Development Interactive E-module Based on Problem Solving to Improve Student Learning Outcomes

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Abstract. This research aims to determine the validity, practicality and effectiveness of developing interactive e-modules based on problem solving. The type of research used is Research & Development (R&D) with a 4D model, namely define, design, develop, disseminate. The validation sheet filled out by the validator is used to assess the validity of the e-module being developed, the teacher response sheet and student response sheet are used to assess the practicality of the e-module being developed, while the students' pretest and posttest questions are used to assess the effectiveness of the e-module. The results of research on the development of problem solving-based e-modules show that at the validation stage, the media expert's assessment received an average percentage of 87% in the very valid category and material experts received an average percentage of 86% in the valid category. The percentage results of the practicality test were 97.5% in the small group and 98.3% in the large group in the very practical category. The results of the effectiveness test based on the results of the significance test obtained an N-gain value of 0.8 in the small group and 0.8 in the large group, which is in the high category. The test results concluded that the problem solving model-based e-module had been tested for its validity, practicality and effectiveness as physics teaching material..

Keywords: Development, E-module , Interactive, Problem Solving.

1 Introduction

The rapid development of various aspects in the era of globalization demands every nation to enhance the potential and quality of its human resources. Indonesia is one of the developing countries that cannot escape the strong currents of globalization. Education is the transfer of values, knowledge, experiences, and skills to the younger generation as an effort by the older generation to prepare the living functions of the next generation, both physically and spiritually [1]. One of the fundamental problems faced by the education world today is that the teaching and learning process does not align with the goals that are intended to be achieved. This is a result of the teachers' lack of mastery in using various strategies, teaching methods, learning materials, and learning resources. Another factor that hinders this is the lack of variety in the

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types of learning materials used by teachers and students during the teaching and learning activities (Zulkifli, 2017).

Teaching materials are something used by teachers or learners to facilitate the learning process. They can take the form of reading books, worksheets, or presentations. They may also include newspapers, digital materials, food packages, photos, direct conversations with native speakers, instructions given by teachers, written assignments, cards, or discussion materials among learners. Thus, teaching materials can take many forms that are considered capable of enhancing the knowledge and/or experience of learners (E. Kosasih, 2021). One form of teaching materials can also be in the form of digital books/modules known as E-modules.

E-modules are one of the supports and opportunities for teachers to create teaching materials that can be used in schools. E-modules are developed by utilizing electronic devices, which will certainly make it easier for both teachers and students in their use. The use of E-modules is an alternative choice to support teaching and learning activities because they are more effective and interactive, meaning that not only teachers but also students are involved in their use, which is certainly engaging for students. E-modules are one of the alternatives that can be used. The development of e-modules is considered appropriate for online and offline learning activities because students can learn independently according to the instructions in the module. The appearance of the e-module is engaging as it contains animations and videos that are not boring, allowing students to continue learning happily.

Soviana, Gummah, & Habiburrahman (2017) state that students learning independently allows them to learn actively and creatively. E-modules are also contextual so that students can relate the material being studied to their everyday lives, both in the family environment, school, community, and as citizens, with the aim of finding meaning in the material for their lives. The design of the e-module should be tailored to the success that needs to be improved. The success of enhancing learning outcomes is related to the problem-solving or issues that students need to address. The problem-solving process involves using various methods and new ideas while still adhering to existing concepts. One suitable model to apply is the Problem Solving model.

The problem-solving learning model is the students' skill in using a thinking process to solve problems through facts or seeking data sources, analyzing the information obtained, formulating alternatives to solve the problem, and applying effective rules. On the other hand, Daryanto (2017) problem solving is a learning process that actively involves students during the learning process to solve given problems, thereby enhancing students' thinking skills.

2 Method

This research was conducted for approximately 2 (two) months, from April to May in the even semester of the 2023/2024 academic year at MAS PONPES DARUL QUR'AN located on Pasar 1 Street, Dusun 1, Amplas Village, Percut Sei Tuan District, Deli Serdang Regency as the research location, because in that school there are issues, namely; first, the teacher only uses textbooks as the means and facilities for teaching materials, and second; students feel bored with the monotonous teaching methods, third; The teachers' ability to operate computers is also not sufficient to compile E-Modules, fourth; Problem Solving-based E-Modules in physics learning.

