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Research Article

The Validity of Mathematics Learning Model Based on Realistics Mathematics Education and Literacy in SMP

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Abstract.

This study aims to determine the validity of the Mathematics Learning Model Based on Realistic Mathematics Education and Literacy that has been developed. This type of research is the Plomp model design research which consists of three stages, namely preliminary research, the development or prototype stage, and the assessment stage. The model developed produces products that are documented in book form, namely model books, hypothetical learning trajectories, teacher books, and student books. The validity of the developed model is investigated at the prototype stage. The data in this study are the results of the experts' assessment of the four products. Data collection techniques using a questionnaire. The data collection instruments in this study were model book validation sheets, hypothetical learning trajectory sheets, teacher book validation sheets, and student book validation sheets. The data obtained were analyzed using descriptive statistical techniques. The results of the data analysis show that the Mathematics Learning Model based on Realistic Mathematics Education and Literacy developed meets the valid criteria.

Keywords: Learning model; mathematics education; realistic mathematics

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1. Introduction

This research is motivated by the problem of the low mathematics ability of students in Indonesia. One of the indicators can be seen from the results of the Program for International Student Assessment (PISA). This is because PISA aims to test students' knowledge and skills in mathematics[1]. In addition, PISA assessment can also be used to identify the level of mathematical ability of students in several countries[2]. Indonesia's participation in PISA from 2000 to the present shows the mathematical abilities of students who are always in the lowest 10 ranks. This shows the weak ability of Indonesian students in solving math problems related to the real world.

Mathematical ability in PISA is assessed using the concept of literacy[3]. Mathematical literacy is the ability to understand and use mathematics in various contexts, as well as the ability to reason mathematically[4]. Therefore, the low student achievement in PISA

TABLE 1: Indonesian Students' Mathematical Ability PISA Results.

Year	Indonesian		Number of Participant Countres	International Average Score
	Score	Rank		
2000	367	39	41	500
2003	360	38	40	500
2006	391	50	57	498
2009	371	61	65	496
2012	375	64	65	494
2015	386	63	70	490
2018	379	73	79	494

Source: [3]

reflects the low mathematics literacy of students. How about the mathematics literacy skills of junior high school students in Bukittinggi? To find answers to these questions, a mathematics literacy ability test was conducted on junior high school students in Bukittinggi. The school was selected by purposive sampling. Purposive sampling is a sampling technique with certain considerations[7]. The school selected as a sample was considered as a superior school. The results of the test on 62 9th grade students of SMP Negeri 1 Bukittinggi in August, the highest score achieved by students was only at the interval [61-70] as many as 1.61% of students. The highest percentage of students in the interval score [31-40] was 32.26%. These results answer the question that the mathematics literacy of junior high school students in Bukittinggi is also in the low category.

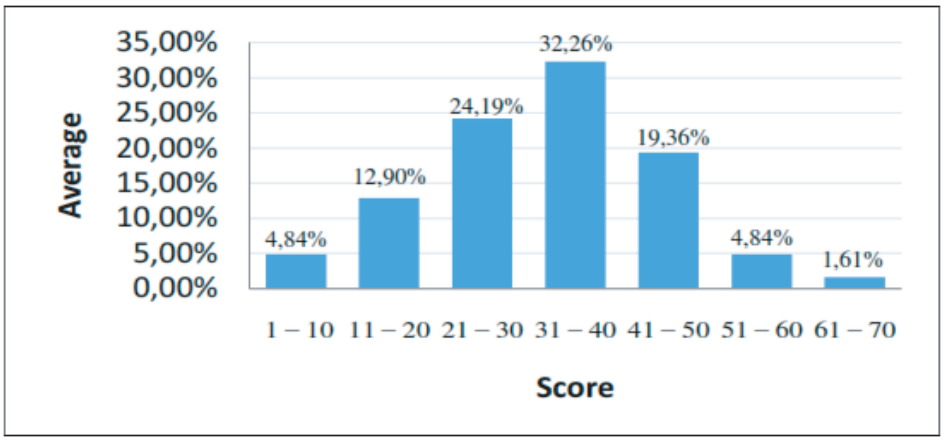

Figure 1: Student's Mathematical Literacy in SMPN 1 Bukittinggi.

