

Improve Critical Thinking by Developing Teaching Materials Based on Realistic Mathematics Learning

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ABSTRACT

The research aim of this study are (1) to determine the development of mathematics teaching materials based on Realistic Mathematics Learning approach (RML) to improve students critical thinking skills. (2) To determine the feasibility of teaching materials to improve students critical thinking. (3) To determine the improvement of teaching materials in students critical thinking skills. This type of research is development research. The development model refers to the ADDIE development model which consists of five stages, namely Analysis, Design, Development, Implementation, and Evaluation. The study was carried out on class VIIID MTs Al-Ihsan Kalikejambon Tembelang Jombang in the 2020/2021 academic year. The results obtained that the average media validity score based on the Realistic Mathematics Learning approach on the material of Statistics class VIII from the experts, namely mathematics lecturers, was 72,4% which was categorized as quite valid, and mathematics teachers were 80,6% which was categorized as valid. Practicality is obtained based on the results of observational data on the implementation of teaching materials based on Realistic Mathematics Learning, obtained an average of 69,4% which is in the fairly good category. The effectiveness is obtained from the results of questionnaires on student responses and student learning outcomes. An average of 91,67% was obtained from the data from student questionnaires who were in the good category, for each aspect that was responded to. As many as 81,3% of students were able to achieve the criteria of complete learning so that the Realistic Mathematics Learning-Based Learning media was categorized as effective.

Keywords: *Teaching Materials; Realistic Mathematics Learning; Critical Thinking.*

INTRODUCTION

One of the subjects that forms the basis for other sciences is Mathematics, because it includes the ability to count, logic and think (Nasrulloh & Umardiyah, 2020). Regulation of the Minister of National Education of the Republic of Indonesia Number 22 of 2006 states that the purpose of learning mathematics in schools is for students to have the ability to understand mathematical concepts, explain relationships between concepts, use reasoning, solve problems, and communicate ideas.

Mathematics is one of the compulsory subjects in schools that has an important role in human life (Cahyaningsih & Nahdi, 2020). Along with the development of information technology today, education undergoes changes and innovations that will continue to develop in the world of education. That school mathematics has a goal, one of which is to equip students with critical thinking skills. Critical thinking skills are very important for students. According to Nasrulloh & Umardiyah (2020) critical thinking is a mental activity that cannot be separated from human life, the critical thinking ability of each individual is different from one another so it needs to be fostered from an early age.

The critical thinking ability of junior high school students in Indonesia is still in the low category. This is based on a four-year study report by the International Trends in International Mathematics and Science Study (TIMSS) conducted on junior high school students with the characteristics of questions at a high cognitive level that can measure students' critical thinking skills, showing that Indonesian students are in low rank (Hadi & Novaliyosi, 2019).

The students' critical thinking ability is still relatively low, indicating that there are things that are not optimal in the mathematics learning designed by the teacher. One of the efforts that teachers can do to

improve students' critical thinking skills is through the management of learning implementation (Meishanti, 2020). Developing mathematics teaching materials with appropriate learning models is one of the efforts that can be made by teachers (Nahdi & Cahyaningsih, 2019). Teaching materials are a set of media or learning tools which contain materials, methods, limitations and methods of evaluating which are designed systematically and attractively to achieve the desired goals, namely the achievement of competencies and sub-competencies by sharing their complexity (CS Widodo & Jasmadi, 2008).

In addition to developing teaching materials, the selection of learning approaches needs to be done well (Lilawati & Rohmah, 2019). One of the learning approaches that will improve critical thinking skills is the Realistic Mathematics Learning (PMR) approach. Realistic Mathematics Learning Approach is an approach related to everyday life or the environment. PMRI is an innovative learning approach and has several characteristics, including providing active learning conditions for students, involving students to solve a problem in their own way, so that students can learn knowledge related to the problem and at the same time have the ability to solve problems (Rahmawati, 2013). Saefudin (2012) said that the principle of PMRI or PMR is the same as RME although in some respects PMRI or PMR is different from RME because the context, culture, social system and nature are different.

This is supported by the research of Cahyaningsih & Nahdi (2020) regarding the development of elementary mathematics teaching materials based on realistic mathematics education learning models that are oriented towards critical thinking skills. The results show that the developed learning tools meet the valid, practical, and effective criteria used to develop students' critical thinking skills. Another fact is from the research conducted by Oftian & Saefudin (2017) regarding the Effect of the Indonesian Realistic Mathematics Learning Approach (PMRI) on the Mathematics Problem Solving Ability of Class VII Students of SMP Negeri 2 Srandakan. The results of this study indicate that learning by using the Indonesian Realistic Mathematics (PMRI) learning approach has an effect on the mathematical problem solving ability of class VII C students at SMP Negeri 2 Sradakan.

