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Developing E-Module Realistic Mathematics Education to Improve Problem Solving Abilities and Interest in Learning

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Abstract

This study aims to produce E-Modul using the RME approach to improve the problem solving abilities and interest in learning of Junior High School Students Class VIII that meet the criteria of valid, practical, and effective. This research is ADDIE model which goes through five stages: analysis, design, development, implementation, and evaluation. The subjects of this research consisted of 30 class VIII students of SMP Negeri 1 Depok, Sleman, D.I. Yogyakarta. The results show: (1) The RME E-Module has the characteristics of using contextual problems, developing mathematical models from real problems, students constructing their own, there are interactive activities, and connecting between topics or subjects. (2) Products and instruments meet valid criteria; (3) The practicality results of the E-Module reached a score of 90% by teacher assessment and 81.013% by student assessment, and learning implementation reached 94.44% thus meeting practical criteria; (4) The t-value in the hipothesis test is less than 0.05 so that E-Module meets the effective category.

Keywords: *Flat Side Construct; E-Module; Interest in Learning; Problem Solving; RME*

Introduction

In the development of the era, various types of digital technology have also experienced very rapid development in the Industrial Revolution 5.0. According to Marcen et al (2022), information and communication technology is increasingly becoming a significant part of education and even in students' daily lives. In the world of educational technology, various multimedia information can be easily obtained by students anytime and anywhere. However, student involvement and the effectiveness of technological resources are still far from clear (Ní Shé et al., 2023). Mathematics is an important subject at various levels of education. In organizing mathematics learning, there are various developments that include cognitive aspects (empirical factual knowledge), affective (related to emotions), and psychomotor (related to physical activity) of students (Ahmad et al, 2022: 1).

To support effective and innovative learning, teachers should be able to use adequate learning media for the continuity of the learning process (Hasiru et al., 2021). Various developments in learning media in principle continue to be carried out, such as the development of interactive media (Damopolii et al., 2019), and also the development of media in the form of learning modules and videos (Tamu et al., 2020). One of the innovative learning media in mathematics learning is the interactive E-Module as a learning media and teaching material for mathematics learning (Rochsun & Agustin, 2020). The

advantage of using E-modules is that students have more opportunities to learn independently (Hadiyanti et al., 2021). By using e-modules, students can learn independently without or with teacher guidance, control learning outcomes through the use of competency standards in each module that students must achieve, and they become more responsible for their actions (Fisnani et al., 2020).

A good learning tool should be able to assess students' mathematics skills, including problem solving. Since it takes multiple ways to overcome an obstacle and solve an issue, problem solving is a complicated cognitive activity. It is not only expected of students to be able to solve the questions or problems presented while they are being taught problem solving skills in mathematics; rather, it is intended that developing this habit would prepare them for a life filled with challenging situations (Surya & Andriana Putri, 2017).

Based on research conducted by Rustanuarsi & Karyati (2019), students' mathematical problem-solving abilities are still low, seen from the complexity of the solved mathematical problems with an average percentage of 57% low complexity, 40% medium complexity, 3% high complexity. Furthermore, based on the PISA survey in 2022, Indonesia was ranked 69th out of 81 participating countries with an average score of 366 for mathematics, this figure is still far from the international average score of 472. In addition, when compared to the results of PISA in 2018, there was a decrease in the average score for mathematics by 13 points. However, Indonesia's ranking rose 3 levels compared to 2018. Only 18% of students reached level 2 ability, meaning that most students were unable to interpret and recognize, without direct instruction, how simple situations can be represented mathematically. This shows that students' mathematical problem-solving abilities are still low.

One of the factors that influence students' low problem solving in mathematics learning is a non-conducive learning atmosphere, lack of motivation, the learning models and methods used by teachers are not interesting so that students feel bored, and lack of interest in learning (Septian et al., 2019). In the study, Septian also stated that students' low interest in learning has a negative impact on students' problem solving. Furthermore, research conducted by Agustin & Hartanto (2018) explains that there is an influence between interest in learning and mathematical problem solving abilities. Thus, it can be said that low interest in learning has a negative impact on students' problem solving abilities. In line with this, someone who has an interest in something, has a desire to learn more, has positive feelings, pays attention to the material, lesson objectives, and lessons (Mumba et al., 2015). Students usually find learning relatively easy when they are interested in the activity (Zhang & Wang, 2020). From this explanation, it can be explained that students with low interest in learning can affect students' problem solving abilities. This happens because students are not interested in mathematics lessons which causes students to tend to have difficulty in solving problems.

