

Development of Learning Device Based on Realistic Approach to Improve Problem Solving Ability Mathematic of Student at Junior High School

Susanna Ronaria Harahap
Department of Pascasarjana
Faculty of Mathematics
Universitas Negeri Medan
Medan, Indonesia

Corresponding email: susannaharahap@gmail.com

Abstract— The purpose of this study were (1) To analyze the effectiveness of learning devices based on the developed realistic approach;(2) To analyze the improvement of students' mathematical problem solving skills which taught through learning tools based on Realistic Approach; and (3) analyzing the process of answers that made by the students in mathematical problems. The topic in this study was the comparison in grade VII of Junior High School 27 Medan. This study done through two stages, the first stage was the development of learning device based on realistic approach using Thiagarajan, Semmel and Semmel (Four-D), and the second stage tested the learning tools based on realistic approach developed in VII-5 and VII-7 grades Junior High School 27 Medan. Based on I and II trial results were obtained that: 1) learning tools based on realistic approaches are effective, reviewed from a) mastery of classical student learning; b) achievement of learning objectives; c) ideal learning time and d) student's response to activity and learning tool based on realistic that developed is positive. 2) Improved students' mathematical problem solving abilities and 3) The student response process in trial II is more variety and better than trial I. Learning tools that produced were the lesson plans, student worksheets, teacher textbooks, student textbooks, and students' mathematical tests for VII grade of Junior High School.

Keywords: *Device development, 4-D model, realistic approach, problem solving.*

I. INTRODUCTION

In facing the globalization time nowadays, reliable human resources who have high confidence and able to solve problems encountered is a must. Those skills can be obtained by learning mathematics. According to [1] mathematics a tool for developing and fostering the ability of logical, critical, and systematic thinking in a person. It is intended to equip students in problem-solving abilities. In accordance with [2] in the discipline of mathematics, the use of problem solving skills has been extremely important and highly influential. Problem solving in the foundation of mathematical and scientific discoveries". This is similar to the National Council of Supervisors of Mathematics [3] that: Problem Solving is

the process of applying previously acquired knowledge to new and unfamiliar situations. Problem Solving strategies involve Posing questions, analyzing situations, translating result, illustrating result, drawing diagrams and using trial and error."

The low learning outcome of student in math is due to lack of context emphasis in daily basis. This is in accordance with [4] the low ability of mathematical solving is caused by the learning of mathematics in the classroom does not improve the ability of high-level thinking and less directly related to daily life. Based on research [5] that: many students have difficulty in learning mathematics. Students do not have the desire to try and think in high level to find a solution in problems that found in studying mathematics but instead as much as possible they always avoid the problem, and this case resulting in their low learning outcomes.

The low ability of problem solving is also seen from the result of initial observation and interview with Mrs. Marianti, as the mathematics teacher of Junior High School 27 Medan, revealed that the students have difficulties in solving the problem and they students were not accustomed to write down what they have known and asked in the question, even they did not understand with the problem and how to solve it.

The lesson plan (RPP) suppose to be complete in describe the conditions that will take place. But the reality in Junior High School that matter was not found. From the interview with Mrs. Marianti found that the existing RPP is incomplete, sometimes still teacher centered, and there was no assessment rubric.

The textbook is a learning support tool. The development of good textbooks must meet valid and effective criteria. But in fact based on the observations result that conducted by the researcher in the field, that the textbooks is still directly provide the formulas as the solution for the problem, the steps given can not measure the ability of mathematical problem solving.

LKS is a sheet that contains the tasks that must be done by the students. Teachers must be careful and have the skills in

preparing the LKS, so that students' activities meet the criteria of competence that wanted to be achieved. However, according to the field observations of researcher in Junior High School, found out that the existing LKS has been compiled by the teachers as Mrs. Marianti said, but according to the researcher, that LKS was still apply conventional tasks, such as the application of formulas, which less allowing the students to explore the problem solutions.

