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Mathematics-Based Development Module Problem-Based Learning Model to Improve Critical Thinking Ability

Hertyas Tri Novintya,[1] Masters of Mathematics Education, Ahmad Dahlan University, Indonesia
Suparman,[2] Masters of Mathematics Education, Ahmad Dahlan University, Indonesia

Abstract: *This study aims to produce a product in the form of a valid and practical problem based learning mathematics module based on critical thinking skills. This type of research is a 4D model development research which includes defining, planning, developing and disseminating stages. The results of the research were a valid and practical mathematical module on the social arithmetic material. The validity of the module reaches a very good category in terms of the expert judgment. The practicality of the module reaches a good category in terms of student assessment, and observation of learning implementation. The effectiveness of the module can be seen from the results of the t-test.*

Keywords: *Module Development, Problem Based Learning*

INTRODUCTION

The ability to think critically is very important because by having the ability to think critically can help students think rationally in overcoming the problems that are being faced and find and develop alternative solutions to these problems (Karim, 2015). Critical thinking skills are a priority in the goals of education (Utami, 2016). The students need to comprehend that critical approach development is important for the new work situation (Forrester, 2008). Critical thinking is an important and necessary skill because it is required in the workplace, it can help you deal with mental and spiritual questions, and it can be used to evaluate people, policies, and institutions, avoiding social problems (Hatcher and Spencer, 2005 in Duron, 2006). Furthermore, according to Lambertus (2009) critical thinking allows students to analyze their own thoughts to ensure that they have made choices and draw smart conclusions. Develop the ability to think critically is an important element for modern education approaches and models (Karakoc, 2016). The dominant thinking skill that is strongly needed in this 21st century is critical thinking skills (Kharbach, 2012). The critical thinking skills can be trained because they are the key skills needed in the 21st century (Fuad 2017). From some of these opinions, students' critical thinking skills need to be possessed in mathematics learning.

The observation results of researchers at Muhammadiyah 6 Yogyakarta Middle School showed that students' critical thinking skills were still weak. This is indicated by the students' difficulties in finding ways that can be used to deal with problems. Based on the results of the question and answer to the mathematics teacher, this is because the teacher has not directed students to find solutions to a problem independently. Students will work on the questions in the book after the teacher explains the problem-solving path. Although learning continues to run well, it does not train students to think critically because students solve problems in a way that is given by the teacher.

The survey results that have been conducted also show that there are still few teachers who develop learning tools independently. The teacher uses the device resulting from downloading from the internet or from copying a friend's file so that the learning that has been carried out does not vary. Though good learning is planned by considering the characteristics of students and material. Judging from the learning approach, learning planning has contained an approach in accordance with the 2013 curriculum but in practice, two teachers used the lecture method

1 Novintya, Hertyas Tri, Master of Mathematics Education, University of Ahmad Dahlan, Indonesia. email: hertyas081191@gmail.com

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and three other teachers had tried to use the learning approach according to the 2013 curriculum but claimed not to understand the flow. When viewed from the learning sources used, most of them are reference books from certain publishers whose material presentation still has not applied a certain learning approach path.

Ikashaum (2015) says that mathematics modules can be used by teachers as an alternative to improving students' critical thinking skills. Hayati in Pratiwi (2010) revealed in his research that module development can improve students' critical thinking skills. In line with Novintya (2017) in his research explained that students need math modules that present problems in daily life.

PBL is a comprehensive pedagogical framework that can support teachers in adapting to this educational reform (Simone, 2014). A number of studies suggest that problem-based learning approaches can improve critical thinking skills. (Susilo, 2012) By developing a problem-based learning tool, Four D Models can improve students' critical thinking skills. Furthermore, according to Setyorini (2011) a problem-based learning model can improve students' critical thinking skills. On the other hand, the results of Jumaisyaroh's research (2014) contained an increase in students' critical thinking abilities who were given problem-based learning compared to students who were given conventional learning. Problem-based learning models provide more opportunities for students to optimize critical thinking skills than direct learning models (Sunaryo, 2014). There is an increase in students' critical thinking skills taught by a problem-based learning model higher than conventionally taught students (Husnidar, 2014). The structure of the PBL sessions allowed students to think critically and relate the problems to their clinical settings (Rogal, 2008). Problem-based learning is a learning model where students work on authentic problems with the intention to compile their own knowledge, develop inquiry and critical thinking skills, develop independence, and confidence, therefore PBL can improve critical thinking skills according to Arends (2008).