An interactive and enjoyable learning atmosphere can be realized in various ways. Such as using interesting learning media with the use of technology, one of which is the use of interactive E-modules. Students will be interested in learning if the material is delivered easily and related to everyday life. One of the learning approaches that begins with everyday life is the Realistic Mathematics Education (RME) approach. Research conducted by Sulastri & Kusmanto (2016) showed that there was an increase in student motivation and student learning outcomes after learning using the RME approach, in addition, the results of Hasibuan et al (2019) research revealed that mathematical problem-solving abilities increased after learning using learning devices based on the RME approach.

Based on the problems and solutions that have been described, the researcher feels the need to conduct research and development of E-Modules using the RME approach to improve the problem-solving abilities and learning interests of grade VIII junior high school students on the material of flat-sided spatial structures.

Method

This study uses the Research and Development (R&D) method of the ADDIE model which goes through five stages, namely: Analyze, Design, Develop, Implement, and Evaluate (Branch, 2010). The subjects of the field trial consisted of 30 students of class VIII E of SMP Negeri 1 Depok Sleman. The instruments used in this study consisted of: (1) a validity measuring instrument, namely a validation sheet; (2) a practicality measuring instrument, namely a practicality sheet; (3) an effectiveness measuring instrument, namely a problem-solving ability test and a student learning interest questionnaire.

This validity analysis aims to determine the level of validity of the E-Module with the RME approach developed. There are 5 validated instruments, namely products by material experts and media experts, problem-solving ability tests, learning independence questionnaires, teacher and student practicality sheets, and learning implementation observation sheets. A research instrument is said to be valid if the results of the expert assessment are at least in the "Good" category. The criteria for product validity were presented in table 1.

Table 1. Product validity criteria

Score Interval	Range	Category
$x > \bar{x} + 2{,}1\ sb_i$	> 85	Very good
$\bar{x} + 1{,}2\ sb_i < x \leq \bar{x} + 2{,}1\ sb_i$	$70 < x \leq 85$	Good
$\bar{x} + 0{,}3\ sb_i < x \leq \bar{x} + 1{,}2\ sb_i$	$55 < x \leq 70$	Enough
$\bar{x} - 0{,}6\ sb_i < x \leq \bar{x} + 0{,}3\ sb_i$	$40 < x \leq 55$	Less
$x \leq \bar{x} - 0{,}6\ sb_i$	≤ 40	Very less

(Modified from Widoyoko, 2017: 238)

Information:

x = Empirical score

$\bar{x}$ = Ideal average = $\frac{1}{2}$ (maximum score + minimum score)

sb_i = Ideal standard deviation = $\frac{1}{6}$ (maximum score - minimum score)

This practicality analysis was conducted with the aim of determining the level of practicality of the product being developed. The level of practicality was obtained from the results of the learning implementation observation sheet, as well as the product practicality assessment sheet filled out by teachers and students. The criteria for product practicality if the percentage of product practicality is more than 70% (Akbar, 2013). The following is a table of criteria for the practicality of learning implementation.

Table 2. Practicality Criteria

Range	Category
85,01 % - 100 %	Very Practical
70,01% - 85%	Practical
50,01%-70%	Less Practical
0%-50%	Impractical

Source: Akbar (2013)

The effectiveness analysis is reviewed from the purpose of making it, namely to improve students' problem-solving abilities and learning interests. The effectiveness criteria for the aspects of problem-solving abilities and learning interests in this study are: (1) There is an increase in the average post-test score of students' problem-solving abilities and learning interests; (2) The average post-test score of students' problem-solving abilities and learning interests is more than 75. The test used was a one sample t-test, wich using IBM SPSS Statistics 25. E-Modul was said to be effective if the t-value < 0.05, in other words, hypotesis 0 was rejected.

Results and Discussion

Results

In this study, the ADDIE model was used to develop an E-Module with the RME approach to improve the problem-solving ability and learning interests of grade VIII junior high school students. The following is a complete summary of product development based on each stage of the ADDIE model.

Analysis Stage

The analysis stage includes needs analysis, student characteristics analysis and material analysis. Based on the results of observations conducted at SMPN 1 Depok Sleman using observation sheets filled in by teachers and students, as well as interviews with one of the grade VIII mathematics teachers, it was concluded that both teachers and students felt the need to use E-Modules for learning flat-sided geometric shapes. Students of class VIII E can be grouped into three abilities, namely high, medium, low abilities. In general, junior high school students today are born in the 2009-2011 range which is the Alpha generation, so they are inseparable from technology, especially smartphones. Even at school, students are allowed to bring smartphones and all students have them. Material analysis is carried out by adjusting the curriculum applied at SMP Negeri 1 Depok Sleman. The curriculum applied is the independent curriculum. The analysis is carried out by analyzing learning achievements into learning objectives and then compiling a flow of learning objectives.

