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EFFECTIVITY OF SCIENCE E-MODULES BASED ON MULTIPLE REPRESENTATION OF VIBRATION, WAVE AND SOUND TO IMPROVE PROBLEM SOLVING SKILLS JUNIOR HIGH SCHOOL STUDENTS

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ABSTRACT

Learning system that is in line with the 21st century, education has an impact on how society develops in the period of society 5.0. Along with enhancing comprehension, science education also tries to equip pupils with additional problem-solving abilities. The usage of instructional materials, specifically, is one way to help students' problem-solving abilities in science learning. Multiple representation-based e-modules that are interactive teaching aids. Research and development (R&D) is the approach taken in this field of study. The N-Gain test is a data analysis tool used to evaluate the efficacy of the e-module. Data is transformed into percentages, then examined and divided into many categories. the outcomes of getting an effectiveness score of 0.71 with a high category using the n-gain test. Based on the findings of the research, it can be said that the multiple representation-based science e-module designed to help junior high school students with their problem-solving abilities has been successful and is suitable for use in the classroom as a teaching tool.

Keywords :*E-Modul; Effectivity; Multiple representation; Problem Solving Skill*.

I. INTRODUCTION

Education is a field that influences the development of society in the era of society 5.0 with the application of learning systems that are in accordance with the 21st century [1]. Science and technology are important foundations for the development of a nation [2]. Natural science is one of them. Natural Science (IPA) is a science that studies phenomena in the universe and has been tested using systematic steps. Science is the mastery of knowledge and the process of discovery in the form of concepts, principles, and facts. Science learning not only aims to improve student understanding, but also provides other skills that help students to solve problems.

The use of 4C (Communication, Collaboration, Critical Thinking and Problem Solving, and Creativity and Innovation) in science learning can be an alternative to improve students' skills [3]. Problem solving skills are very important in science learning because learning not only requires understanding but also solving that arises during learning. Problem solving skills are students' skills in observing, understanding, analyzing, and thinking critically on a problem which is then analyzed in an effort to solve the problem [4]. The existence of problem-solving skills

can have a good effect on students such as designing decisions carefully, precisely, systematically, logically and seeing decisions from various points of view.

Problem solving skills have several indicators. The following are indicators of problem-solving skills according to George Polya: 1) understand and identify the problem faced (understood the problem); 2) identify problem-solving strategies that are appropriate to solve the problem. (device a plan); 3) carry out problem solving in accordance with the planned strategy (carry out the plan); 4) Check back the results obtained (look back).

Based on the results of the assessment by PISA (The Program for International Student Assessment) in 2018, there was a decline in scientific achievement, namely Indonesia only reached a score of 396, ranked 71 out of 79 countries. The PISA assessment in 2018 focused on measuring students' ability to engage in solving issues related to science and science. The low problem-solving skills of students shown in research conducted by [5] showed that 31 students at Junior High School 2 Sampang achieved results as many as 25 students had low abilities, 2 students had medium abilities, and 4 students with high abilities. The low problem-solving skills of students are caused by two factors, including factors from within students (internal) and environment (external). Internal factors of students that can trigger low problem-solving skills include talent, interest and lack of motivation in learning activities that are lacking [6]. One solution that can be used to improve students' problem-solving skills in science learning is the use of teaching materials, namely. Interactive teaching materials in the form of e-modules.

E-modules (electronic modules) are teaching modules whose presentation is in electronic form that makes it easier for students to use because it contains graphics, audio, images, videos, animations, and formative exercise questions that can directly occur feedback [6]. According to research [7] the developed science e-module can facilitate student learning, improve students' science literacy skills and assist students in solving problems in everyday life. The advantages of e-modules used in learning include; 1) able to foster student learning motivation; 2) more interesting and interactive; 3) can contain animation, video and audio so as to make students not bored; 4) systematic preparation of e-modules so that they are easy to understand and do not confuse students; 5) can be accessed at any time [8]. Multiple representation-based E-Modules are solutions that aim to improve students' problem-solving skills. Multi means more than one, while representation means a way to describe objects or processes. Representation is the drawing, inference of objects, concepts or processes [9]. Multiple representation in this e-module is in the form of representations of science material in different formats such as verbal, images, graphs, diagrams and mathematical equations [10]. Multiple representation-based teaching materials can provide students with the ability to combine verbal, graphic, image, and mathematics in teaching materials [12].

Verbal representation is a representation in the form of elaboration of a concept in the form of words or sentence. Image representation is a representation presented in the form of a picture or sketch based on a description (verbal) that has been described which also serves to provide an overview of the verbal representation. Graphic representation is a form of representation that contains the relationship between one variable and another based on both verbal and mathematical explanations given. Mathematical representation is representation in the form of presentation of symbols, formulas, equations, and data processing [13].

