

Developing Learning Materials Using Realistic Mathematics Education to Increase Junior High School Students' Mathematical Disposition and Connection Ability

Syu'aida Hazar Nasution
Department of Mathematics Education
State University of Medan
Medan, Indonesia
Corresponding email: aiaida.math@gmail.com

Izwita Dewi
Department of Mathematics Education
State University of Medan
Medan, Indonesia

E. Elvis Napitupulu
Department of Mathematics Education
State University of Medan
Medan, Indonesia

Abstract-This research aimed to produce valid, practice, and effective learning materials using realistic mathematics education. Moreover, the learning materials designed is intended to help students improve their mathematical disposition and mathematical connection ability. This is a developmental research using the 4-D model. Instrumentation consists of observation sheet, lesson plan, teacher's and student's book, mathematical connection test, and questionnaire on mathematical disposition. The first trial took place in class VII-C and the second trials in class VII-B SMP Swasta Siti Hajar Medan. The result of the study indicated that learning tools (materials) developed valid both in terms of content and construct, practice, and effective. The students mathematical connection ability increased within medium category, whereas their mathematical disposition increased from the first to the second trial.

Keywords development of learning tools, realistic mathematics education, mathematical disposition and connection ability.

I. INTRODUCTION

The quality of education is closely related to the quality of learning. Because the quality of education will create a smart, open, peaceful, and democratic life.

Various efforts have been made Kemendikbud to improve the quality of national education. One of them is implementing the 2013 curriculum as a refinement of the

previous curriculum. [1] also explains "the standard of graduation competency in the 2013 curriculum based on Permendikbud number 54 year 2013 is that students must have effective and creative thinking and acting in the abstract and concrete realms according to the ones studied in schools and other similar sources". That way students should have the ability to think creatively in learning.

The ability to think especially high-level mathematical thinking in the students themselves does not just appear but needs to be developed. One of the mathematical abilities included in the Higher Mathematical Thinking Ability is mathematical connection ability.

Judging from the results of the researchers' survey in the form of providing diagnostic tests to students of class VII SMP Swasta Siti Hajar Medan showed that 82% of the number of students have difficulty in solving the problem of mathematical connections. In the research conducted by [2] also found that students are often able to register mathematical concepts related to real problems, but few students are able to explain why the concept is used in the application.

In addition to develop cognitive abilities, mathematics learning also develops affective attitudes. This is in line with the long-term goal of mathematics learning, which imparts higher ability to think like analytic, critic and creative, resulting in mathematical dispositions and social skills cultivation [2]. The development of the affective domain that

became the objective of mathematics education at the junior high school level according to the 2006 curriculum is essentially growing and developing mathematical dispositions.

Viewed from the affective sphere, the mathematical disposition of students needs to be developed because mathematical disposition affects the success of students in solving mathematical problems well. Correspondingly, students' mathematical disposition abilities must be improved because, according to [3] "student disposition toward mathematics is the major factor in determining their educational success". From these statements indicate that mathematical disposition is a major factor in determining the success of learning mathematics students.

However, students' disposition to mathematics is still low. This is proved in the preliminary study of researchers to school. From the results of given questionnaires that the students' response to mathematics is still negative as students are less interested, not confident and easily desperate when solving math problems. The result was obtained from the questionnaire of disposition ability in the form of statement as many as 15 points with the answer choice Strongly Agree, Agree, Disagree and Strongly Disagree to Private Junior High School student SitiHajar Medan.

In response to the problems that occur in the learning process of mathematics in schools, especially related to the importance of the ability of connection and mathematical disposition of students which ultimately resulted in low mathematics learning outcomes, it is needed a solution of learning approach that can accommodate the increased ability of connections and mathematical disposition of students. One approach to learning that can be used is the Realistic Mathematics Education (RME). Judging from its characteristics, PMR can encourage students to be able to develop learning more actively and more meaningfully and can improve students' mathematical connection and disposition [4].