This study was carried out in the 10th grade, which consisted of a small group (10 students) and a large group consisting of one class (35 students). The media developed in this research is an interactive e-module based on problem solving. The software used to create the e-module is Canva. The Canva application is used to create attractive designs that can be saved as a PDF. The electronic module developed is integrated with the Problem Solving learning model. Problem solving is a learning method that requires students to find the answer without special assistance which will provide superior results and encourage students to solve problems with their own thoughts (Nasution, 2008: 173).

2.1 Define

The first stage of definition is useful for determining and defining the needs in the learning process and collecting various information related to the product to be developed, where this stage consists of initial analysis (front end), learner analysis and task analysis.

2.1.1 Front-end Analysis

The physics teacher of MAS PonPes Darul Qur'an explained that his ability to operate a computer was not proficient enough and time constraints did not allow him to learn how to make e-modules, which required him to use monotonous methods and use textbooks to convey material to students during the learning process. So in this case teaching materials are needed that can be student-centered, namely the availability of electronic modules that support student center learning programs. (Sri yunimar et al, 2021) state that the teaching materials used by teachers in digital learning need to be more attractive, in order to improve student learning outcomes. So teachers must be able to develop and make teaching materials that are interesting and fun, for example, such as using e-modules. In line with the statement (Feriyanti, 2019) states that e-modules are a form of presentation of independent teaching materials that are arranged systematically, which are presented in electronic format, where each learning activity in it is connected by a link, e-modules are also equipped with a presentation of learning videos, audio and images that can make it easier for students to understand learning.

2.1.2 Learner Analysis

This analysis was conducted to determine the analysis of students' media needs, based on the results of the needs analysis it was found that the K13 curriculum requires teachers to realize student-centered learning programs, prepare students to have the ability to think critically, and solve problems. However, this learning model cannot be applied in the learning process because there are no teaching materials designed to be student-centered. This analysis is contained in the form of a questionnaire, the results of the analysis of student media needs can be seen in Table 1.

Table 1. Results of Media Needs Analysis of Students

No	Statement	Options		%
		Yes	No	
1	I feel happy when studying Physics	28	7	80
2	Renewable energy is my favorite subject	25	10	71
3	I have difficulty in understanding the concept of renewable energy	27	8	77
4	I have difficulty in understanding the relationship between renewable energy	25	10	71
5	I have difficulty understanding the concepts and phenomena that occur in the law of conservation of energy	30	5	86
6	My teacher uses textbooks for teaching materials during the learning process	29	6	83
7	My teacher gives examples of problems and applications of the material taught	28	7	80
8	My teacher does not use LCD in learning activities	28	7	80
9	My teacher does not use media in every lesson	30	5	86
10	Learning media can help me understand renewable energy material in outline.	30	5	86
Amount		**280**	**70**	**800**
Avarage Percentage (%)				**80**

Based on the data in Table 4.1, the results of the analysis of students' media needs reached an average of 80%, including in the “need” category. Where there are 83% of students said the teacher used textbooks for teaching materials during the learning process, 80% of students stated that the teacher did not use LCD in learning activities, 86% of teachers did not use media in every lesson, 86% of students said that using learning media can help students understand learning material. As cited in Febrianti et al, (2017) stated that physics teaching materials for the 2013 curriculum used by educators are currently 73.6% in the form of textbooks and the remaining 34.36% of educators who explain the material themselves using media (software / simulations / PPT, videos, animations, and images).

2.1.3 Task Analysis

This analysis is made to find out the activities that students will do in the learning process, starting from the flow of learning objectives (ATP), learning objectives (TP) to learning outcomes (CP) which will be structured through e-modules developed using the problem solving learning model. The activities carried out in the classroom are learning activities in the classroom begin with the teacher explaining the learning objectives to be learned, then providing problems that need to be solved and explaining how good problem solving procedures are.

1. After that students look for supporting literature to solve the problems given and determine several solutions taken to solve the problem with other methods such as demonstrating in front of the class, discussing then doing the task according to the teacher's instructions and finally drawing conclusions.