In the realistic framework of Mathematics Education, (Freudenthal) stated that "mathematic is human activity", therefore mathematical learning is advised depart from human activity. "A realistic problem is not necessarily a real-world problem and can be found in the student's daily life. A problem is called "realistic" if the problem is imaginable or real in the mind of the student. However, most educators only provide learning based on a non-interactive handbooks and do not support the enhancement of problem-solving skills. To support the research that will be conducted, [6] stated that there is an impact of Realistic Mathematics (PMR) in improving the mathematics problem solving ability, Further [7] concluded "This is a futher evidence that pupils taught an RME based curriculum are more able to make sense of their mathematics, both in achieving answers and in reasoning why they feel are correct". The Realistic Approach also influences the character of the students. [8] stating that: Quality of students' character who were treated by realistic mathematics education is better then students' character who were treated by conventional mathematics education..

Based on above descriptions, the researcher concludes that need a research to find out of, how effectiveness of learning device based on realistic approach developed? How to improve students' mathematical problem solving skills taught through learning tools Realistic Approach? and how to process the student answers.

II. METHODS

The type of this research is developmental research. The developmental model which applied is the Thiagarajan 4-D model.

1. Population and samples.

The population of this research was all students on VII grade of Junior High School Medan. Sampling is done by using purposive sampling, so that the student of class VII-5 and VII-7 were selected as the samples.

2. The development of learning tools

Development of learning tools includes: Teacher Handbook, Student Book, Lesson Plan, Student Worksheet, and as the research instrument was mathematical problem solving ability test. Learning device development is done by [9]

3. Instruments and techniques of data analysis.

Instruments or data collection tools in this research are tests, and questionnaires. The test was used to measure the ability of mathematical problem solving and questionnaires used to retrieve student response data. Furthermore, to see the

effectiveness of instructional tool and the effectiveness of this research is seen from: (1) classical student learning mastery, that is minimum 85% student who follow lesson able to follow learning able to reach minimum 75; (2) achievement of learning objectives 75%; and (3) the time allocation in the study is the same or less than the usual learning time, (4) the positive student response.

The achievement of the learning objectives for each item of the test was analyzed using the formula:

$$T = \frac{\text{number of students score for item-i}}{\text{total maximum score for item-i}} \times 100$$

A positive student response in learning, was analyzed by quantitative descriptive, that calculated by using the formula [10]:

$$\frac{\text{number of students responds to certain aspects}}{\text{total number of students}} \times 100\%$$

To determine the achievement of learning objectives based on student response, if the number of students who giving a positive response is greater or equal to 80% from the quantity of subjects that studied for each trial. Furthermore, to process student answers seen from the suitability of students' answers with indicators of students' mathematical problem solving abilities.

III. RESULTS AND DISCUSSION

1. The Development Stage description of Learning Tool Based on Realistic Approach.

Learning device development was done by using 4-D model which consists of four development stages, as follows:

a. Define Stage

1) Final-preliminary analysis

The facts indicated that the teacher does not yet have a good learning tool. As, the Lesson Plan that used is not a description of the learning process that being implemented, and is still known as the copy-paste material from another teacher. LKS which used is not synchronized with lesson plan, and the LKS still use the conventional questions.

4) Students' Analysis

The results of the characteristics study of Junior High School 27 Medan students' on VII grade in average 13-14 years old, If associated with the stage of cognitive development according to Piaget (Trianto, 2011), then VII grade students are at the stage of formal operational development. Based on the interview with Mrs. Marianti, S.Pd as the VII grade mathematics teacher at Junior High School 27 Medan, it was found that students in VII grade class are heterogeneous students that seen from students' cognitive ability..

5) Concept Analysis

The results of the comparative material concept analysis refer to the 2013 curriculum, which covering the definition of comparison, comparison of value and the reversed ratio values.

4) Task Analysis

The result of task analysis is to understand the concept of comparative comprehension, understanding the concepts of comparative worth and able to solve daily problems that related to the concept of comparative worth and also can comprehend the concept of comparison turns value, thus able to solve daily problems which associated with the concept of comparison turns value.