In addition, to be able to improve the ability of students' mathematical connections and dispositions, it is necessary to have a good learning tool prepared by the teacher. Teachers should be able to develop effective and interesting learning tools for students to have a positive response to the learning delivered. Creativity in developing learning resources is very important by developing learning tools in accordance with methods, learning strategies and abilities to be gained in the learning process. For that, teachers are required to prepare the design of learning such as developing learning tools.

Based on the above, we need a tool based on RME to overcome the low ability of connection and mathematical disposition of students and a learning device that characteristics and steps in accordance with the needs of students and can improve the ability of students' mathematical connections and dispositions. Furthermore, the device can also be used by teachers in the learning process. Therefore, researchers develop learning tools using RME to improve students' mathematical connection and disposition skills.

II. LITERATURE

Connection Ability

Mathematical connection is one of the standard capabilities set by the National Council of Teachers of Mathematics or NCTM and has been adopted and used in mathematics learning. The mathematics learning formulated by [5] outlines that students must learn mathematics through understanding and actively building new knowledge from previously possessed experiences and knowledge. Mathematical connection is defined as the relationship of mathematical ideas, the interrelation between internal mathematical concepts or external relationships [6].

Mathematical Disposition

Mathematical disposition is one of the factors that contribute to determine success in learning mathematics. A student with a high disposition will be more persistent and resilient in the face of more challenging math problems and will be more responsible for their own learning and always develop good habits in mathematics. This is in accordance with the opinion of [7] says that mathematical disposition relate to how students solve mathematical problems, whether they solve them with confidence, diligence, interest, and flexible thinking to find various solutions to problem solving.

Realistic Mathematics Education (RME)

Realistic mathematics education is one of the learning approaches that conforms to the change. RME was first introduced and developed in the Netherlands in 1970 by a group of mathematicians from the Freudenthal Institute, Uterecht University in Holland. This approach is based on the concept of Freudenthal who argues that mathematics is a human activity. With the main idea is that students should be given the opportunity to reinvent ideas and mathematical concepts with adult guidance.

According to [8] the characteristics of RME are using contextual problems, models, production and construction of students, interactivity and intertwinment.

III. METHOD

This research includes development research using 4-D model of development Thiagarajan, Semmel, and Semmel (1974).

Subject and Object

Subjects in this study were students of class VII of SMP Swasta Siti Hajar Medan 2016/2017 academic year, whereas the object of this research were learning materials using realistic mathematics education. Trial 1 was done in class VIIB and trial 2 was done in class VIIC.

Developing Learning Material

Learning materials developed in this study were lesson plans, teacher's book, student's book, student's work sheets. Instrumen for collecting data in this study are tests, questioners and observation sheets. Developing learning material was done by using the 4-D model which consisted of

4 steps that were defining, designing, developing and disseminating.

Instrumens and Data Data Analysis Techniques

4. The Validity of Learning Materials

Learning materials are said to be valid if they meet the criteria of content validity and construct validity. The validity of content was done by 5 validators by giving score 1 to 5 in each assessment column based on aspects: 1) format, 2) language, 3) content, and 4) illustrations. Furthermore the overall expert assessment was processed by calculating the average score to obtain the criteria of content validity assessment and will be outlined in Tabel 1.:

Table 1. Rate Validity Criteria of Learning Materials

Average Value (Va)	Criterion Validity
$1 \leq Va < 2$	Invalid
$2 \leq Va < 3$	Less valid
$3 \leq Va < 4$	Enough valid
$4 \leq Va < 5$	Valid
$Va = 5$	Veryvalid

Note:

Va is the value of determination level validity scale of learning materials.