Based on the various problems that have been described, this becomes the basis for researching the development of this teaching material. The teaching materials that the researchers will develop are in the form of electronic books (E-Books). The e-book compiled by the researcher aims to assist students in working on various problems on a material concept and applying the concepts that have been found. Students are trained to find concepts independently through problems related to everyday problems that students can imagine. With the E-Book that has been developed, it is hoped that students' critical thinking skills will increase and students can solve various problem concepts related to everyday problems independently. The purpose of this study was to describe the validity, practicality, and effectiveness of the developed teaching materials. The teaching materials developed are in the form of electronic books (E-Books) with a Realistic Mathematics Learning approach to Statistics material. With this research, it is hoped that it can provide more in-depth information about the development of mathematics teaching materials based on realistic mathematics learning approaches to improve students' critical thinking skills and can be a reference for educators and other researchers who will raise the same theme but with different and more diverse perspectives.

METHOD

This study uses research and development (Research & Development) which aims to develop mathematics teaching materials based on realistic mathematics learning approach (PMR) to improve students' critical thinking skills in Statistics material. The research and development method (Research & Development) is a research method used to research, produce new products, and test the effectiveness of these products (Sugiyono, 2015).

The teaching materials developed in this study are in the form of electronic books (E-Books) which are expected to make it easier for students to solve problems that exist in Statistics material. The development model used in this study refers to the ADDIE model developed by Dick and Carry (1996). The ADDIE model consists of five stages, namely Analysis, Design, Development, Implementation and Evaluation.

The first stage of the ADDIE development model is the analysis stage. At the analysis stage, it is divided into needs analysis and material analysis. Needs analysis is carried out to identify and analyze the feasibility of the product to fit the objectives. The instrument used is an interview which includes preparation, situation, and media that will be used in learning and a pre-test to measure students' initial abilities. Meanwhile, material analysis is carried out to determine the learning materials that will be used in the E-Book which are adjusted to the basic competencies and competency standards that will be

achieved by students and the school curriculum and student needs. In this case, the material to be used is Statistics material for even semester VIII SMP students.

The second stage is the design stage or initial design. Researchers design teaching materials that will be developed in accordance with the results of the data obtained at the analysis stage. The design process is carried out by designing the E-Book component consisting of cover, introduction, table of contents, basic competencies and competency achievement indicators, concept maps, activity 1: analyzing data from a known distribution, activity 2: measuring data concentration, activity 3 : measurement of data distribution, competency test, and bibliography as well as designing statistical materials that are tailored to the basic competencies to be achieved. Then the research determines the appropriate assessment by using formative assessment conducted at the end of the lesson. This assessment is carried out to determine student learning outcomes during the learning process (Abidin, 2016).

The third stage is the product development stage, namely by producing a design of learning devices and research instruments that have been validated by experts before being tested. Suggestions and inputs obtained during the validation test from material experts and media experts became revision material for the improvement of the developed learning tools. The purpose of the validation is to determine the feasibility of the E-Book theoretically and empirically so that it can be tested on respondents.

The fourth stage is the implementation stage. At this implementation stage, the researcher implements and implements the results of the design. Product testing in the field resulting from the development stage has been carried out and is declared suitable for use. The implementation of the developed product is carried out in schools using E-Books as teaching materials used in learning. At this stage, students provide feedback about the E-Book that has been used by using a feasibility test instrument in the form of a validated student response questionnaire. This assessment aims to obtain responses regarding the validity and effectiveness of the E-Books that have been used. The effectiveness of E-Books in learning is measured by being given a test in the form of a post-test to measure the learning outcomes that have been achieved.

The fifth stage is the evaluation stage. The evaluation stage is also carried out at the design stage of the product being developed. At the design stage, evaluation is carried out as a material for improvements to things that are not right and then the product development stage. At the product development stage, product evaluation is carried out based on input or suggestions obtained from the validator as an improvement to get a product that meets expectations. Then the final evaluation is carried out at the implementation stage, namely after testing the product. Evaluation is carried out based on the results of student assessments related to products developed through response questionnaires given after the product is used during learning. This evaluation stage is carried out to produce a good product that is relevant to the needs of the respondents.