Learning about vibration, waves, and sound can be problematic since the concepts are abstract and students need to be able to solve problems. Therefore, innovation in scientific education is required, for instance via innovative teaching materials. Multiple representations included in electronic modules (e-modules) can aid pupils in developing their problem-solving abilities. The existence of multiple representation in electronic modules (e-modules) can help students in improving problem-solving skills. Based on the background and description of these problems, the purpose of this study is to determine the effectiveness of multiple representation-based science e-modules to improve students' problem-solving skills.

II. METHOD

Research and Development (R&D) is the type of research used in this study. Research and Development (R&D) is a research method used to create a product and test. validity, practicality and effectiveness of the resulting product. ADDIE development model (Analyze, Design, Develop, Implement, and Evaluate) to produce a product in the form of multiple representation-based science e-modules to improve the problem-solving skills of junior high school students which are effectively used in science learning in junior high school. The study was conducted in the even semester of the 2022/2023 academic year with a sample of 32 students in grade VIII G at Junior High School 1 Jember.

The instruments used in the study were using pretest questions before using e-modules and posttests after using multiple representation-based science e-modules. The data analysis technique used to test the effectiveness of multiple representation-based IPA e-modules is using the N-Gain test as follows:

$$N - gain = \frac{(Spost)-(Spre)}{(Smaks)-(Spre)} \times 100\% \quad (1)$$

Information:
N-gain = Normalized average score
Spost = Average Post-Test Score
Spre = Average score of pre-test
Smax = Maximum score

Table 1. N-Gain Criteria

N-Gain Value	Criterion
$g > 0{,}70$	Tall
$0{,}70 \leq g \leq 0{,}30$	Keep
$g < 0{,}30$	Low

[14]

III. RESULTS AND DISCUSSION

Research Result

The attainment of learning that is carried out utilizing established instructional materials is tested for effectiveness. The effectiveness of instructional materials as measured by student outcomes as measured by learning process skills. If the quality of student learning is impacted by the usage of teaching resources, then those materials are successful.

Based on the outcomes of student assessments in the form of tests, multiple representation-based science e-modules are evaluated for their efficacy. The exam used to evaluate students' problem-solving abilities in the e-module is a pretest-posttest. It is possible to compare the outcomes of an investigation of students' problem-solving abilities before and after employing a variety of representation-based science e-modules in the classroom. The N-gain formula is used to determine how much the e-module's effectiveness value on students' problem-solving abilities has increased. The results of obtaining students' problem-solving skill scores through pretest-posttest can be seen in **Fig. 1** below.

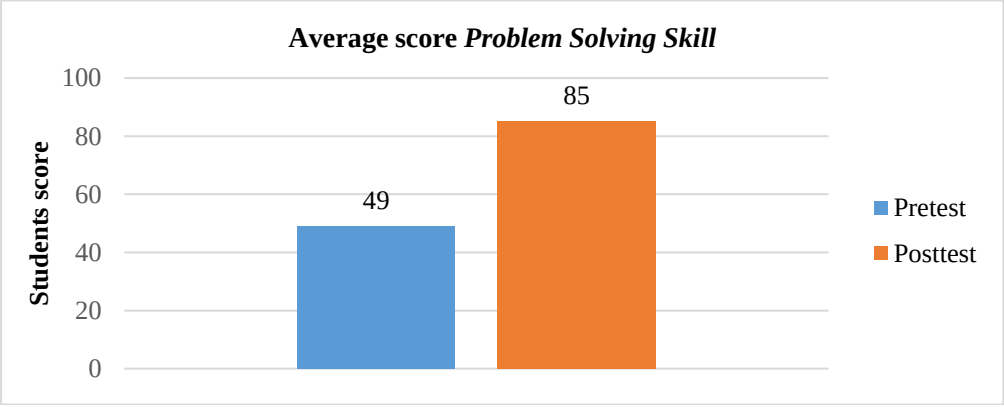

Fig. 1 Average *pretest* and *posttest* students

A comparison of students' problem-solving skill before and after using various representation or multiple representation-based science e-modules is shown in **Fig. 1**. 32 students scored a 49 on the average pretest, and 85 on the average posttest, according to data from the findings of the average pretest evaluation. The multiple representation-based science e-module improved the problem-solving abilities of grade VIII G students, according to the results of the pretest-posttest evaluation. The results are assessed to see how well the N-Gain formula works to help pupils improve their problem-solving skill. Here are the students' scores for the pretest-posttest N-Gain.