Learning materials have been revised based on input from experts and samples tested outside of the classroom in order to get eligible subjects. Then, the test results are analyzed for validity and reliability. The formula used to calculate the validity is the product moment correlation [9], that is:

$$r_{xy} = \frac{N \sum_{xy} - (\sum_x)(\sum_y)}{\sqrt{\{N \sum x^2 - (\sum x)^2\} \{N \sum y^2 - (\sum y)^2\}}}$$

Note:

r_{xy} : correlation coefficient between variable x and y

X : score items

Y: total score

N : the number of students who take the test (sample)

Then, to determine the coefficient of reliability of a test used in narrative form alpha formula [10], as follows:

$$\alpha = \left(\frac{k}{k-1} \right) \left(1 - \frac{\sum \sigma_n^2}{\sigma_t^2} \right)$$

Note:

α : reliability coefficient test

k : the number of test items

$\sum \sigma_n^2$: the number of variance test scores of each item

σ_t^2 : total variance

5. The Practicality of Learning Materials

The practicality of the learning materials was observed based on the validator's assessment and the implementation of

learning materials. The validator assessment criteria are met if it is found on the validation sheet that all validators states that learning materials can be used with "a few revisions" or "no revision".

Furthermore, the learning materials implementation was observed based on the observer's assessment where they chose score 1 to 5 on each aspect of learning materials implementation that were lesson plans, teacher's book, student's books, student's work sheets. The average total score obtained was categorized into the percentage of learning implementation and will be outlined in Tabel 2.

Table 2. Qualification Percentage of Learning Implementation

The Percentage of the implementation	Category
$k \geq 90$	Very Good
$80 \leq k < 90$	Good
$70 \leq k < 80$	Fair
$60 \leq k < 70$	Poor
< 60	Very Poor

Note:

k = Average total of learning materials implementation

6. The Effectiveness of Learning Materials

The effectiveness of learning materials was observed based on students' active activity meets the criteria of achieving the percentage of ideal time set, mastery of students' connection ability classically, that is minimum 85% students follow learning able to reach score, and 80% students give positive responses to learning materials.

III. RESULT

Define

The purpose of learning can be identified by first analyzing instructional needs. The process of identifying instructional needs begins with identifying problems in the field. Based on preliminary observations, students' mathematical disposition and connection ability are still low. That's because students are not accustomed to using the connection ability so that the impact also on the low students' mathematical disposition. This is also supported by the teachers of state schools who have not been able to develop learning materials that focus to increase students' mathematical disposition and connection ability. Based on these findings, the main purpose of developing this materials are to develop learning materials to improve students' mathematical disposition and connection ability.

Design

The main activity of this step was to write the initial draft of learning materials including the lesson plans, teacher's book, students' books, students' work sheets, and test of connection ability and questionnaires mathematical

disposition. The instructional materials were based on KI, KD, and indicators on social arithmetic material, and adjusted to the purpose of learning and improving mathematical disposition and connection ability. Based on these objectives, 5 essays and mathematical disposition questionnaires consisting of 30 questions were prepared.

Develop

1. Validity

At this stage content validity and construct validity are performed. Content validity is done by 5 validators. Validation results by the validator indicate that all learning materials developed have met the valid criteria with a total average value of teacher book of 4.25, student books 4.37, LKS 4.31, test of mathematical connection ability and statement item of mathematical disposition questionnaire has also been in valid category. While the validity of constructs obtained by providing tests of connection and mathematical disposition to students who have learned the material. The result of construct validity indicates that the test grain of connection ability and the questionnaire of mathematical disposition is valid. Then calculated the reliability of the test items of connection ability and the matrix disposition questionnaire and obtained that the pretest reliability of mathematical connection capability of 0.613 (high category), posttest mathematical connection capability of 0.810 (very high category) and mathematical disposition questionnaire of 0.932 (very high category).

1. Practically on Trial 1

The first criterion of practicality has been met as all validators assume that the developed learning materials can be used with little revision. This assessment is given to experts and practitioners at once with the provision of materials validation sheets. The second criterion of practicality has also been fulfilled, the percentage of learning materials implementation reaches 80.94% (good category). The implementation of the learning materials used is reviewed at each meeting. The implementation of all learning materials used in the research is observed by an observer who is a teacher of mathematics studies at every meeting conducted. Thus, learning materials developed in trial 1 can be said to be practical.