There are a number of factors why Indonesian students 'mathematical literacy is low, namely a) students' ability to solve non-routine problem problems is still weak, b) Test questions designed by teachers or the government as evaluation tools are still low-level

questions, c) Students are accustomed to accepting concepts mathematics in finished form without knowing how to find it[5]. In addition, the assessment instruments made by the teacher are generally less related to the real world context of students, and do not facilitate students to express their thinking and argument processes[6].

Problems in mathematics education and education in Indonesia also contribute to the low achievement of students' mathematics literacy. Some of the problems of education in Indonesia are a) the learning process in schools is very oriented towards mastering theory and memorization, as a result, the ability of students to learn and reason is underdeveloped, b) Too tight the school curriculum, which causes the learning process in schools to become routine, and less able to cultivate student creativity to learn[8]. Whereas in mathematics education, problems were found: a) the approach to learning mathematics is very mechanistic and conventional, b) the learning process only focuses on the objectives and learning outcomes, while the process is ignored[9].

To develop students' mathematical literacy skills, it can be done by applying appropriate learning methods, so that students are involved in the problem-solving process with perseverance and self- confidence. In determining the appropriate learning method, teachers first need to understand the nature of mathematics and the level of cognitive development of students[10]. More than that, in developing mathematical literacy, learning that is carried out must have a link between learning steps and aspects of mathematical literacy[11]. One learning approach that is believed to facilitate the achievement of mathematical literacy is Realistic Mathematics Education (RME)[12].

RME is an approach to learning mathematics that was first introduced and developed in the Netherlands since 1971 by the Freudenthal Institute, a research institute under Utrecht University, based on Freudenthal's thinking about mathematics as a human activity[13] [14]. In Indonesia, the RME learning approach is known as the Indonesian Realistic Mathematics Education (PMRI), which is an implementation of the realistic mathematics approach in Indonesia, which has been implemented since 2001[15]. PMRI is the result of adaptation of RME which has been harmonized with the conditions of culture, geography and life of Indonesian society in general[16].

Since PMRI was introduced in Indonesia in 2001, many teachers and researchers have implemented and developed it in mathematics learning. However, until now there has not been an increase in the achievement of students' mathematics literacy from the PISA assessment. Analysis of the RME approach, it was found that the RME approach did not fully cover aspects of mathematical literacy explicitly. This can lead to learning designs created by teachers or researchers when applying the RME approach in learning far from the content of mathematical literacy. Therefore, the researcher tries to develop a

Mathematics Learning Model Based on Realistic Mathematics and Literacy Education (MLMB-RMEL) to optimize the achievement of students' mathematical literacy. The discussion in this paper focuses on the validity of the MLMB-RMEL that has been developed.

2. Methods

2.1. Types of research

This type of research is educational design research with the type of devolepment studies. This is because this study designs and develops an educational intervention as a solution to educational problems[17]. The educational intervention was carried out in the form of a Mathematics Learning Model Based on Realistic Mathematics and Literacy Education (MLMB-PMRL), as a solution to mathematics education problems, especially the problem of low student achievement of mathematics literacy.

2.2. Model Design Research

The development in this study uses the Plomp model which consists of three stages, namely a) preliminary research, b) development or prototyping phase, and c) assessment phase[18]. These three stages of development are described as follows.

Preliminary research aims to analyze the main problems that underlie the importance of the MLMB-RMEL model. This stage is divided into 3 parts, namely: a) need and context analysis, b) review of literature, and c) development of a conceptual and theoretical framework. The results of this preliminary research analysis become the basis for designing the product to be developed. Development or prototyping aims to design the MLMB-RMEL product or prototype. Activities at this stage are cyclic in nature, and consist of three steps, namely a) designing a prototype, b) conducting a formative evaluation, and c) revising the prototype.

The assessment phase aims to conduct a more in-depth assessment of the revised prototype. At this stage, the assessment is carried out using summative evaluation to prove the practicality and effectiveness of the product designed through field test activities in large groups.

2.3. Data, Instruments, and Data Collection Techniques

The MLMB-RMEL validity test data was obtained from the results of the experts' assessment of the

product or prototype that had been designed. Collecting data in research is intended to obtain reliable materials, facts, and information. Data collection techniques are techniques or methods that can be used to collect data[19]. In this study, the data collection technique used to test the validity of the MLMB-RMEL was a questionnaire.