Table 2. The effectiveness of *students'* problem solving skills

Component	Class VIII G		*N-Gain*	Category
	Pretest	*Posttest*		
Number of Students	32		0,71	Tall
Lowest Score	35	93		
Highest Score	58	76		
Average Score	49	85		

Pretest-posttest scoring scores are based on **Table 2.** shows the N-Gain of grade VIII G students on their problem-solving skills of 0.71 with a high category. Details of the lowest and highest pretest gains before using the science e-module in learning sequentially were 35 and 58, while the lowest and highest posttest gains after using the multiple representation-based science e-module were 76 and 93 respectively. The N-Gain result of 0.71 with a high category can prove that students' problem-solving skills have improved after using the multiple representation-based science e-module. The breakdown of students' average N-Gain problem solving skills on each indicator is as follows:

Table 3. *N-Gain students' problem solving skills* on each indicator

Problem Solving Skill Indicator	N *Pretest*	N *Posttest*	*N-Gain*	Category
Understood the Problem	51,74	85,42	0,70	Keep
Device a Plan	56,42	88,37	0,73	Tall
Carry Out the Plan	48,70	87,11	0,75	Tall
Look Back	35,42	77,08	0,65	Keep

Table. 3 indicates that there has been an increase in the N-Gain markers of problem-solving skill. The N-Gain value for the comprehended the problem indication in the medium category was 0.70. The device a plan received an N-Gain rating in the high category of 0.73. In the medium category, the carry out the plan indicator received an N-Gain value of 0.75 and the glance back indicator received an N-Gain value of 0.65. The look back indicator yields the lowest N-Gain problem solving skill score. The medium category on the look-back indication indicates a moderate development in pupils' problem-solving abilities, which is good but not exceptional.

Discussion

The effectiveness of a developed product in the learning process must be considered while evaluating it. Effectiveness is a behavior-driven transformation. Effectiveness is used to determine how effective multiple representation-based science e-modules that have been developed when trials are carried out in learning. The effectiveness value of the e-module can be seen from the results of the pretest-posttest assessment which contains indicators of problem-solving skills. A simple way that can be used to determine changes in student learning outcomes during the use of the developed product is to use a pretest-posttest test [15]. The purpose of this pretest is to gauge students' comprehension before they begin the e-module. Additionally, the outcomes of the posttest, taken after students utilized the e-module to aid their learning, revealed disparate outcomes. This variation demonstrates how student learning results have improved both before and after utilizing the e-module. In an effort to improve learning outcomes, testing learning activities can improve the efficacy of student learning. The tests administered can take the shape of pretests or posttests, each of which serves a specific purpose, namely determining if the learning objectives and learning activities were successfully completed [21].

According to the results of **Table 2.** about the effectiveness of using multiple representation-based science e-modules on problem solving skills for grade VIII G students with pretest-posttest assessments obtaining an average N-Gain of 0.71 with a high effectiveness category. The N-Gain value obtained shows that there is an increase in student evaluation results, so that the e-modules used in learning can be said to be effective. In line with the statement given by [16], namely if teaching materials are included in the effective category, the teaching materials can improve students' learning abilities and outcomes and be able to improve the quality of learning for the better. [7] said that multiple representation-based teaching materials used in learning are effective in improving student learning outcomes with high effectiveness categories.

Based on **Table 3.** i.e. the average N-Gain value of students' problem solving skills on each indicator shows that the carry out the plan indicator gets the highest N-Gain value of 0.75 in the high category while the look back gets the lowest N-Gain value of 0.65 in the medium category. The carry out the plan indicator shows that students are able to apply the results of problem planning into the process of solving the problems faced. The carry out the plan indicator shows students' higher-order thinking skills in finding solutions to solve problems by understanding the problems that occur well so as to find the right alternative solutions [17].

The look back indicator shows that students still have difficulty in making conclusions from the results of solving the problems they have faced. Students are still not skilled in providing specific conclusions from the results of solving calculation problems accompanied by units when writing answers. The ability of students to draw conclusions is still moderate because students do not understand the concepts in the problem so they cannot solve according to the problem at hand. Research [18] medium category on the look back indicator where students only write correct answers but not accompanied by logical explanations. The low look back indicator shows that the teaching materials used have not been maximized in facilitating students' problem-solving skills. The e-module developed by the researcher already includes activities that can increase students' problem-solving skills but are still not optimal, namely the activities in the e-module are still less detailed to facilitate problem solving skills. The solution needed is to add practice questions to the activities in the e-module.

The use of a multiple representation approach in the presentation of material in e-modules provides advantages such as: 1) the representation of text, images, graphs and mathematical equations; 2) there is an audio-visual representation in the form of learning videos sourced from YouTube in e-modules that can be played repeatedly so as to adjust the level of student understanding; 3) The material is visualized in more detail so that students understand more easily. The visualization of material in the e-module can help students to understand the material more easily and deeply [19].

IV. CONCLUSION

Research and development of multiple representation-based science e-modules to improve students' problem-solving skills have been completed. Based on the results of the description of data analysis that has been explained in the previous chapter, the conclusion of the results of data analysis is that multiple representation-based science e-modules to improve students' problem-solving skills that have been developed are included in the high category with an N-Gain score of 0.71 with a high category, so that the e-module is said to be effective in improving students' problem solving skills.

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