

Development of Open-Ended-Based Mathematics E-Module on Quadrilateral Material of Junior High School

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ABSTRACT

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The purpose of this research was to develop an open-ended-based mathematics e-module that is feasible in terms of being valid, practical, and effective. This product used the quadrilateral material of Junior High School. The method used is the Research and Development (R&D) research using the ADDIE model (Analysis, Design, Development, Implementation, Evaluation). Based on the results of the study, the assessment by material experts and media experts was in the valid category, then the practicality assessment in terms of the results of the questionnaire response analysis of students and teachers met the practical category, and the effective product was seen from the student's test results and analyzed using one-sample t-test the conclusions of the research hypothesis were the average student learning outcomes of the experimental class are greater than minimum completeness 75. With that, the open-ended mathematics e-module product on the quadrilateral material of grade 7 Junior High School can be said to be valid, practical, and effective.



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A. INTRODUCTION

Mathematics is significant to be taught at every level of education because it is a basic science for the development of other sciences (Farapatana et al., 2019). Mathematics is integrated with one of the fields of education, so that it can encourage students to think wisely connecting one another or as a whole so that thinking skills are needed in solving mathematics problem (Kurniawati et al., 2020). Building thinking skills in the 21st century is currently one of the challenges in the field of education, one of which is creative thinking. Creativity is the ability to generate new ideas or products and produce breakthroughs in the fields of science and technology (Kusuma et al., 2021).

Students must be active in the search and development of knowledge, the truth of science is not limited to what is conveyed by the teacher (Kurniati & Astuti, 2016). Students can develop their potential through an integrated learning process (Feri & Zulherman, 2021). Many students learn mathematics only according to what is taught and exemplified by the teacher, they are not pushed to look for other alternatives that may be more effective. The usual routine problems for students as exercises or assignments are always given to the

correct answer, even though the complete process is the main goal in learning mathematical problem solving (Dahlan, 2016). As a result, when students are faced with non-routine questions or issues, students become confused and have difficulty working on them.

According to Fianti et al. (2016), by using open-ended problems, the basic concepts can be explored, so the students do not only recall the certain facts but almost all possible fact to solve the problems. Open-ended approach is one of the learning approaches with open issues and can build interactive activities between mathematics and students so that it invites students to be more active in learning. According to Anwar et al. (2019), open-ended is a learning approach that begins by giving students an open-ended problem. Open-ended problems also train students to express ideas, explore and look for varied questions, develop learning knowledge and describe everything that students learn (Maryam et al., 2019).

In addition, due to the current COVID-19 pandemic conditions, learning is carried out online and students must study independently at home. To help the learning process, teaching materials are needed that support the current conditions. Anggoro (2015) explains that in the learning process of using modules, students are required to learn independently and be able to solve problems by issuing new ideas, and teachers can see how far students can think creatively in solving problems on questions. According to Perdana et al. (2017), "one of the media resources that students can use for independent study is in the form of modules and the given module to assist in motivating students to learn and improve learning outcomes of the students self". However, because the current learning process is daring, the development of teaching materials can be done by utilizing technology, so that it can be accessed online. According to Sofyan et al. (2019), by utilizing technological advances, we can find modules in electronic form (e-modules) that are specifically designed according to learning material and can be used easily by educators. This e-module activity is one of the teaching materials that demands student's independency to find a concept (Serevina et al., 2018). E-modules are expected to attract students' interest in learning and can be accessed easily by students using computers or gadgets anywhere and anytime (Saraswati et al., 2019).

The novelty of this research is the application of an open-ended problem in the development of e-module mathematics for grade 7 Junior High School with Quadrilateral material as a breakthrough for dealing with online learning. So that the purpose of this learning is to develop valid, practical, and effective learning using an open-ended problem to the material of Quadrilateral grade 7 Junior High School.