The data collection instrument is a tool used when collecting research data[20]. The data collection instruments for the MLMB-RMEL validity test that have been developed are the model book validation sheet, the hypothetical learning trajectory book validation sheet, the teacher's book validation sheet, and the student book validation sheet. All instruments before use are validated by experts in order to obtain a valid instrument so that the data obtained from the instrument is also valid. The results of the expert's assessment were analyzed to determine the validity level of the instrument, as well as the consistency and agreement between raters in assessing the instrument. Assessment of the instrument is related to the aspects of instructions, content, and language. The results of the validator's assessment are all instruments used are very valid, have very high reliability, and good ICC.

Table 2: The results of instrument validation.

Instruments	Validity	Reliability	ICC
Validation Sheet of MLMB-RMEL	4,2	0,667	0,643
Validation Sheet of HLT Design	4,27	0,811	0,833
Validation Sheet of Teacher's Book	4,27	0,703	0,703
Validation Sheet of Student's Book	4,53	0,750	0,771

2.4. Data Analysis Technique

Data analysis technique is a method for processing data into information so that the characteristics of

the data become easy to understand and useful for answering research questions or problems. The data obtained from the data collection instrument were analyzed using descriptive statistics to answer the question whether the MLMB-RMEL and the product developed were valid. The validity data of the MLMB-RMEL model were obtained from

the results of the validation by five validators. The data collected was then analyzed using the percentage technique with the formula:

$$P=\frac{\sum \text{score per item}}{maximum\ score} \times 100\% (1)$$

To determine the validity of a model and its supporting system, it is obtained by matching the average value of the total validity with the criteria for cavalry. The learning model is said to be valid if the expert's assessment of the components of the learning model and its supporting products is at least in the valid category.

TABLE 3: Instrument Validity Criteria.

P (%)	Category
0 – 20	Not Valid
21 – 40	Less Valid
41 – 60	Quite Valid
61 – 80	Valid
81 – 100	Very Valid

Source: Modified from[21].

3. Results and Discussion

Analysis of the results of preliminary research that has been carried out, obtained information about the need and context analysis which includes analysis of teacher and student needs, curriculum analysis, concept analysis, and analysis of student characteristics, as well as literature review and conceptual framework [22] [23]. Based on the activities that have been carried out in the preliminary research phase, it was decided to choose the material for the System of Two Variable Linear Equations in SMP to be developed. This information forms the basis for designing the MLMB-RMEL in the development or prototype phase. The products designed are documented in the form of books, namely model books, teacher books, and student books. The results of product design in the early stages are called Prototypes 1. The evaluation of Prototype I in terms of its validity is carried out through self evaluation and expert review in the formative evaluation activity in the development or prototype phase. The results of self-evaluation after revision were then discussed with experts. The results of discussion I with experts obtained a number of comments and suggestions for improvement.

Revisions were made to the three products according to expert comments and suggestions. The following shows the revised results in the syntax of the model.

Table 4: Results of the 1st Discussion with Experts.

No	Name of the Product	Comments and Suggestions
1	Model Book	Cover title changed The syntax has not yet shown novelty Come up in 4C skills syntax
2	Teacher's Book	Cover title changed Revised preface to title and content Add HLT
3	Student's Book	Cover title changed Revised preface to title and content The presentation of the material did not reflect the characteristics of PMR

Table 5: Revised Syntax of the Model

Syntax before revision	Syntax after revision
1. Provide realistic problems 2. Hold group discussions 3. Conduct class discussions 4. Provide Individual Exercise 5. Reflect	1. Provide Realistic Problems 2. Developing the Model 3. Work Mathematically 4. Interpretation 5. Class Discussion 6. Mathematical Literacy Exercises

The revision of the product as a result of discussion I with experts is shown and discussed again with the expert to get reinforcement, explanation and accuracy of the product being developed. Discussion II with experts obtained comments and suggestions for improvements to the model book, while in HLT, teacher books and student books according to the expert were good.

Table 6: Results of the 2nd Discussion with Experts.

No	Name of the Product	Comments and Suggestions
1	Model Book	Finding mathematical ideas and concepts through horizontal and vertical mathematical modeling processes is not enough just by giving 1 activity/problem, it may require more than 1 activity/problem. Come up with the syntax of this facilitating activity.

