Development Learning Devices To Improve Student's Mathematical Literations

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Abstract. The purpose of this study was to determine: (1) how to develop valid problem-based learning-oriented learning devices, (2) how to develop practical problem-based learning-oriented learning devices, (3) how to develop effective problem-based learning-oriented learning devices, and (4) whether applying problem-based learning-oriented learning devicescan improve students' mathematical literacy skills. This research is a development research using the Thiagarajan development model, namely the modified 4D (Define, Design, Develop and Disseminate) model. The learning devicesdeveloped were lesson plans, student activity sheets, student books, and students' mathematical literacy test instruments. The research instruments were: (a) validation sheets for learning devicesincluding: lesson plans, student activity sheets, student books and tests of mathematical literacy skills; (b) the observation sheet to see the teacher's ability to manage student learning and activities; (c) a research questionnaire to see student responses to learning. The results of data analysis indicate that the learning devicesdeveloped are oriented toward problem-based learning that meet the criteria of validity, practicality and effectiveness. There was an increase in students' mathematical literacy skills using the developed learning devices.

Keywords: mathematical literacy; learning devices; problem based learning.

How to Cite: Simanungkalit, R. H., Suyitno, H., Isnarto, I., Dwijanto, D. (2021). Development Learning Devices To Improve Student's Mathematical Literations. *ISET: International Conference on Science, Education and Technology, 7*(1), 489-494.

INTRODUCTION

Literacy is defined as literacy, literacy, literacy or proficiency in reading and writing (Teale & Sulzby, 1986; Cooper, 1993; Alwasilah, 2001). Mathematical literacy is an individual's capacity to formulate, use, and interpret mathematics in various contexts (Rosalia, et al., 2015; OECD, 2014; Stecey, K & Turner, R., 2015). This includes mathematical reasoning and the use of mathematical concepts, procedures, facts and tools to describe, explain, and predict phenomena or problems.

At the international level, there are two main assessments that assess students' mathematical and scientific literacy skills, namely TIMSS (Trend in International Mathematics and Science Study) and PISA (Program for International Student Assessment). TIMSS was held regularly once in four years since 1994/1995 to determine the achievement of grade 4 and grade 8 students in mathematics and science, while PISA was held regularly once in three years since 2000 to determine the literacy of 15 year old students in mathematics, science, and read. The focus of TIMSS and PISA is literacy which emphasizes the skills and competencies of students obtained from school and can be used in everyday life and in various situations (OECD, 2009; OECD, 2010; Stacey, 2011).

In terms of Mathematics and Science literacy skills, the results of the 2015 PISA study showed that Indonesian students had not shown satisfactory achievement. Mathematical literacy of Indonesian students is only able to rank 28 out of 37 countries, with an achievement of a score of 386 and still below the international average score of 490. For scientific literacy it is also in 28th place out of 37 countries with an achievement of a score of 403, and still below the international average score of 493.

The low mathematical literacy is due to the fact that students are not accustomed to solving reasoning problems and problem solving. This is in line with the OECD (2010) which states that literacy problems in the PISA study require reasoning and problem-solving abilities that emphasize various problems and situations in everyday life. From this explanation it is clear that the demands of learning mathematics are not only having the ability to count, but the ability to reason logically and critically in problem solving. Solving this problem is not a problem in the form of routine problems but rather problems faced in everyday life.

One of the efforts that can be made to improve students' mathematical literacy skills is by innovating mathematics learning and developing learning tools. Teachers play an important role in designing innovative learning in supporting students' abilities in understanding mathematics.

Teachers must arrange and plan good and mature preparation to improve students' mathematical literacy. One form of preparation that must be prepared by the teacher is a learning tool. Learning tools are very important, because learning tools are a form of preparation made by teachers before they carry out the learning process (Brata in Komalasari, 2011; Suparno, 2002; Suhadi, 2007). Considering that learning tools are very important, various efforts have been made by the government, starting from workshops, mentoring, training and also forming experimental schools in the preparation and development of learning tools, but the reality in the field is that there are still many teachers who do not have learning tools when teaching. It is often found that the learning equipment is only "just made" for administrative purposes only.