Design Stage

At this stage, the product to be developed begins to be designed so that an E-Module is obtained using the RME approach to improve students' problem-solving abilities and learning interests. In the design process, the selection of the right media and format is carried out and a storyboard is made. In addition to product design, this stage also involves designing a learning implementation plan using the product, as well as compiling the instruments that will be used. the stages carried out such as designing the content of the material and practice questions that will be used in the E-Module used. then choosing the right and appropriate media to present the selected material, In this study, the media that will be used are Canva and Heyzine Flipbooks as the main media, and Live Worksheet as a supporting media for interactive student worksheets.

Development Stage

At this stage, the final product will be developed, the process of validation, revision, and testing of the product, as well as the evaluation of its feasibility.

Product Development Results

The E-Module was developed using the Heyzine Flipbook Maker Website, where the content was previously designed using Canva to make it look more attractive. The components in the E-Module are adjusted based on the E-Module preparation guidelines issued by the Ministry of Education and Culture in 2017 and adjusted to the RME approach and problem-solving process. The components consist of cover, table of contents, manual, E-Module identity, initial competency, Pancasila student profile, concept map, materials, learning flow, and bibliography.

The materials in the E-Module are arranged based on the characteristics of RME, namely using realistic problems as presented in the following figure.

Figure 1. Examples of Realistic Problems in E-Module

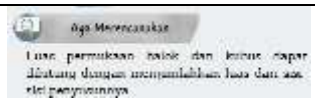
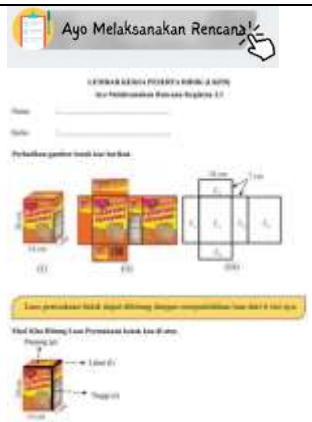
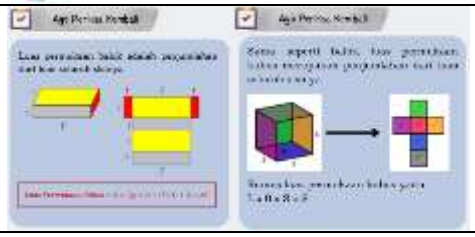
Next, the E-Module is arranged using the principles of horizontal and vertical mathematization as shown in the table below.

Table 3. The Mathematization Process Contained in the E-Module

Mathematization	Definition	Activities in E-Module
Horizontal	The process by which students solve real-world problems mathematically using their own language and symbols	
Vertical	The process by which students use formal mathematical symbols or notations that are mechanically manipulated and arranged to solve problems directly without the aid of context.	

In addition, the E-Module product is also arranged based on the stages of problem solving, namely understanding the problem, preparing a solution plan, implementing the plan, and interpreting the solution. presented in the following table.

Table 3. The Stages of Problem Solving Contained in the E-Module

Problem Solving Skills	Activities in E-Module
understanding the problem	
preparing a solution plan	
implementing the plan	
interpreting the solution	

Product Validation

A product is said to be valid if it can measure what should be measured. Expert validation is carried out to measure the feasibility of the instrument used based on expert opinion. Expert validation in this study was a lecturer in the Mathematics Education Masters study program at Yogyakarta State University. The instruments whose validity was tested were the E-Module product, learning implementation observation sheets, teacher and student practicality sheets, problem-solving ability tests, and learning interest questionnaires. The validity analysis of the E-Module was assessed by material experts and media experts. The results of the E-Module validation assessment from the material and media sides were both included in the "Good" category. Thus, the E-Module is suitable for use because it meets the validity standards from both the material and media sides. Then, the results of the validity analysis of the learning implementation observation sheet, teacher and student practicality sheets,

problem-solving ability tests, and learning interest questionnaires, showed that these instruments were included in the "good" to "very good" category.

Implementation Stage

First, a small-scale trial was conducted to determine the readability of the E-Module that had been developed. Only a few students were taken as samples. The suggestions related to the readability of the E-Module were regarding network constraints when accessing the E-Module so that a review was needed to reduce the file capacity. Next, a large-scale trial was conducted in class VIII E at SMP Negeri 1 Depok Sleman with 30 students. This large-scale trial aims to obtain data on the practicality and effectiveness of the E-Module. Practicality data was obtained from the results of the learning implementation observation sheet, the teacher's practicality sheet questionnaire, and the student's practicality sheet questionnaire. Meanwhile, effectiveness data was obtained from the results of the problem-solving ability test and the results of the student's learning interest questionnaire. The trial was conducted in 7 meetings (including the pre-test and post-test).