5) *The Formulation of learning objectives*

The results of the learning objectives formulation were adapted to the core competencies and basic competencies of the 2013 curriculum.

b. Design Stage

1) **Test Preparation**

The test which used was a test of mathematical problem solving abilities in the form of a description.

2) **The selection of media and tools**

The media and support tools that used were including the Lesson plan, Teacher Handbook (BG), Student textbook, Student Worksheet (LKS).

3) **Format Selection**

The format of Lesson plan that used was adjusted to the characteristics of Realistic Approach in order to become a unity for the expected implementation of the impact on improving students problem solving skills in SMP N 27 Medan.

4) **Initial Design**

At this stage the initial draft of the lesson plan (RPP) was planned for 3 meetings, teacher manual for each meeting, student book and LKS for each meeting, problem-solving test, scoring guide, and answer key. All results at this design stage are called Draf-I.

c. Developmental stage

The results of draft-I were tested the validity of the expert review and field trials.

1) **Expert validation result**

After being validated by five experts, found out that the result of a small revision. Furthermore, the research instrument is a test of students' mathematical problem solving skills, first tested in the class outside the sample, then the validity and reliability test were conducted.

2) **Trial 1**

Once the learning device developed has met the valid criteria. Then the next learning device in the form of draft II is tested in place of research that is test I conducted in class VII-5. The result of analysis of trial data I is the learning tool has not been effective, because there are still some indicators of effectiveness that have not been achieved. The result of completion in the classical ability of the mathematical student problem solving ability on trial 1 can be seen in table 1.

Table 1 Completion Level Classical Mathematical Problem Solving Abilities in Trial I.

Categories	Mathematical Problem Solving Abilities	
	Number of Students'	Percentage
Complete	32	80%
Not complete	8	20%
Total	40	100%

According to table 1, it can be seen that the students' completion of learning classically based from the result of problem solving ability, found out that the number of complete mastery students are 32 people from 40 students (80%) and the number of not complete mastery students is 8 people from 40 students (20%). In addition, the achievement of learning objectives in the first trial has been achieved. While the learning time used has been in accordance with the criteria of learning achievement.

Based on the results of analysis and test I, it is necessary to revise some learning device components developed in the hope that the learning tools based on realistic approach can improve students problem solving abilities.

3). Trial II

After conducting trial I in draft II, further improvements are made to produce instructional tools that meet effectiveness. The result of revision in trial I produced draft III which will be tested on the students of class VII-8. Trial II is conducted as many as three meetings in accordance with the RPP that has been developed. Test II was conducted to measure the effectiveness of learning tools (draft III) developed based on a realistic approach aimed at improving students' mathematical problem solving abilities. Overall, the classical completeness level of students' mathematical problem solving abilities in trial II can be seen in table 2.

Table 2 Completion Level Classical Mathematical Problem Solving Abilities in Trial II

Categories	Mathematical Problem Solving Abilities	
	Number of students'	Percentage
Complete	36	90%
Not compete	4	10%
Total	40	100%

According to table 2, it can be seen that the students' completion of learning classically based from the result of problem solving ability, found out that the number of complete mastery students are 36 people from 40 students (90%) and the number of not complete mastery students is 4 people from 40 students (10%). In addition, the achievement of learning objectives in trial II has been achieved. While the learning time used has been in accordance with the criteria of learning achievement. Thus it can be concluded that the learning tools based on realistic approach to trial II which is a revision of trial I have met the quality of effective learning tools.

d. Disseminate stage

The dissemination of learning tools based on the guided discovery model has been conducted at Junior High School 27 Medan, and disseminated to other Junior High Schools that have similar characteristics to the pilot school. As the objective in being able to be used in the next semester on comparative material.

1. Improvement of Student Mathematical Problem Solving Ability by Using Learning Tool Based on Realistic Approach.

Based on the results of the analysis of students' mathematical problem solving abilities in trials I and II showed that the average of students' mathematical problem solving abilities on the post test results in the trial was 79.25 increased to 82.06 in trial II. Thus, there was an increase in the average scores of students' mathematical problem solving ability of 2.81. Furthermore, the improvement of each indicator of students' mathematical problem solving abilities increased on the average of students' mathematical problem solving abilities as much as 0.02, as much as 0.09 on the understanding indicator problem, as much as 0.08 on the completion plan indicator, and re-examining by 0.09. This showed that the solution students' mathematical problems using learning tools developed based on realistic approach has significantly increased.