2. This means that students report on the tasks given by the teacher. Practical activities are carried out in the Lab room and classroom using computers (PCs) that have been provided at school.
3. Activities carried out in the computer lab are to test the products developed by researchers, namely interactive e-modules. Where this product will look practical or not when used by students and whether this product can help students solve problems / problem solving contained in the e-LKPD in the e-module.
4. After carrying out activities in the computer lab, in addition to the practicality of the interactive e-module based on problem solving. problem solving-based interactive e-module on Renewable Energy material, students are also able to solve problems contained in the e-LKPD in the e-module by creating.
5. One meeting lasts 2 x 45 minutes, the utilization of learning time is still not optimal. There are some students who are less active in learning, especially if one computer is used for two or more students.

2.1.4 Concept Analysis

This analysis aims to determine the content of the material compiled by researchers on the developed interactive E-module, where the material used by researchers is Renewable Energy using the 2013 Curriculum (K13) in accordance with the curriculum used in the school that the researchers studied.

2.1.5 Specifying Instructional Objectives

This analysis is carried out to determine the objectives of the learning competency outcomes based on material analysis and curriculum analysis.

2.2 Develop

2.2.1 Expert Appraisal

Material and media validation is determined from the assessment of material and media experts. The results of the assessment of materials and media become the basis for the feasibility of media used in problem solving-based interactive e-module development research. Material validation was carried out by practitioners from Medan State University namely Mr. Dr. Ridwan Abdul Sani, M.Si as validator 1 and MAS PonPes Darul Qur'an teacher namely Mrs. Bestrica Kurnia, M.Pd as validator 2. Media validation was carried out by practitioners from Harapan University namely Dr. Ari Usman, S.T., M.Kom as validator 1 and Mr. Divi Handoko, S.T., M.Kom as validator 2.

a. Media Expert Validation on Problem Solving-Based Interactive E-Module

This part of the problem solving-based interactive e-module development was validated without revision. The assessment made by the validator of the problem solving-based interactive e-module includes: screen design appearance, ease of use, consistency, usefulness and graphics. The results of the analysis of interactive e-modules validated by media experts are contained in the form of a questionnaire where the questionnaire and data are processed. The data analysis of the media expert validation results can be seen in Table 2 below.

Table 2. Media Expert Validation Results on Problem Solving-Based Interactive E-Modules

No	Aspect	Percentage(%)
1	Screen Design Display Aspect	87
2	Ease of Use	94
3	Consistency aspect	80
4	Aspects of Usability	87
5	Graphics Aspect	88
	Average Percentage	**87**

The results in 2 obtained the total average value of validation of interactive e-modules based on problem solving by validators is 87%. The problem solving-based interactive e-module developed obtained a value of > 60%, so based on the validity criteria, the problem solving-based interactive e-module developed obtained a value in the "Very Feasible" category to be used in the learning process. The two media validators concluded that the problem solving-based interactive e-module studied and developed was feasible to implement without revision. The assessment of each aspect can be seen in Figure 1.

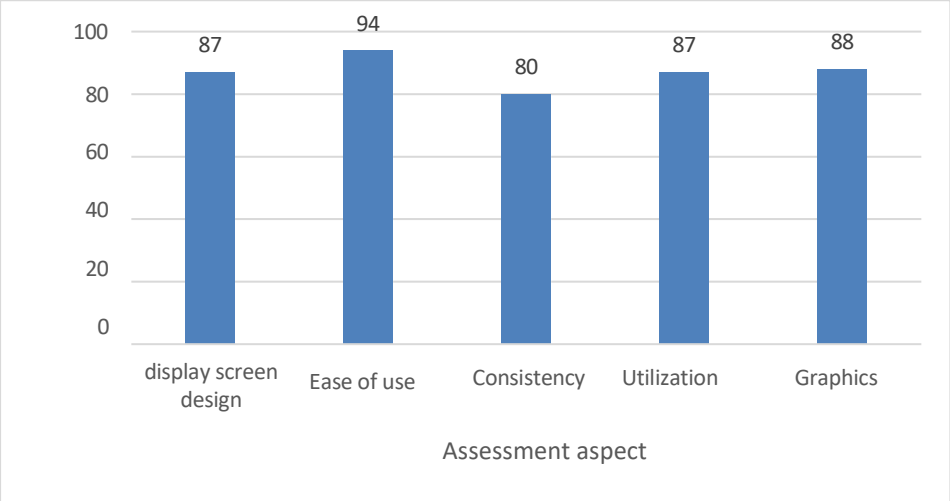

Fig. 1. Percentage of Media Expert Validation Results on Problem Solving-Based Interactive E-Modules.

b. Material Expert Validation on Problem Solving-Based Interactive E-Modules

The assessment conducted by the two validators on problem solving-based interactive e-modules includes aspects: content feasibility, linguistic feasibility, presentation feasibility, and problem solving assessment by students. The data analysis of the material expert validation results can be seen in Table .3.