RESULT AND DISCUSSION

Result

The assessment of the validity of the mathematics learning device is carried out by the validator. The evaluation of the validity of the E-Book is carried out by the validator on the aspects of the suitability of the accuracy of the material, learning, problem application, physical appearance, language, and layout. The results of the assessment can be seen in the following table 1:

Table 1. E-Book Assessment Questionnaire Results by Validator I

No.	Rated aspect	Score	Average Percentage	Explanation
1.	Material Accuracy	28	70%	Quite Valid
2.	Learning	11	73%	Quite Valid
3.	Application Problem	17	68%	Quite Valid
4.	Physical appearance	21	70%	Quite Valid
5.	Language	16	80%	Valid
6.	Layout	12	80%	Valid
	Total	105	441%	
	Percentage Validity		72,4%	Quite Valid

Based on the results of the table 4, The percentage of validity of validator I is 72.4%. Based on the assessment criteria, it shows that the E-Book has a validity Quite Valid/not revised. This means that the development of E-Books by implementing Problem Based Learning activities meets the criteria for conformity to material accuracy, learning, problem application, physical appearance, language, and layout.

Table 2. E-Book Assessment Questionnaire Results by Validator II

No.	Rated aspect	Score	Average Percentage	Explanation
1.	Material Accuracy	36	90%	Valid
2.	Learning	11	73%	Quite Valid
3.	Application Problem	20	68%	Quite Valid
4.	Physical appearance	23	77%	Quite Valid
5.	Language	15	75%	Quite Valid
6.	Layout	12	80%	Valid
	Total	117	463%	
	Percentage Validity		80,6%	Valid

Based on the results of the table 5, The percentage of validity of validator II is 80.6%. Based on the assessment that the E-Book has validity Valid / not revised. This means that the development of E-Books by implementing Problem Based Learning activities meets the criteria for the suitability of the material, learning, application of problems, physical appearance, language, and layout. The assessment of practicality quality can be seen from the results of observations of the implementation of teaching materials carried out by mathematics teachers (Validator II). The results can be seen in the following presentation:

Table 3. Results of Observation of the Implementation of Teaching Materials

No.	Model Components and Observation Aspects	Score	Average Percentage	Explanation
1.	Syntax	9	90%	Good
2.	Learning	6	43%	Les Good
3.	Reaction Principle	10	83%	Good
	Total	25	216%	Quite Good
	Percentage Validity		69,4%	Quite Good

Based on the results of the table 6, it can be seen that the implementation of learning has been going well as expected. Therefore, the research product is said to be practical with an average percentage of 69.4% with the criteria of Good Quite.

The effectiveness of the developed learning tools is measured based on the results of student response questionnaires and student learning outcomes. critical thinking skills can be seen from student learning outcomes. effectiveness is seen from the comparison of the scores of the Pre-test and Post-test results, student learning outcomes can be seen below and briefly explained in the following table 7.

Table 4. Percentage of Each Aspect of Students Critical Thinking Ability

No	Variable	Score
1.	Total students	15 Student
2.	Post-Test Average	81,3
3.	Pre-Test Average	44.8
4.	Maximum Score	93
5.	Minimum Score	64
6.	Total Students Who Completed	13 Student
7.	Total Students Who Did Not Complete	2 Student

Table 5. Results of Analysis of Students' Critical Thinking Ability Test

Test Results	Pre-test	Post-test	Pre-test Percentage	Post-test Percentage
Students Complete	0	13	0%	87%
Students Not Complete	15	2	100%	13%
Total	15	15	100%	100%

Based on the results of the table 7 and 8, The post-test percentage score of the critical thinking ability of class VIIID students is 81.3, so it is included in the very effective category and the percentage of classical completeness is 87%, so the results of the critical thinking ability test of students meet the very effective category. These results indicate that the learning tools developed are effective in terms of students' critical thinking skills.

Effectiveness is also measured through the results of student responses as follows:

$$\begin{aligned}
 \text{E-Book Effectiveness Percentage} &= \frac{\text{The number of questions answered well by students}}{\text{total questions}} \times 100\% \\
 &= \frac{22}{24} \times 100\% \\
 &= 91.67\%
 \end{aligned}$$

Then the student response questionnaire is achieved in the Good category.

Discussion

Based on the detailed results and descriptions of the research results that have been described above, teaching materials are obtained in the form of E-BOOK based on Realistic Mathematics Learning (PMR) to improve students' critical thinking skills. The teaching materials were developed using the ADDIE research model. The development of teaching materials is tested with validity, practicality, and effectiveness tests.