B. METHODS

This research is a Research and Development (R&D), which is developing an open-ended mathematics e-module based on quadrilateral material for grade 7 Junior High School (called SMP). The steps used in the development and research use the ADDIE model that consists of Analyze, Design, Development, Implementation, and Evaluation (Mulyatiningsih, 2011). This research was conducted at SMP Negeri 4 Purworejo, Central Java, with the test subjects were 16 grade 7 students. Data collection in this study used expert validation sheets, student and teacher response questionnaires, and evaluation questions. Validation was carried out by material experts and media experts. The practicality of the product is obtained from the results of the questionnaire analysis of student and teacher responses to product development.

The effectiveness of the product is obtained from the results of the analysis of student learning tests with evaluation questions.

The validity and practicality of the open-ended-based mathematics e-module on the quadrilateral material for grade 7 Junior High School were analyzed using qualitative descriptive data in the form of input, criticism, and recommendations. In addition, analysis of product validity and practicality was also carried out using quantitative descriptive data on expert validation sheets and response questionnaires. The stages of validity analysis are as follows:

1. Create a product validation instrument table for experts.
2. Find the average of each criterion from the validator.

$$K_t = \frac{\sum_{h=1}^n V_{hi}}{n}$$

Description: K_i = Average Criterion i

V_{hi} = The h -th validator assessment score for the i -th criterion

n = Number of validators

3. Calculate the average of each aspect.

$$A_i = \frac{\sum_{j=1}^n K_{ij}}{n}$$

Description: A_i = Average aspect of i

K_{ij} = Average for the i -th aspect for the j criteria

n = The number of criteria in the i -th aspect for the j criteria

4. Calculates the average total validation.

$$V = \frac{\sum_i^n A_i}{n}$$

Description: V = The average total validity of the module

A_i = Average aspect of i

n = Number of aspects

5. Determine the validity category by matching the total mean with the validity criteria, as Shown in Table 1.

Table 1. Product Validity Criteria

Interval Average Score	Validity Level
$3 \leq V \leq 4$	Valid
$2 \leq V < 3$	Quite Valid
$1 \leq V < 2$	Invalid

(Wicaksono et al., 2014)

The practical analysis according to Wicaksono et al. (2014) is as follows:

1. Give a score on the student response questionnaire table with answers strongly agree (4), agree (3), disagree (2), disagree (1).
2. Summing up the total score of each student statement in the response questionnaire for all indicators.
3. Giving practicality value by using the formula:

$$x = \frac{\sum f}{N} \times 100\%$$

Description: x = Final value

f = Score

N = Max score

4. Interpret the results obtained with the following criteria, as shown in Table 2.

Tabel 2. Product Practicality Percentage Criteria

Value Interval	Criteria
$80\% < x \leq 100\%$	Very Practical
$60\% < x \leq 80\%$	Practical
$40\% < x \leq 60\%$	Practical enough
$20\% < x \leq 40\%$	Less Practical
$x \leq 20\%$	Not Practical

(Sugiyono, 2015)

The effectiveness of the open-ended-based mathematics e-module on quadrilateral material for grade 7 Junior High School is seen from the results of student learning tests with evaluation questions. The data used is derived from the value of student learning outcomes with an open-ended-based e-mathematical module that was developed. The effectiveness of the product is obtained from the results of hypothesis testing. The hypothesized value is the minimum completeness limit applicable in SMP Negeri 4 Purworejo of 75. Hypothesis testing is carried out with normality test and t-test. The normality test used is the Shapiro Wilk test, after the data is declared to be normally distributed, it is followed by a t-test using a one-sample t-test to get a conclusion about the effectiveness of the product. The data is said to be effective if the research hypothesis is accepted, with the conclusion that the average value of student learning outcomes is greater than the minimum completeness limit of 75.

C. RESULT AND DISCUSSION

1. Result

The product resulting from the development of an open-ended-based mathematics e-module on the quadrilateral material for grade 7 Junior High School, apart from being able to be used by teachers for distance learning, can also be used by students in knowing and practicing questions independently or in groups. This product development carries out in 5 stages, the stages are as follows:

a. Analysis Stage

The analysis was carried out by conducting interviews and observations at SMP Negeri 4 Purworejo and examining the material to be taught, as shown in Table 3.