Evaluation Stage

The evaluation stage is the last stage in the development research with the ADDIE model. The evaluation stage produces data on the practicality and effectiveness of the developed E-Module. Practicality data is obtained based on the percentage of learning implementation, practicality questionnaires by teachers, and practicality questionnaires by students. Effectiveness data can be seen from the results of the pre-test and post-test which are analyzed whether there is an increase or not.

Product Practically

Teachers and students provide assessments of the E-Modules that have been developed. The assessment was carried out by a mathematics teacher and all students of class VIII E after implementing learning using the RME E-Modules in mathematics learning. The results of the analysis obtained a percentage of 90% and 81.013% so that it can be concluded that the E-Module using the RME approach produced was stated as "very practical" and "practical"

Product Effectiveness

A product is said to be effective if it meets the established criteria. The E-Module product uses the RME approach aimed at improving students' problem-solving abilities and learning interests. Therefore, there are two indicators to measure the effectiveness of the E-Module, namely the cognitive aspect in the form of problem-solving abilities and the affective aspect in the form of students' learning interests. The instrument was given during a large-scale trial twice, namely the pre-test and post-test. There are two hypotheses that were tested, namely hypothesis 1 (H1) There is an increase in the average pretest-posttest score of students' problem solving ability and learning interest, and hypothesis 2 (H2) The average posttest score of students' problem solving ability and learning interest is more than 75. The results of the analysis of the effectiveness of the E-Module are presented in the following table.

Table 4. Result of E-Module Effectiveness

Aspect	Hypothesis	T value	Sig. (1-tailed)
Problem Solving	H1	44.267	0.000
	H2	2.468	0.010
Learning Interest	H1	15.580	0.000
	H2	5.031	0.000

Based on the data analysis, it can be concluded that the RME E-Module meets the effective criteria for improving students' problem-solving abilities and learning interests.

Discussion

The results of the study showed that the percentage of students who completed the problem-solving ability and learning interest tests were 80% and 83%. This finding is in accordance with the results of research conducted by Sari (2016) that more than 80% of students have an interest in learning mathematics using RME learning devices. In addition, research conducted by Delita et al (2022) also showed positive results regarding the use of E-Modules for learning on student learning motivation with an average score of up to 74. This is in accordance with the findings in this study which showed an average learning interest after learning using E-Modules with the RME approach of 80.03. Furthermore, research conducted by Payadnya et al (2023) showed an increase in HOTS problem solving results by 19% after learning using electronic media with the RME approach. This is in accordance with the results of this thesis research, namely an increase in problem solving results of even 49%. This is also in line with the results of research conducted by Setiyani et al (2020) which showed an average increase in the experimental class of 47.54%.

Conclusion

Based on the results of the research and development of the E-Module that have been presented, the following conclusions were obtained. E-Modules use the RME approach to improve problem-solving skills and learning interests of junior high school students in grade VIII on flat-sided geometric shapes. The specifications are: Mathematics learning activities in the E-Modules are designed based on the characteristics and principles of RME as well as problem-solving steps; learning activities are carried out in groups consisting of 4-5 students; Problem-solving skills are facilitated with student worksheets containing steps in the problem-solving process; and then students' learning interests are facilitated in the E-Modules with various video and image features and attractive designs according to the students' level of education, making students interested in learning the material. The E-Module product uses the RME approach to improve problem-solving skills and learning interests of junior high school students in grade VIII on flat-sided spatial geometry material is suitable for use in terms of validity. The validation results by material experts and media experts show that the E-Module, learning implementation observation sheets, teacher and student practicality questionnaires, problem-solving questions, and learning interest questionnaires are included in the "valid" category. The E-Module product uses the RME approach to improve problem-solving skills and learning interests of junior high school students in grade VIII on flat-sided spatial geometry material and is feasible to use in terms of practicality. The results of the practicality questionnaire by teachers and students show that the E-Module is included in the "very practical" and "practical" categories. The E-Module product uses the RME approach to improve problem-solving skills and learning interests of grade VIII junior high school students on flat-sided geometric shapes material is feasible to use in terms of effectiveness. The results of the One Sample t-Test on the problem-solving ability test and the student learning interest questionnaire showed that H0 was rejected for all hypotheses. Thus, it can be said that: there is an increase in the average pretest-posttest score of students' problem-solving ability and learning interest; and the average posttest score of students' problem-solving ability and learning interest is more than 75. Based on these results, it can be concluded that the E-Module uses the RME approach on flat-sided geometric shapes material is effective in improving students' problem-solving abilities and learning interests.

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