The first stage of ADDIE model development is the analysis stage. At the analysis stage, it is divided into needs analysis and material analysis. A needs analysis was conducted to determine the extent to which mathematics learning was carried out in class VIII of MTs Al-Ihsan Kalikejambon. Material analysis is carried out to determine learning materials that are tailored to the school curriculum and student needs.

The second stage is the design stage or initial design. The design phase is carried out by designing and selecting learning tools in the form of an E-BOOK, and also designing research instruments consisting of learning device validation sheets, student learning outcomes tests, student response questionnaires, and learning implementation observation sheets. Learning is done based on the lesson plan that has been designed by the researcher. The lesson plan used by the researcher is a lesson plan based on problem based learning. The design of the E-BOOK also uses the steps of a learning model that is adapted to problem based learning. Students are presented with problems related to everyday problems (problem orientation), students are guided to solve problems and propose alleged problem solving (Learning Orientation), then students conduct investigations by collecting information with the teacher facilitating students in solving problems by asking questions that critical (Individual Investigation), students present the results of the problem (Development and presentation of the results of problem solving), students are guided to reflect on the problem solving process (Analysis and Evaluation of the problem solving process).

The third stage is the product development stage, namely by completing the design of learning devices and research instruments which will then be validated first by the validator before being tested. Suggestions and input for validation from validators and teachers become revision material for improving the developed learning tools. The fourth stage is the implementation or trial stage. At this stage the learning tools were tested in class VIIID MTs Al-Ihsan Kalikejambon on April 4, 2021 and April 11, 2021 for 4 meetings. The first meeting was conducted to test students' critical thinking skills, the second and third meetings were carried out with a learning process using statistical material and the fourth meeting was conducted to test critical thinking skills and fill out student response questionnaires.

The fifth stage is the evaluation stage. At this stage, the calculation of the learning tools developed is carried out. Aspects assessed are aspects of validity, practicality, and effectiveness. The validity aspect is obtained from the results of the assessment or assessment of mathematics lessons by lecturers and mathematics. Practical aspects were obtained from the learning implementation sheet and the effectiveness aspects were obtained from student learning outcomes tests (students' critical thinking skills test) and from student response questionnaires.

Based on the assessment of the mathematics lecturer, the percentage of validity was 72.4% with a fairly valid/not revised category. The assessment of the mathematics teacher obtained a percentage of 80.6% in the valid/not revised category. Pre-test was conducted to determine students' critical thinking skills and obtained with a completeness level of 0% and an average critical thinking ability of 44.8. From the results of the calculation of the value of observing the implementation of learning, an average score of 69.4% was obtained with the criteria being quite good or quite practical. The results obtained from the student response questionnaire that has an average score of 91.67% of the statements that are responded well by students and are included in the good or practical category. Post-test results obtained from the percentage of students' completeness of 87% with very effective criteria and the average critical thinking ability of students is 81.3. Based on the description, it can be said that the mathematics lesson material in the form of E-BOOK for Statistics material based on realistic mathematics learning (PMR) to improve critical thinking skills of MTs Al-Ihsan Kalikejambon students which was developed has a fairly valid, practical and effective quality.

CONCLUSION

Based on the results of the discussion carried out, it can be concluded that development research using the ADDIE model. In the Analysis stage, an analysis of the material, student characteristics, and learning objectives and student needs is carried out. the design stage is the making of an E-Book which is carried out with the stage of making materials and questions in Microsoft word, making the appearance as attractive as possible then the material and questions are converted into pdf and then sent to students through the class group provided by the VIIID MTs homeroom Al-Ihsan Kalikejambon. In the development stage, product validation is carried out to material experts and media experts. The Implementation phase was carried out based on the results of student responses with a total of 15 students from MTs Al-Ihsan Kalikejambon school. The evaluation stage was carried out to see whether the statistical mathematics E-Book learning media was effective or not used in learning mathematics. The results of data analysis from material experts (mathematical education lecturers) are 72.4% with a fairly valid category meaning the material is quite suitable to be used for learning media, validation of media experts (Mathematics Teachers) is 80.6% with a valid category meaning the media is quite feasible to use for student use. Student learning outcomes show that the average score is 81.3 based on the KKM, so the average value of all students in the complete qualification is 87%. Based on the KKM, the value of the number of students who complete the qualification is complete. This shows that the learning media for the Mathematics Statistics E-Book is good and feasible to use in learning mathematics for class VIII statistics at MTs Al-Ihsan Kalikejambon Jombang. Based on development research with limited research, the manufacture of electronic learning media books (E-Books) with statistical material for class VIII MTs Al-Ihsan Kalikejambon Jombang still has many shortcomings and weaknesses.

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