Table 3. Material Expert Validation Results on Problem Solving-Based Interactive E-Modules.

No	Aspect	Percentage (%)
1.	Content Appropriateness	78
2.	Language Feasibility	93

3.	Presentation Feasibility	93
4.	Problem solving assement by students	80
	Avarage Percentage	**86**

The results of the material expert validation of problem solving-based interactive e-modules on renewable energy material conducted by the two validators by filling out a material validation questionnaire based on aspects of content feasibility, language feasibility, presentation feasibility, and problem solving assessment aspects, it can be seen that of the four aspects obtained a percentage of 86% with the category "Very Feasible". The assessment of each aspect can be seen in Figure 2.

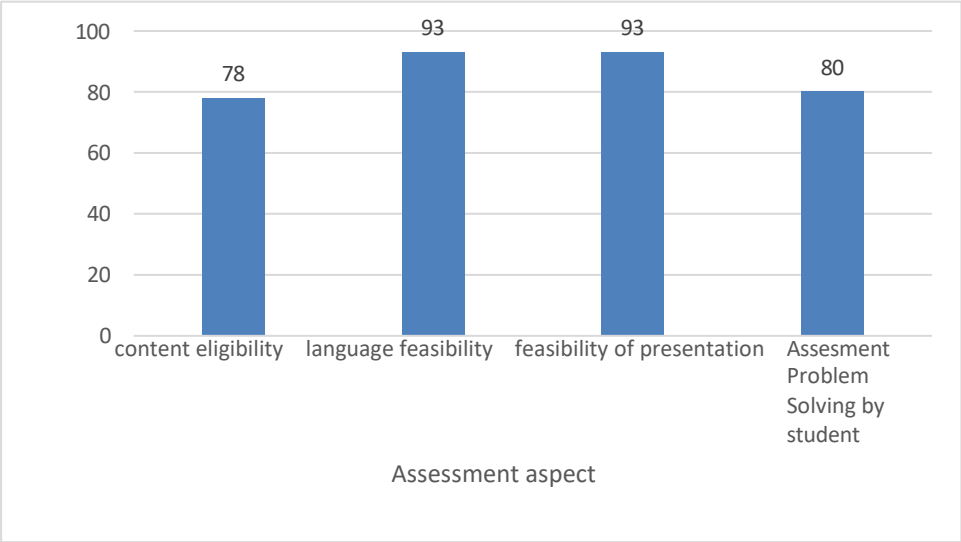

Fig. 2. Percentage of Material Expert Validation Results on Problem Solving-Based Interactive E-Module.

2.2.2 Development Testing

At the product trial stage carried out by researchers included two trials, namely small group trials and large group trials. Researchers conducted trials on class X students of MAS PonPes Darul Qur'an, Percut Sei Tuan District, Deli Serdang Regency as many as 10 students for small groups and 35 students for large group trials. After carrying out learning activities using problem solving-based interactive e-modules on Renewable Energy material, the effectiveness of the interactive e-modules developed by researchers will be seen by comparing the increase in pretest learning outcomes with postest and the practicality of interactive e-modules will be seen when the product can be easily used by students and students fill out questionnaires that have been distributed by researchers. The success of the learning media developed by researchers is seen in the results of product trials conducted by researchers in schools.

3 Result and Discussion

3.1 Small Group Trial

Students of class X MIPA-3 MAS Ponpes Darul Qur'an as many as 10 students were the initial stage of the trial. Students carried out the learning process using interactive e-modules based on problem solving. The practicality of problem solving-based interactive e-modules can be seen when the product can be easily used by students and from students' assessment/response to problem solving-based interactive e-modules by filling out questionnaires that have been distributed by researchers and the effectiveness of problem solving-based interactive e-modules will be seen when there is a comparison of the increase in student learning outcomes in the initial test (pretest) and final test (posttest).

3.1.1 Practicality of Media on Problem Solving-Based Interactive E-Modules

The results of student responses to problem solving-based interactive e-modules in small groups are in Table 4 media practicality.