2. Effectiveness on Trial 1

The first criterion of effectiveness is the mastery of student's mathematical connection ability in class and it is found that 17 students complete (77,3%) and 5 non students (22,7%) from 22 students who followed posttest of mathematical connection. Thus, the posttest result of students' mathematical connection ability in trial 1 has not fulfilled the classical completeness because it only got 77.3%. So it can be concluded that the completeness of mathematical connection ability has not been classically met.

The second criterion of effectiveness is students' activity fulfills ideal time percentage and it is found that there are 4

categories (category 1, 3, 4 and 5) that have reached percentage of ideal time and there is 1 category not fulfill percentage of ideal time, that is activity category reading student's book and student's worksheet (category 2). That's 3 out of 5 categories (categories 4 and 5 are met) has reached the percentage of ideal time in trial 1. The average percentage of ideal time of student activity time in trial 1 will be outlined in Table 3.

Table 3. Average Percentage of Ideal Time of Student Activity

Meeting	Frequency For Each Type of Activity				
	1	2	3	4	5
I	20,49	11,46	30,21	31,94	5,90
II	18,23	19,79	25,52	32,29	4,17
III	22,57	12,85	23,96	33,33	7,29
IV	22,57	14,93	24,65	29,51	7,29
Average	24,15	14,75	26,08	31,76	6,16

Criterion activity:

Activity 1 : $20\% \leq \text{Percentage of Ideal Time} \leq 30\%$

Activity 2 : $10\% \leq \text{Percentage of Ideal Time} \leq 20\%$

Activity 3 : $25\% \leq \text{Percentage of Ideal Time} \leq 35\%$

Activity 4 : $25\% \leq \text{Percentage of Ideal Time} \leq 35\%$

Activity 5 : $0\% \leq \text{Percentage of Ideal Time} \leq 5\%$

The third criterion of effectiveness is students' positive response and it is found that the average percentage of student's response is above 80%. So it can be concluded that the student's response is in positive category.

Based on the above description it can be concluded that the learning materials has not met the criteria effectively so that it needs to be revised to some learning materials components developed with the hope of problem based learning material can improve the ability of student's mathematical connection and disposition on trial 2.

3. Practically on Trial 2

The first criterion of practicality has been met as all validators assume that the developed learning materials can be used with little revision. This assessment is given to experts and practitioners at once with the provision of materials validation sheets. The second criterion of practicality has also been fulfilled, the percentage of learning materials implementation reaches 85,06% (good category). The implementation of the learning materials used is reviewed at each meeting. The implementation of all learning materials used in the research is observed by an observer who is a teacher of mathematics studies at every meeting conducted. Thus, the learning materials developed in trial 1 can be said to be practical.

4. Effectiveness on Trial 2

The first criterion of effectiveness is the mastery of student's mathematical connection ability in class and it is

found that 21 students are complete (91,3%) and 2 students aren't complete (8,7%) from 23 students who followed the posttest of mathematical connection. Thus, the posttest result of students' mathematical connection ability in trial 2 has fulfilled the classical completeness because it got 91,3%. So it can be concluded that the completeness of the ability of mathematical connection has been classically met.

The second criterion of effectiveness is student's activity. It fulfills with ideal time percentage and it is found that all categories of student's activity have reached the percentage of ideal time set. So it can be concluded that the percentage of ideal time student activity on trial 2 already meets the criteria of achieving the percentage of ideal time set. The average percentage of ideal time of student activity time in trial 2 will be outlined in Table 4.