As a result of the above conditions, the learning tools produced by the teachers are very far from being demanded. Many teachers ignore that teaching is a series of systems starting from planning, implementing, evaluating, and reflecting. Besides that, it is often found that the learning tools used are still focused on the material contained in the curriculum so that students tend to memorize only without understanding the concepts and their meanings. As a result, when students are faced with problems that are not routine such as math literacy problems, students will find it difficult to solve them.

The absence and incompleteness of learning tools will result in a lack of teacher preparation in teaching mathematics, including giving questions to students. Teachers have difficulty in giving various questions related to everyday problems. This is the reason students are not used to solving problem-based problems or mathematical literacy. This problem now needs to be addressed.

The development of learning tools must be adjusted to the level of knowledge and experience of students (Simanungkalit, 2016). Learning tools must be arranged in an appropriate learning model as well. The teacher must be able to choose a learning model that can improve students' reasoning and problem solving abilities so that later it will increase their mathematical literacy. Selection and use of appropriate learning will produce maximum results. The use of learning models that are not in accordance with student development will have an impact on the stages of student learning development. The learning model that can overcome the problems that have been disclosed is Problem Based Learning (PBM). Nur (2008) states that PBM is used to cultivate and develop thinking, problem-solving, and intellectual skills.

Based on the explanation above, the writer wishes to develop PBM-oriented mathematics learning tools to improve students' mathematical literacy. The formulation of the problems in this study are: (1) Do the learning tools developed with PBM orientation meet the valid criteria? (2) Do the learning tools developed with PBM orientation meet the practical criteria? (3) Do the learning tools developed with PBM orientation meet the criteria of being effective?, and (4) whether applying PBM-oriented learning tools can improve students' mathematical literacy skills?.

The objectives of this study were: (1) to determine the validity of learning tools developed with PBM orientation, (2) to determine the practicality of learning tools developed with PBM orientation, (3) to determine the effectiveness of learning tools developed with PBM orientation, and (4) to know the increase in mathematical literacy skills with PBM-oriented learning tools.

METHOD

Types of research

This type of research is research and development (R&D). This research was conducted at SMP Negeri 12 Pematangsiantar. The population in this study were students of class VIII. This research design uses the Thiagarajan model known as the modified 4-D model (Define, Design, Develop, and Disseminate). The learning tools developed were lesson plans, student activity sheets (LAS), student books, and instruments to test students' mathematical literacy skills.

The quality of learning tools developed with PBM orientation is assessed based on Nieven's (2007) criteria. These criteria assess the quality of learning tools based on three aspects, namely: (1) Validity; (2) Practicality (Practically); and (3) Effectiveness (Effectivenes).

Data Collectors

Techniques and data collection tools in this study were carried out using:

(1) Check List Sheet

The check list sheet is used to obtain data in the form of a validator statement about aspects of the device being developed. The technique used is to provide learning tools that have been prepared along with validation sheets to the validator to be assessed by marking (√) in the

available column. The instruments that were validated were: RPP, LAS, Student Book, and mathematics literacy ability test

(2) Observation Sheet

The observation sheet is used to collect data on the implementation of learning with PBM. The technique used to collect this data is to provide observation sheets for the feasibility of learning to partner teachers to fill in during the learning process. The instrument observed was the teacher's ability to manage student learning and activities during learning.

(3) Learning Questionnaire

The questionnaire in this study was used to measure student responses related to learning and the devices used. After learning ends, each student will be asked to fill out a questionnaire on the learning and the tools used.

(4) Mathematics Literacy Ability Test

The mathematical literacy test is structured equivalent to the PISA math literacy problem and is used to determine the increase in mathematical literacy skills.

Data analysis techniques

The analysis techniques in this study are grouped into 4 groups, namely:

(1) Analysis of the validity of the developed learning tools

The learning tools prepared are validated by validators or experts to see the level of agreement between validators. Based on the expert's opinion, the level of agreement between observers (experts) will be determined, with the criteria of validity values as follows:

$1 \leq Va < 2$: invalid
$2 \leq Va < 3$: less valid
$3 \leq Va < 4$: sufficiently valid
$4 \leq Va < 5$: valid
$Va = 5$: very valid

(2) Analysis of the practicality of the developed learning tools

The practicality of learning tools is seen from (a) the ability of teachers to manage learning and (b) student responses to learning.