Table 4. Media Practicality in Small Groups

No	Aspect	Percentage (%)
1	Aspects of Feasibility of Content Presentation of Material	97
2	Aspects of Language Feasibility	97
3	Aspects of Utilization Feasibility	98
4	Aspects of Feasibility of Graphics	98
Average Percentage		**97,5**

Table 4 is a recapitulation of the student response questionnaire sheet to the problem solving-based interactive e-module with an average percentage of all aspects of the indicator of 97.5%. Based on the criteria for student responses to problem solving-based interactive e-modules developed, the average percentage value is “Very Practical”. Interactive e-modules are practical if the results of a positive student response questionnaire are > 60%. Thus, the e-module developed is practical to use when viewed from the student response questionnaire on interactive e-modules based on problem solving. The assessment on each aspect of the indicator can be seen in Figure 3.

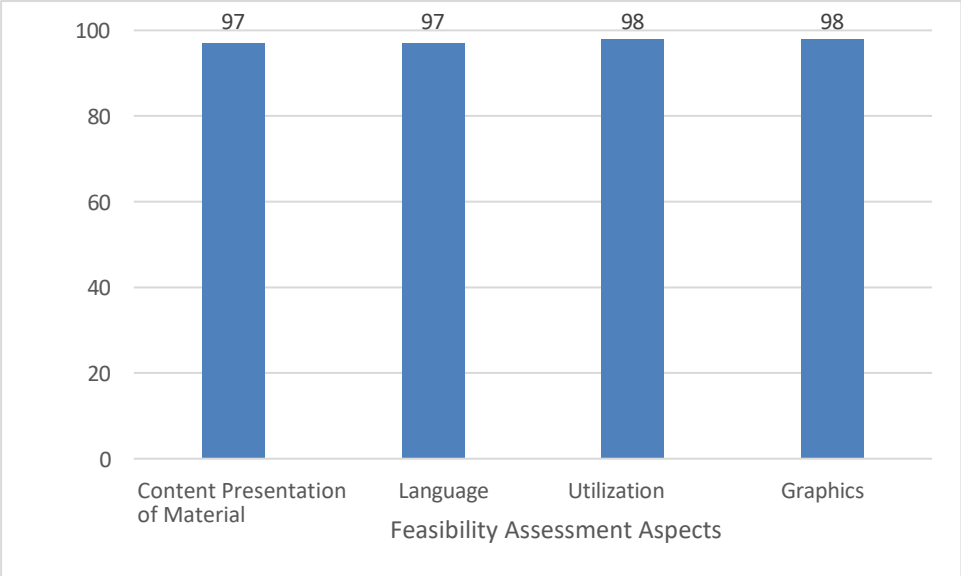

Fig. 3. Percentage of Practicality of Small Group Media for Each Aspect.

3.1.2 Media Effectiveness of Problem Solving-Based Interactive E-Modules

The effectiveness of interactive e-modules based on problem solving can be seen if the classical learning outcomes of students in one class 85% of students reach a score of 75. Classical learning completeness is reviewed from the increase in student learning outcomes obtained from the comparison of the final test score (postest) and the initial test score (pertest). The final test was in the form of multiple choice questions totaling 20 questions. The increase in student learning outcomes can be calculated by N-gain, according to Hake (1997) the level of normalized gain is categorized as high if $g > 0.7$. The increase in student learning outcomes on the use of interactive e-modules based on problem solving is listed in table 5.

Table 5. Improvement in Small Group Student Learning Outcomes

Student	Pretest	Postest	Postest-Pretest	Ideal Skor (100-Pretest)	N Gain Score	Description
1	30	85	55	70	0,8	High
2	25	85	60	75	0,8	High
3	30	80	50	70	0,7	Medium
4	30	85	55	70	0,8	High
5	20	80	60	80	0,8	High
6	25	85	60	75	0,8	High
7	30	80	50	70	0,7	Medium
8	35	85	50	65	0,8	High

9	15	80	65	85	0,8	High
10	20	75	55	80	0,7	Medium
Mean	**26**	**82**	**56**	**74**	**0,8**	**High**

Table 5 is a recapitulation of student learning outcomes before (pre-test) and after (posttest) using interactive e-modules based on problem solving. This interactive e-module is declared effective seen from the increase in student learning outcomes included in the "High" category obtained a value above g> 0.7, namely 0.8.

