, which is included in the very good category and is effective for improving the scientific reasoning of junior high school students.

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