Table 3. Analysis Result

Type of Analysis	Results
Needs Analysis	1) The results of interviews with teachers and school observations showed that the teaching materials used were textbooks and worksheets, while the learning methods used were discussion and question and answer methods. 2) Learning in schools cannot do face-to-face due to the COVID-19 pandemic that has resulted in online learning. Some of the impacts that occurred were that some material was not conveyed to students, students were less active in

Type of Analysis	Results
	learning, and teachers had a little difficulty monitoring student progress. The lack of media used by teachers during online learning is one of the obstacles.
Material Analysis	1) The results of the material analysis state that one of the materials that will teach for the even semester of grade 7 is quadrilaterals. The material of rectangular is material whose discussion can be included in an open-ended approach so that students are expected to easily learn and come up with creative ideas. In this e-module, the application of the open-ended problem is not only in practice questions but also in finding concepts or formulas for quadrilaterals.

b. Design Stage

The formulation of basic competencies that must be mastered following the curriculum used is the 2013 curriculum. The selected basic competency is 3.11 affecting the perimeter and area formulas for various types of quadrilaterals (square, rectangle, rhombus, parallelogram, trapezoid, and kite). The learning approach used in the e-module is an open-ended approach, where learning begins by providing open problems to students. The open-ended problem used in the e-module is expected to bring up students' creative ideas.

c. Development Stage

In this stage, the preparation of an open-ended-based mathematics e-module on the quadrilateral material for grade 7 Junior High School. The cover is made with the Corel Draw application so that it looks more attractive by paying attention to colors, images, fonts, and layouts so that the appearance obtains according to the desired design. The modules are arranged using Microsoft Office Word so that the modules are more systematic. E-module creation using the Kvisoft FlipBook Maker Pro application, as shown in Figure 1.



Figure 1. Front Cover of Mathematics E-Module

Then the material and media validation by experts, the results of the validation were used as the basis for repairing and perfecting open-ended mathematics e-modules on the quadrilateral material for grade 7 Junior High School. There are inputs and suggestions from media experts to revise the product, namely adjusting the color product, choosing a more attractive image, writing style, and font size. Input and suggestions from material experts, namely clarifying orders and information on solving problems and completing the properties of quadrilaterals. Based on the results of expert validation, it is known that the validity of the product developed is as shown in the following Table 4.

Table 4. The Average Results of the Assessment of Material Experts and Media Experts

No	Aspect	Average	Criteria
1	Material Expert	3,69	Valid
2	Media Expert	3,59	Valid
Average		3,64	Valid

d. Implementation Stage

At this stage, designs and media that have been validated in real situations are implemented, namely with limited field trials and extensive field trials. In a restricted field trial, students were asked to respond to an open-ended mathematics e-module on students' creative thinking skills that had been used by filling out a questionnaire. The results of student responses in the limited field trial showed in the following graph, as shown in Figure 2.

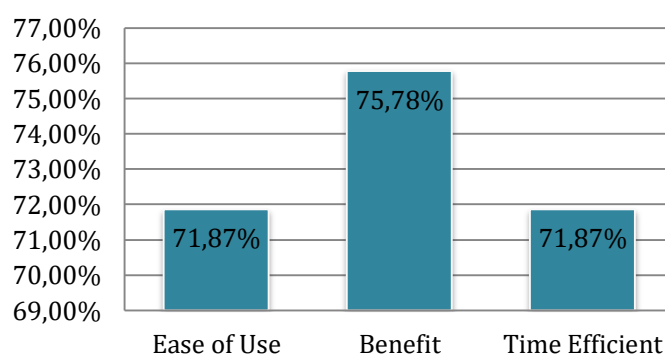


Figure 2. Graph of the Percentage of the Practicality of E-Modules in Limited Trials

The results obtained from student responses are an average of 2.94 or 76.74% with "practical" criteria. After making improvements from the suggestions given by the respondents, extensive field trials were carried out. In a large field trial, students and teachers were asked to fill out response questionnaires and complete evaluation questions.

e. Evaluation Stage

At this stage, an analysis of the practicality and effectiveness of the open-ended-based mathematics e-module was carried out on the quadrilateral material for grade 7 Junior High School. From the results of filling out the student and teacher response questionnaires, a practical analysis was carried out and the following results were obtained, namely, as shown in Figure 3.