3.2 Large Group Trial

tudents of class X MIPA-3 MAS PonPes Darul Qur'an as many as 35 students (large group) are part of the final product trial (implementation) in this study. Students carry out the learning process by using interactive e-modules based on problem solving.

3.2.1 Practicality of Media on Interactive E-Modules Based on Problem Solving

Practicality obtained from the results of student responses to problem solving-based interactive e-modules in large groups is in Table 6 media practicality.

Table 6. Media Practicality in Large Groups

No	Aspect	Percentage (%)
1	Aspects of Feasibility of Content Presentation of Material	99
2	Aspects of Language Feasibility	98
3	Aspects of Utilization Feasibility	97
4	Aspects of Feasibility of Graphics	97
Average Percentage		**97,5**

Table 6 is a recapitulation of the student response questionnaire sheet to the problem solving-based interactive e-module with an average percentage of all aspects of the indicator, namely 98%. Based on the criteria for student responses to problem solving-based interactive e-modules developed, the average percentage value is "Very Practical". Interactive e-modules are practical if the results of a positive student response questionnaire are > 60%. Thus, the e-module developed is practical to use when viewed from the student response questionnaire on interactive e-modules based on problem solving. The assessment on each aspect of the indicator can be seen in Figure 4.

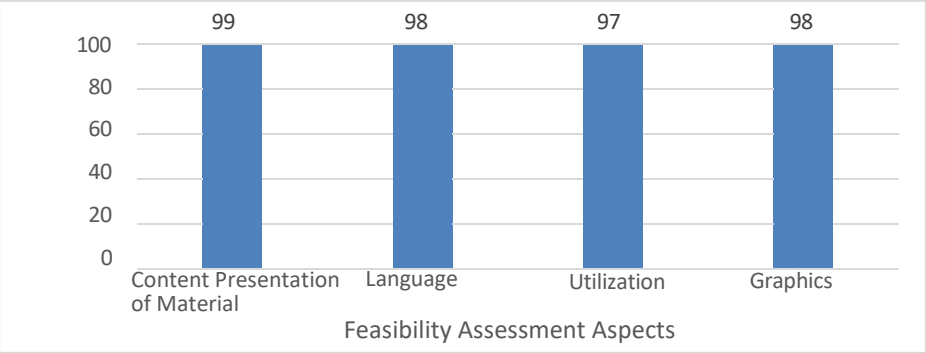

Fig. 4. Percentage of Large Group Practicality for Each Aspect.

3.2.2 Media Effectiveness of Problem Solving-Based Interactive E-Modules

The final stage of this research was carried out to determine the effectiveness of this problem solving-based interactive e-module, the effectiveness of problem solving-based interactive e-modules is said to be effective if the classical learning outcomes of students in one class 85% of students reach a score of 75. Problem solving-based interactive e-modules are declared effective seen from the increase in student learning outcomes included in the "High" category obtained values above g> 0.7, namely 0.8 (Hake, 1997). The final test is in the form of multiple choice questions totaling 20 questions. The increase in student learning outcomes on the use of interactive e-modules based on problem solving is listed in Table 7.

b) Media Effectiveness of Problem Solving-Based Interactive E-Modules

The final stage of this research was carried out to determine the effectiveness of this problem solving-based interactive e-module, the effectiveness of problem solving-based interactive e-modules is said to be effective if the classical learning outcomes of students in one class 85% of students reach a score of 75. Problem solving-based interactive e-modules are declared effective seen from the increase in student learning outcomes included in the "High" category obtained values above g> 0.7, namely 0.8 (Hake, 1997). The final test is in the form of multiple choice questions totaling 20 questions. The increase in student learning outcomes on the use of interactive e-modules based on problem solving is listed in Table.7.