Products are revised again according to expert comments and suggestions. Revisions were made to the model book, namely the syntax component of the model (Table 6). The revision of the product as a result of discussion II with experts is shown and discussed again with the expert to get reinforcement, explanation and accuracy of the product being developed. The results of discussion III with experts stated that the product was feasible. The product that is feasible according to this expert is called Prototype II, then the validity test is carried out with 5 experts at the expert review stage. The assessment of 5 experts consisting of 3 material experts, 1 educational technology expert, and

1 linguist, the results obtained by the validity value for Model Books, HLT, Teacher's Books, and Student Books, respectively 85.23%, 86.8%, 83.42, and 82.41%.

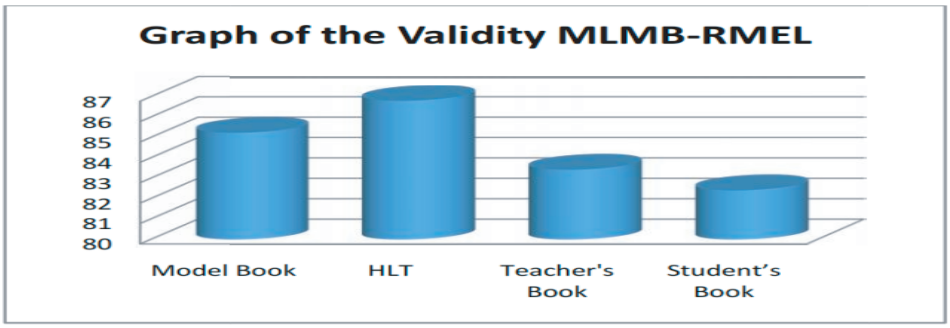

Figure 2: Average Value of Product Validity MLMB-RMEL.

TABLE 7: Syntax Revision of the 2nd Discussion Results Model with Experts.

1	Provide realistic problems. The teacher provides realistic problems at the beginning of learning and asks students to understand these problems. The teacher provides an explanation if there are students who do not understand the problems given. In this case, the teacher only explains the situation and condition of the problem by providing the necessary instructions for certain parts that are not understood by students.
2	Develop a model. Students develop their own models of realistic problems provided with teacher guidance. Model development is needed as a bridge from concrete mathematical knowledge (informal mathematics) to formal mathematical knowledge.
3	Work mathematically. The teacher encourages students to work mathematically after students have succeeded in getting a mathematical model or mathematical problem through the model development stage. Students can use mathematical concepts and skills they already master to find mathematical solutions or mathematical results.
4	Interpretation. The teacher asks students to interpret the mathematical results that have been obtained into the context of the realistic problems given at the beginning. Interpreting is necessary because a real problem does not end in a formal solution, but we expect a real solution to a real problem. In interpreting, students construct and communicate explanations and arguments in the context of the problem.
5	Conduct evaluation. At this stage students are asked to check the solutions that have been obtained by reconciling the results of the answers with the original questions. In other words, students need to evaluate the strategies they are using. Students evaluate the rational reasons from mathematical solutions to real problems.
6	Class discussion. The teacher conducts class discussions, namely discussions held between groups in the classroom, where there are groups of presenters and groups of responses involving the teacher as a facilitator. The purpose of class discussion is to unite various opinions between discussion groups in order to obtain a final conclusion or appropriate solutions to realistic problems that are given as a collective agreement.
7	Provide other realistic problems in a similar context. The teacher provides other realistic problems in a similar context to students. Students try to solve new problems with more advanced techniques, namely focusing on mathematics, not on contextual situations. With this, it is hoped that students will gradually begin to move to the formal level in solving the next realistic problems.
8	Practice math literacy problems. The teacher provides practice for math literacy problems to students. The aim is to train and familiarize students with math literacy problems so that they can facilitate the achievement of students' mathematical literacy. The work of the practice questions is done individually and then it is discussed classically

4. Conclusions

Based on the results of the analysis of the validity test data by 5 experts, consisting of 3 material experts, 1 educational technology expert, and 1 linguist, it was found that the Development of Mathematics Learning Models Based on Realistic Mathematics Education and Literacy had very valid criteria. This is shown by the experts' assessment of the four products from the research and development results that gave a value above 80%. Thus, the Mathematics Learning Model Based on Realistic Mathematics and Literacy Education is appropriate for the achievement of mathematics literacy in junior high school students.

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