(a) The teacher's ability to manage learning

The teacher's ability to manage learning is the ability to develop a familiar and positive learning atmosphere, including the ability to open learning, organize learning, close learning, manage time, and manage the learning climate. Based on observations made by the observer in the implementation of learning, the teacher's ability to manage the learning process is determined by the average score given by the observer using a rating scale, which is as follows:

$$KG = \frac{\bar{A}+\bar{B}+\bar{C}+\bar{D}+\bar{E}}{5}$$

Where: KG = teacher ability
$\bar{A}$ = the average ability to open learning
$\bar{B}$ = average ability to organize learning
$\bar{C}$ = average ability to close learning
$\bar{D}$ = average ability to manage time
$\bar{E}$ = average ability to manage the learning climate

Based on these average scores, teachers' abilities are categorized as follows:

The criteria:
$1.00 \leq KG < 1.50$ = Very Bad
$1.50 \leq KG < 2.50$ = Not Good
$2.50 \leq KG < 3.50$ = Good enough
$3.50 \leq KG < 4.50$ = Good
$4.50 \leq KG \leq 5.00$ = Very Good

Teachers are said to be able to manage learning if the average value is in the **Good Enough category**.

(b) Student response to learning

Data from student response questionnaires were analyzed using qualitative descriptive by presenting positive and negative responses from students in filling out the student response questionnaire sheets calculated by the formula:

% response for each aspect = (Sum. Student gave a specific aspect) / (Sum number of students)

To determine the achievement of learning objectives in terms of student responses, if the number of students who gave a positive response was greater or equal to 80% of the many subjects studied for each trial.

(3) Analysis of the effectiveness of the developed learning tools

The effectiveness of learning tools can be seen from (a) students' learning completeness and (b) student activities during learning.

(a) Student learning completeness

The criterion states that students are said to have mathematical literacy skills if 80% of students who take the test have at least moderate mathematical literacy skills (get a score of more

than or equal to 2.66 or a minimum of B-). The score intervals for determining the level of student mastery are categorized in table 1 below:

Table 1. Student Mastery Level

Nu	The Value of The r Predicate	Predicate
1	0.00 ≤ Value ≤ 1.00	D
2	1.00 < Value ≤ 1.33	D+
3	1.33< Value ≤ 1.66	C-
4	1.66< Value ≤ 2.00	C
5	2.00 < Value ≤ 2.33	C+
6	2.33< Value ≤ 2.66	B-
7	2.66< Value ≤ 3.00	B
8	3.00 < Value ≤ 3.33	B+
9	3.33< Value ≤ 3.66	A-
10	3.66< Value ≤ 4.00	A

The level of student success is determined by the percentage of student learning completeness.

(b) Student activities

The level of active student activity is the percentage of time that students are active in the learning process and reach their ideal time. The level of active student activity can be seen from the percentage of students who absorb information and the percentage of interference from other students during the learning process. The level of student activity is also determined by comparing the allocation of learning time used with the percentage of ideal time used for each student activity which is shown in Table 2.

Table 2. Percentage of Ideal Time for Student Activities

Types of Student Activities	Effective Percentage (P)	
	Ideal Time	Tolerance (5)
Listening / paying attention to teacher / friend explanations actively	14	9 ≤ P ≤ 19
Read and understand the problems given	11	6 ≤ P ≤ 16
Solve problems according to procedure	38	33 ≤ P ≤ 43
Doing discussions or asking questions	24	19 ≤ P ≤ 29
Draw conclusions related to material and problems	13	8 ≤ P ≤ 18
Irrelevant student behavior in teaching and learning activities (interference)	0	0 ≤ P ≤ 5

(4) Analysis of increasing students' mathematical literacy skills

To calculate the increase in students' mathematical literacy skills using learning devices developed with PBL orientation, it is determined by the Normality-Gain formula, namely:

$$N - gain = \frac{\text{Postest Value} - \text{Pretest Value}}{\text{Ideal Value} - \text{Pretest Value}}$$

With the following criteria:

$gain < 0.3$ = low category

$0.3 \leq gain \leq .,7$ = moderate category

$gain > 0.7$ = high category

RESULTS AND DISCUSSION

a. Results of validation of learning devices

The results of the validation analysis of learning devices by experts are in the valid category. Lesson Plan with an average total validity value of 4.13, Student Activity Sheet (SAS) with an average total validity value of 4.17, and Student Books with a total average value of 4.10.