Based on the problems above, the researcher offered a solution to develop a mathematical problem-based learning based on class VII for social arithmetic material. The hope can help teachers in teaching and learning activities and can help students practice handling problems in working on questions and be able to convey their ideas so that they are expected to improve critical thinking.

METHOD

This type of research is research and development using the 4D development model which includes the stages of defining, planning, developing, and disseminating Thiagarajan (1974). The following stages of research:

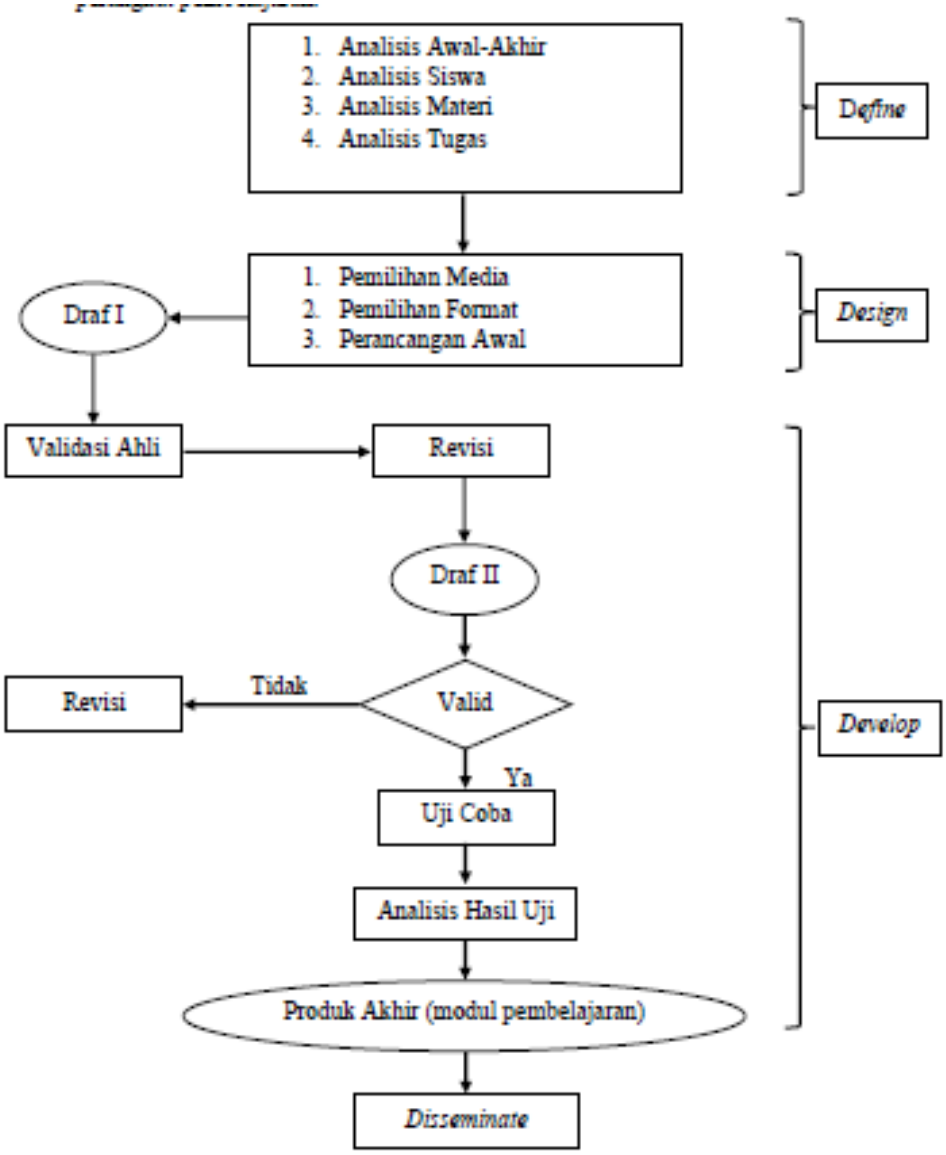

Fig 1. 4D Development Flow

This research was conducted at 6 Yogyakarta Muhammadiyah Middle School and Depok Sleman 3 Muhammadiyah Middle School from January to March 2018. The subjects of the development trials were students of class VII A of 6 Muhammadiyah Middle School of Yogyakarta as many as 17 students. While in Muhammadiyah 3 Junior High School Depok Sleman used class VII A to assess the practicality of the module produced.

Instruments used in this study include: (1) instrument to determine the validity of the module validation sheet. (2) instruments for measuring practicality consisting of student practicality assessment sheets, and learning implementation observation sheets. (3) instruments to measure effectiveness in the form of pretest and posttest questions of students' critical thinking. The instrument used in this study was first validated by one expert validation.

This research data is analyzed qualitatively and quantitatively. The qualitative data includes data reduction, data display and conclusion drawing. Quantitative data analysis is obtained from the t-test.

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RESULTS AND DISCUSSION

At the stage of defining modules that will be developed on all basic competencies of social arithmetic materials. The results of the initial analysis indicate that there are still few teaching materials that provide opportunities for active involvement of students in learning. Whereas in Permendikbud No 65 of 2013 it is demanded that learning can motivate students to participate actively.

The design phase module is compiled based on core competencies and basic competencies derived directly from the basic framework document and curriculum structure of 2013 junior high school issued by the Ministry of Education and Culture. While the indicators to be achieved are the elaboration of the basic competencies of social arithmetic material.