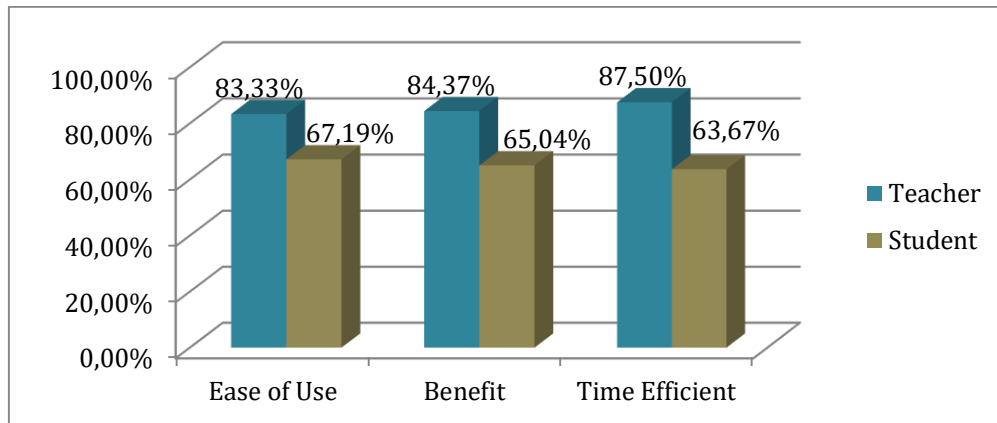


Figure 3. Graph of the Percentage of the Practicality of E-Modules in Extensive Trials

So that the average value of student and teacher responses is 3.01 or 66.56% with the "practical" criteria, as shown in Table 5.

Table 5. Average Results of Student and Teacher Responses

Response	Score	Percentage	Criteria
Student Response (Broad Field Trial)	2,62	65,45%	Practical
Teacher's Response	3,39	84,72%	Very Practical
Average	3,01	66,56%	Practical

The analysis of the effectiveness of the open-ended-based mathematics e-module was carried out by testing the hypothesis. The results of the normality test and t test are listed in the Table 6.

Table 6. Results of Data Analysis of Experimental Class Learning Results

Test	Sig. ($\alpha=0,05$)	Results	Conclusion
Normality (Shapiro Wilk)	0,058	$0,891 > 0,887$	H_0 : Accepted, data is normally distributed
T-test (One Sample t test)	0,031	$2,37 > 1,753$	H_1 : Accepted, the average value of student learning outcomes is greater than minimum completeness limit of 75.

Based on the results of the hypothesis test above, it can be seen that the normality test shows that the data obtained are normally distributed. So that a t-test can be carried out, and the results are that the research hypothesis is accepted with the conclusion that the average value of student learning outcomes is greater than minimum completeness limit of 75. These results indicate that the open-ended mathematics e-module based on the quadrilateral material for grade 7 Junior High School is effective.

2. Discussion

The media developed by the researcher is in the form of an Open-Ended-Based Mathematics E-Module for grade 7 Junior High School material which is expected to help teachers and students in independent learning and generate new ideas/ideas in solving problems. Afghani & Surtama (2021) stated that "by using an online system, technology encourages students to be more innovative and creative in learning". In addition to the

appearance of the e-module developed with the Kvisoft Flipbook Maker Pro application in the form of an attractive book, the addition of images and videos is also an important part so that learning content can be conveyed directly to students. Prastowo (2015) states that "images that can support and clarify the content of the material are needed, in addition to clarifying the description, it also adds to the attractiveness and reduces the boredom of students to learn it".