Table 7 Improvement of Large Group Student Learning Outcomes

Sample	Pretest	Postest	Postest-Pretest	Ideal Skor (100-Pre)	N Gain Score	Describe
1	70	95	25	30	0,8	High
2	55	95	40	45	0,9	High
3	60	90	30	40	0,8	High
4	75	95	20	25	0,8	High
5	75	95	20	25	0,8	High

6	75	95	20	25	0,8	High
7	55	90	35	45	0,8	High
8	40	85	45	60	0,8	High
9	40	85	45	60	0,8	High
10	35	85	50	65	0,8	High
11	60	90	30	40	0,8	High
12	65	90	25	35	0,7	Medium
13	40	85	45	60	0,8	High
14	65	90	25	35	0,7	Medium
15	55	85	30	45	0,7	Medium
16	50	90	40	50	0,8	High
17	60	95	35	40	0,9	High
18	70	95	25	30	0,8	High
29	60	90	30	40	0,8	High
20	60	90	30	40	0,8	High
21	40	85	45	60	0,8	High
22	70	95	25	30	0,8	High
23	50	85	35	50	0,7	Medium
24	60	90	30	40	0,8	High
25	80	95	15	20	0,8	High
26	60	90	30	40	0,8	High
27	60	90	30	40	0,8	High
28	50	85	35	50	0,7	Medium
29	35	90	55	65	0,8	High
30	60	90	30	40	0,8	High
31	60	90	30	40	0,8	High
32	30	85	55	70	0,8	High
33	45	90	45	55	0,8	High
34	35	85	50	65	0,8	High
35	60	90	30	40	0,8	High
Mean	**56**	**89,85714**	**33,85714**	**44**	**0,8**	High

Table 7 is the percentage of improvement in large group student learning outcomes on the use of interactive e-modules based on problem solving of 0.8 including in the “High” category. This is in accordance with research (Nurfajriani, 2023) which states that the effectiveness of e-modules can be seen from the improvement of student learning outcomes.

3.3 Desiminate

After conducting product trials on small groups and there were no improvements, product trials were continued on large groups, the next stage was the dissemination stage. The purpose of this stage is to disseminate interactive e-modules that have been tested in small groups and large groups. In this study, only limited dissemination was carried out, namely by disseminating and promoting the final product of interactive e-modules on a limited basis to Physics teachers at MAS PonPes Darul Qur'an.

3.4 Discussion Research

The final product of this research is a problem solving-based interactive e-module that contains renewable energy material with the help of the CANVA application. The final product is expected to meet the criteria of valid, practical, and effective. This is in accordance with Nieveen's (2007) statement that quality development must meet three criteria, namely validity, practicality and effectiveness. The purpose of this study is to determine the validity, practicality, effectiveness, and see if there are differences in improving problem solving skills between students who take part in learning by using interactive e-modules based on problem solving and those who do not use interactive e-modules based on problem solving.

Based on research (Sri Agustini, 2020) The development of interactive E-Modules Based on Problem Solving in Physics Learning shows an average validator assessment result of 77.60% in the good category while the average validator assessment result of this study is 86.5% which has increased from previous research and Renewable Energy material has never been discussed before.

The interactive e-module development process carried out by researchers uses the four-D (4D) design. Based on problem identification, learning media such as interactive e-modules used in the physics learning process have never been used at the school and teachers rarely use learning media and only use textbooks due to the lack of teacher ability to operate computers and the limited time available in learning to make learning media. Limitations of learning media, causing students' desire to learn to decrease and affect student learning outcomes. Learning using learning media such as interactive e-modules is very supportive and influential to increase students' desire to learn, because this interactive e-module is designed using Canva so that it makes it easier for students to interact with the media contained in this problem solving-based interactive e-module, this interactive e-module is also designed using a problem solving learning model so that it supports students' motor skills in solving problems.

Based on the results of validation and field trials, it is concluded that the problem solving-based interactive e-module developed meets the three criteria, namely valid, practical and effective, and there are differences in improving problem solving skills between students who take part in learning by using problem solving-based interactive e-modules and those who do not use problem solving-based interactive e-modules.

4 Conclusion

Interactive e-modules based on problem solving as learning media, meet the valid requirements with an average total validity by media expert validators of 87% with valid categories and

material expert validators of 86% with Very feasible category. Interactive e-modules based on problem solving as learning media, meet practical requirements with an average of 97.5% in small groups and 98.3% in large groups with practical categories. Problem-solving-based interactive e-modules as learning media, meet the effective requirements based on the increase in student learning outcomes using problem-solving-based interactive modules stated to increase based on the results of the significance test of the difference in pretest and posttest scores for the normalized level obtained an N-gain value of 0.8 in the small group and N-gain 0.8 in the large group including in the high category.

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