2. Student's Response to Development of Learning Tool Based on Realistic Approach in Improving Student Mathematical Problem Solving Ability.

Based on the results of students responses data analysis on trial I and II which given at the end of learning, it was found out that students feel helpful and happy with learning tools with realistic approach developed in overall, in other words the response given after students were learning by using this learning tool is very positive. If observed from the percentage of students' responses to the learning device components developed, using a realistic approach always satisfies the positive criteria, when the percentage of student responses to each aspect is greater than 80%. So it is concluded that the components of learning tools that have been developed contribute positively to the students learning activities..

3. Answering process that made by Students in in completing the tasks of Students Mathematical Problem Solving abilities.

(a). Task Item number 1

Item number 1 measures the four aspects of problem-solving abilities. In the aspect of understanding the problem, the students in the experiment class I and II were predominantly answered the problem well, but some students have not shown the right understanding and information, here is an example of one of the students' answers on trial I and trial II.

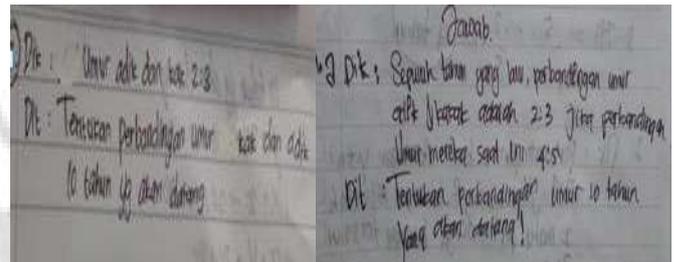


Figure 1. The point of Student Error on task item 1 Understanding the Testing Problem Indicator of Trial I and II

In the aspect of understanding the problem on item 1, the student's answer error lies in the error of translating the problem, the students were not able to write down what is known completely on form of task language but instead wrote it down with their own language.

In the aspect of planning the completion, there were some students in the first and second trial test class that have the correctly answer, because the plan was clearly and leads to the right answer or settlement. However, a small number of students in the first and second trial classes still wrongly answer it, Hereby lies the errors of students' answers on the for the completion indicators of trial I or trial II.

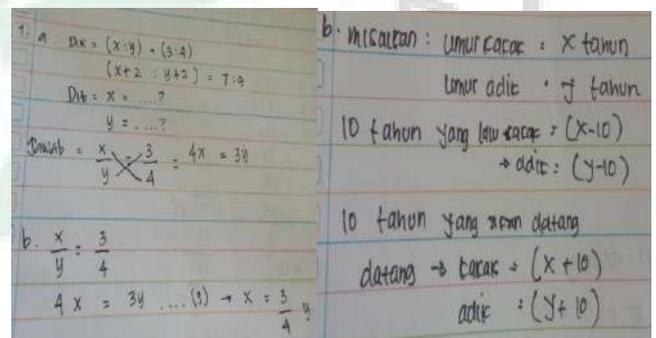


Figure 2. The point of Student Error on task item 1 Understanding the Testing Problem Indicator of Trial I and II.

In the aspect of planning the completion of item no 1, the student's answer errors were lies on incompleteness in planning the problem.

The third aspect was the solving problems / performing calculations. Here lies the error of student answers on the problem solving indicator in trial I or trial II.