The media validation by two validators got an average value of 3.59. Revision on material validation, namely adding the properties of quadrilaterals and clarifying orders and information on student activities and problem-solving. Based on the results of the validation, the product development can be said to be valid. This is supported by the research of Permata et al. (2021) which states "a product that is valid and feasible to use under the validator's assessment".

At the implementation stage, limited field trials and extensive field trials were conducted. The limited field trial was to know the practicality of the e-module which was developed by providing a student response questionnaire, then improvements were made from the suggestions given by the research subjects in the limited field trial. After that, a broad field trial was conducted followed by 16 students of grade 7. After students study the open-ended-based math e-module developed by the researcher. After that, students were given test questions to measure the effectiveness of the e-module, and a response questionnaire to measure the level of practicality of the e-module. The results of the analysis of the practicality of the open-ended-based mathematics e-module obtained a percentage of 66.59% in the practical category. In this study, aspects of the benefits and ease of use got a high score. This indicates that the benefits of the open-ended-based mathematics e-module are felt by the respondents. According to Aditia & Muspiroh (2013), "modules have various benefits, both in terms of the interests of students and from the interests of teachers". Daryanto (2013) states that "the materials used must be adapted to the needs of users and the curriculum and have many benefits". Judging from the responses of users who feel the benefits and ease of using this e-module product, it can be said that it is practical to use. This is in line with the statement of Annisa et al. (2020) that "the practicality of learning media is important to know because one of the requirements for learning media is that it is easy to use".

The results of the analysis of the effectiveness of the open-ended-based mathematics e-module on rectangular material meet the effective criteria. This test was conducted using the one-sample t-test. The results of the data analysis indicate that the hypothesis is accepted. Alfiriani & Hutabri (2017) stated that "effectiveness is seen from the achievement of learning objectives so that the effectiveness test is a test to see the achievement of learning objectives by using products developed for the learning process". Handayani & Suwarjo (2019) research also uses a one-sample t-test to determine the effectiveness of the learning be studied. This means that the development of open-ended-based mathematics e-modules can be used as an alternative in understanding mathematical concepts.

The results of the analysis above indicate that the product of developing an open-ended mathematics e-module is valid, practical, and effective for use in learning. So it can be concluded that the product of developing an open-ended mathematics e-module is feasible to be used as learning material.

D. CONCLUSION AND SUGGESTIONS

An open-ended-based e-mathematical module was developed using the ADDIE development model, with the stages of development of Analysis, Design, Development, Implementation, and Evaluation. Feasibility of E-module mathematics based on open-ended rectangular material with validity test results, from material and media experts obtained average score of 3.64 with valid criteria. Practicality test, student responses obtained average score of 2.62 with a percentage of 65.45%, and teacher responses obtained an average score of 3.39 with a percentage of 84.72%. Based on the instructional media classification guidelines, the developed e-module shows practical criteria. Test the effectiveness of the product, the results of the hypothesis test were obtained that the average student learning outcome was more than minimum completeness limit, so it was concluded that the e-module developed was effective. Based on the results and discussion, it can be concluded that the open-ended mathematics e-module based on quadrilateral material for grade 7 Junior High School is feasible to be applied in learning and can be use in online learning due to COVID-19. This is in line with the results of research conducted by Irwansyah et al. (2021) that the use of teaching materials in the form of electronic modules can overcome the problems faced by teachers and students during online learning from home due to the impact of the COVID-19 pandemic.

The implications based on the results of the study are that the use of the right learning approach to the material to be delivered shows that student learning outcomes can reach more than minimum completeness limit. The results of this study are expected to be used as input for teachers and prospective teachers to pay attention to the right learning approach to improve students' mathematics learning outcomes. The suggestion from the author is that the development of mathematics e-modules can be applied with other learning approaches and also with other materials so that students can gain new experience and knowledge.

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