Table 4. Average Percentage of Ideal Time of Student Activity

Meeting	Frequency For Each Type of Activity				
	1	2	3	4	5
I	20,14	14,24	29,51	33,33	2,78
II	25,52	12,5	28,13	28,65	5,21
III	23,61	11,46	23,61	34,72	6,6
IV	25,35	15,28	23,61	23,26	5,70
Average	23,79	13,75	25,56	29,13	4,85

Criterion activity:

Activity 1 : $20\% \leq$ Percentage of Ideal Time $\leq 30\%$

Activity 2 : $10\% \leq$ Percentage of Ideal Time $\leq 20\%$

Activity 3 : $25\% \leq$ Percentage of Ideal Time $\leq 35\%$

Activity 4 : $25\% \leq$ Percentage of Ideal Time $\leq 35\%$

Activity 5 : $0\% \leq$ Percentage of Ideal Time $\leq 5\%$

The third criterion of effectiveness is student's positive response and it is found that the average percentage of student response aspect is above 80%. So it can be concluded that the student response is in positive category.

Based on the above description it can be concluded that the learning materials have met the criteria valid, practical and effective.

5. The Improvement of Mathematical Connection Ability

The improvement of mathematical connection ability is the fulfillment of indicators of the mathematical connection ability in a better direction according to the criteria established through the process of improving the development of learning materials and reflection of the practice of learning.

The improvement of students' mathematical connection ability with the developed material was seen by calculating the normalized gain index from the pretest and posttest result of mathematical connection capability obtained by the students on trial 1 and trial 2. The average gain value in test 1 was 0.48 included in the medium category. While the average value of gain in trial 2 is 0.61 included in the medium category as well. The results indicate that there is an increase in the students' mathematical connection ability from trial 1 to

trial 2. Gain of students' mathematical connection ability can be seen in Table 5.

Table 5. Gain of Student Mathematical Connection in Test 1 and Test 2

Trial	Gain Score	The number of Student	Average of Gain	Criterion
Trial 1	$g > 0,7$	3	0,48	Medium
	$0,3 < g \leq 0,7$	15		
	$g \leq 0,3$	4		
Trial 2	$g > 0,7$	9	0,61	Medium
	$0,3 < g \leq 0,7$	13		
	$g \leq 0,3$	1		

6. The Improvement of Mathematical Disposition

The improvement of mathematical disposition seen by comparing the mean score of students' mathematical disposition questionnaire on trial 1 and trial 2.

Based on student disposition questionnaire it was found that confident indicators in using mathematics on trial 1 were 3.19 increased to 3.25 on trial 2, persistent and tenacious indicators in doing mathematics task on trial 1 was 3.09 increased to 3.29 on trial 2, the indicator had a curiosity in maths on trial 1 was 3.02 increased to 3.31 on trial 2, the indicator did reflect on the way on trial 1 was 3.23 increased to 3.30 on trial 2, the indicator of flexibility in doing mathematics work on trial 1 was 3.12 increased to 3.32 on trial 2 and the indicators applied mathematics in life daily in trial 1 was 3.18 increased to 3.2 on the trial 2. So it can be concluded that all indicators of mathematical disposition increased from trial 1 to trial 2.

Disseminate

After the learning materials were valid, practical and effective is met at the end of trial 2, then the final materials are obtained. The next step is to do a limited distribution of final materials handover to SMP Swasta Siti Hajar Medan. Submission of learning material to SMP Swasta Siti Hajar Medan in the hope that the math teachers incorporated in the forum can apply the learning materials to the next lesson.

IV. CONCLUSION

The validity of learning materials have met the valid criteria with the average value of total validity of teacher book 4.25, student books 4.37, LKS 4.31, item test mathematical connection ability and the statement item of the mathematical disposition questionnaire has also been in a valid category.

Learning materials have met the practical criteria in terms of the validator response to learning materials is good and can be used with little revision and the implementation of realistic mathematics education materials is good.

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Learning materials have met the effective criteria in terms of the percentage of students' active activities during the learning process met the frame of ideal frame; 91.3% of students' achieve mastery of students' mathematical connection ability calscally and more than 80% of students who give positive responses to the components of learning material.

Learning materials can improve students' mathematical connection ability in terms of average gain of students' mathematical connection ability in test 1 of 0.48 including in medium category, while in trial 2 increased by 0.61 also included in medium category .

Learning materials can improve students' mathematical disposition in terms of the average indicator of mathematical disposition on trial 1 and trial 2.

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