At the develop stage, expert validation and development test activities are carried out. Expert validation was carried out by 1 lecturer and 1 teacher as a media expert, as well as the validation of material experts by 1 lecturer and 1 teacher. This aims to obtain data regarding the validity of the modules produced. The validation sheet used to assess the validity of the module is first validated by 1 expert. In the development test conducted practicality test and observation of the implementation of learning. Practicality tests are carried out by students with high, medium and low ability to assess the module. After the practicality test, the effectiveness test is then carried out.

The data obtained are then analyzed to obtain validity and practicality criteria. Data in the form of validation scores of material experts and media experts, student practicality assessment scores, obtained in the form of a five-scale score then converted into qualitative criteria with the following criteria.

Table 1. Assessment Classification Guidelines

No	Score interval	Criteria
1.	$\bar{X}\,\bar{X} > M_i M_i$ + 1,8 Sbi	Very good
2.	$M_i M_i$ + 0,6 Sbi < $\bar{X} \leq M_i \bar{X} \leq M_i$ + 1,8 Sbi	Well
3.	$M_i M_i$ - 0,6 Sbi < $\bar{X}\bar{X}_{\leq} M_i M_i$ + 0,6 Sbi	Enough
4.	$M_i M_i$ - 1,8 Sbi < $\bar{X}\,\bar{X}_{\leq} M_i M_i$ - 0,6 Sbi	Less
5.	$\bar{X} \leq M_i \bar{X} \leq M_i$ - 1,8 Sbi	Very less

Where Mi is the ideal average, and Sbi is the standard deviation

The module validation results are then summed, the average is calculated and standard deviation. Then the categories are obtained based on the table above. The results of the assessment category for module validity are presented in the following Table 2:

Table 2. A score of Module Validation Results

Validator	Module score	
	Material Aspects	Media Aspects
Expert Lecturer	106	98
Teacher	100	91
	206	189

Total Score	103	94,5
Average	Very Valid	Very Valid

Quantitative data obtained is in the form of a score of expert judgment on module validity. Then, the data is converted into qualitative data to determine the module validity criteria. From these criteria, it can be concluded that the modules that are developed are very valid are used in mathematics learning.