The validity of the mathematical literacy ability test instrument has been selected 4 questions that meet the valid criteria in content and construct.

b. The results of the practicality of learning devices.

(1) The teacher's ability to manage learning

In this study, the teacher's ability to manage learning was included in the quite good category with the teacher's ability score of 3.68. So that in this category it can be said that the teacher is able to manage learning with the learning devices developed and it is concluded that this criterion has been achieved.

(2) Student response

The results of the analysis of student responses to the components of the learning device and the learning process are said to be positive if more than or equal to 80% of the students' responses are in the positive category. In this study, an analysis of student responses was obtained that more than 80% of students gave a positive response to each aspect of the response to learning devices.

The positive response of students cannot be separated from the conditioning of learning with a problem-based learning model, including: the problems posed to students originate from

contextual problems, namely problems that are close to the student's real world or can be reached by students' imaginations to show the usefulness of mathematics in student life through solution to problem. Soedjadi (Sinaga, 2007) states that: determining real problems in the implementation of mathematics learning needs to always pay attention to the reality and the existing environment, so that it is possible and at the same time motivates students to enjoy learning mathematics. This indicates that the learning devices developed with PBL orientation can foster students' motivation and interest in learning in implementing learning.

c. Results of the effectiveness of learning devices

(1) Student learning completeness

The results of the analysis of student learning completeness on mathematical literacy abilities were obtained by 23 students with a minimum value of B-) of 26 students or about 88.46%, so it is concluded that this criterion has been achieved.

(2) Student activities

The results of the analysis of student activities during learning activities have met the ideal time tolerance criteria set. All student activities have been at the ideal time tolerance interval set so that it can be concluded that this criterion has been achieved.

Student activities in the learning process lead to interactions between teachers and students or fellow students, resulting in a conducive classroom atmosphere, each student maximizing his / her abilities. When it is related to student activities in the process of applying the problem-based learning model (PBL) with Piaget's theory, it is stated that social interactions in learning activities both with group friends and outside the group have a major influence on children's thinking. Through this interaction, children will be able to compare the thoughts and knowledge they have formed with the thoughts and knowledge of others. In another part, Jhon Dewey (Trianto, 2009) explains that problem-based learning is the interaction between stimulus and response, which is the relationship between the two directions of learning and the environment.

d. Test Results for Mathematics Literacy Ability Improvement

The results of calculations with N-Gain obtained an increase in students' mathematical literacy skills by 0.56 or in the medium category, meaning that the mathematical literacy skills in the experimental class increased from the previous mathematical literacy skills.

Learning that uses PBL-oriented learning devices emphasizes that learning is controlled by problems. Therefore, learning begins with solving problems, and the problems posed to students must be able to provide new information (knowledge) so that students acquire new knowledge before they can solve the problem. Proposing problems that are often carried out during learning causes students to get used to working on non-routine questions. Giving questions that are not routine causes students' mathematical literacy skills to increase. This is in line with Yazdani (Nur, 2008c) which states that problem-based learning aims to develop basic knowledge in relation to real-world contexts.

CONCLUSION

From the results of the above research, it can be concluded that: (1) the learning devices developed are PBL oriented and meet the valid criteria or fit for use in content and construct; (2) Learning devices developed PBL oriented meet practical criteria seen from (i) the ability of the teacher to manage learning is in a fairly good category with an average acquisition value of 3.68 and (ii) student responses to models and learning devices are in the category positive in every aspect; (3) learning devices developed PBL oriented meet the effective criteria seen from (i) the acquisition of student learning completeness at least a B- value of 88.46% and (ii) student activities meet the ideal time tolerance criteria.

There is an increase in students' mathematical literacy skills by using learning devices developed oriented PBL. The increase in students 'mathematical literacy skills was 0.56 or in the "Medium" category, meaning that the mathematical literacy skills of the experimental class increased from the previous students' mathematical literacy abilities.

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