The practicality level of the module can be known from the students' response to the use of the module. Results from student responses are presented in the following Table 3:

Table 3 Scores of Student Response Results to Modules

Student Response	Total score	Average	Criteria
Grade VII students of Muhammadiyah 6 Middle School in Yogyakarta	1258	78,6	Practical
Grade VII students of Muhammadiyah 3 Middle School Depok	871	87,1	Practical

Quantitative data obtained in the form of student responses to the practicality of the module. Then, the data is converted into qualitative data to determine the module's practicality criteria. From these criteria, it can be concluded that the practice developed module is used in mathematics learning. In addition to student responses, in this study also observed the implementation of learning. Data from observations of learning outcomes are presented in Table 4 below:

Table 4 Percentage of Learning Implementation

Meeting to	Percentage of learning implementation	Average
2	86,67%	
3	80%	86,67%
4	93,33%	

Based on Table 4 above, it can be seen that the average for the three meetings reached 86.67%. This level of implementation has exceeded the minimum limit said to be practical. Effectiveness data can be known by comparing the test results of students' critical thinking skills before being treated (pre-test) with the results of tests of critical thinking skills of students who have been treated (post-test). Paired sample t-test test results from the results of critical thinking ability tests are presented in Table 5 as follows:

Table 5 Paired Sample t-test Test Results (Critical Thinking Ability Test)

	Pair Differences					T	df	Sig. (2-tailed)
Pair 1 Pretest-Posttest	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
	-38.88	10.11	2.45	-44.08	-33.68	-15.85	16	.000

Based on Table 5 above, information is obtained that the significance value is less than 0.05. That is, Ho is rejected. Or in other words, problem-based learning based learning modules are effective in terms of the results of students' critical thinking skills test results.

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From the test results above, it can be seen that using this learning module product can improve students' critical thinking skills. This can be seen from the average increase in the results of the pre-test and post-test from 37.76 to 76.75. According to McKinley (2010: 2) in Astuti (2014) learning outcomes can increase if learning provides space for students to interact with friends or teachers in learning activities including in finding concepts. This linkage supports the results of research that shows an increase in critical thinking skills.

This product can be applied to students with low, medium and high cognitive abilities. This product is devoted to students in grade VII junior high school with social arithmetic subjects, the problems presented are issues related to daily life. The learning steps in this module are in accordance with the stages of problem-based learning. According to Nurkhotimah (2017) and Rahmadani (2017) an increase in learning outcomes can be pursued through a problem-based learning approach. Therefore, problem-based learning based learning modules are very suitable for use in the learning process to improve critical thinking skills.

The disseminate stage. After going through three stages, the final product was obtained in the form of a mathematical module of social arithmetic material for the seventh grade junior high school, then for the dissemination phase the researcher gave the product at 6 Yogyakarta Muhammadiyah Middle School, Depok Muhammadiyah 3 Middle School, and the plan would be disseminated also in the mathematics teacher MGMP Sleman district.

CONCLUSION

The development of mathematical modules for problem-based learning based on preliminary studies includes initial analysis, student analysis, material analysis, and task analysis, using interview guidelines and questionnaires. The results of the preliminary study show the need for the development of modules, the ability of students in critical thinking is still low.

In connection with the validity of the mathematics module based on social arithmetic based problem based learning for VII grade junior high school. The modules that have been produced are validated by material expert lecturers and media experts. The results of the validation of material experts, the modules developed are included in very valid criteria. While the results of the validation of media experts showed that the module developed was very valid. Furthermore, the module trial was conducted at 6 Muhammadiyah Middle School of Yogyakarta, and Depok Muhammadiyah 3 Middle School.

In connection with the practicality of mathematical modules on social arithmetic based on problem-based learning for VII grade junior high school. Problem-based learning based learning module after going through the final stage of the trial, from the results of the student response questionnaire in the field implementation test phase shows that the values obtained in the practical category. The results of observations of the implementation of learning also stated that the modules developed met the practical criteria.

In connection with the effectiveness of mathematical modules on social arithmetic based on problem-based learning for class VII junior high school is effective in terms of the results of critical thinking skills tests.

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