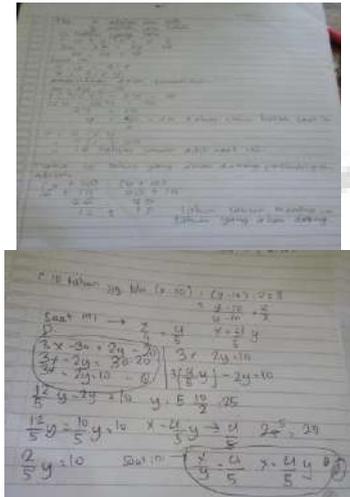


Figure 3. The point of Student Error on task item 1 Understanding the Completion Problem Indicator on Trial II

In the aspect of solving the problem of task item 1, the student's answer error lies in procedural error and the miscalculation, the student has made the comparison formula correctly but less thoroughly in multiplying, nor does not make any conclusion from every obtained answer.

The last aspect of problem-solving abilities is to re-examine student answers. Students were given another problems by checking the given answers,

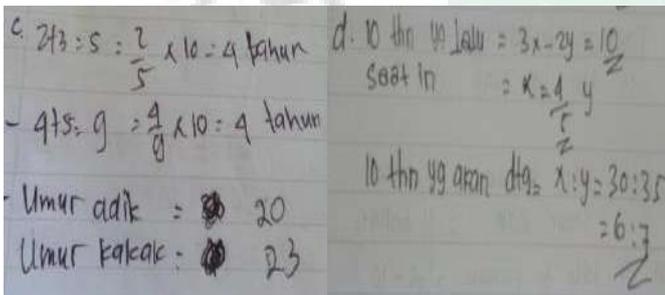


Figure 4. The point of Student Error on task Item 1 Re-check Test Indicator of Trial I and II

In the first experiment class and II, the students answer is good enough to give their opinions respectively, but there were still many of them who did not check and complete the check.

1. The effectiveness of learning tools based on realistic approach

In determining the effectiveness can be seen from four aspects as follows:

1. Classical Student learning completion

Based on the results of data analysis that has been stated previously in the trial I, the percentage of classical completion of problem-solving ability is that 80% of it has not reached mastery criteria. While in trial II, the percentage

of classical completion of problem solving ability is 90% and it has met the criteria of classical completion criteria.

The results above show that students' learning completion in a classical meets the effectiveness criteria. This is because by applying the learning tools based on realistic approach, the students actively seek, arrange their own knowledge, and make CONCLUSIONS from the knowledge that found with guidance and instruction from the teacher in the form of the leading questions.

2. The learning objectives achievement

Based on the result of the achievement analysis of the learning objectives in the first trial and the second trial, the achievement of the learning objectives has been achieved for each item. This is because the realistic approach is deliberately designed so that students could find their own knowledge with the guidance of teachers in the form of questions, demonstrations or other media that needed in achieving the learning objectives.

3. Time allocation

Based on the time allocation achievement which conducted during the first and second experiments, the learning time using the learning tool based on realistic approach is the same as the usual duration of learning that has been done during, which is three meetings or 6 x 40 minutes, with the competence to understand the concept of comparison, comparison worth, value-turning ratio and use it in problem solving in daily basis. Thus, the time allocation that used in accordance to the learning achievement criteria is the same as the usual learning time conducted so far, so it is concluded that the achievement of teaching and learning time I and II has been achieved.

4. Student response towards the learning tools based on realistic approach

Based on the results of the student response data analysis on trial I and II which have been given at the end of the learning process, found out that in overall students feel helpful and happy with applied learning tools based on realistic approach, in other words the response that raised after the students are given learning using this learning device is very positive. The percentage of student response by the developed learning device component, using realistic approach always meet the criteria of student's response which said to be positive, if the percentage of student responses to each aspect is greater than 80%.

Based on the overall acquisition results of the application of learning tools based on realistic approaches in experiments I and II, it was concluded that the effectiveness of learning tools based on realistic approach to improve students' mathematical problem solving ability has fulfilled the effectiveness limits that include the mastery of the classical, achievement in learning objectives, achievement in time allocation and positive student responses..

2. THE IMPROVEMENT OF STUDENTS' MATHEMATICAL PROBLEM SOLVING ABILITIES

Based on the results of the student problem solving abilities analysis in trial I and II, showed that the average problem solving ability test I post test was 79.50 increased to 81.69 in trial II. Thus, there was a 2.19 increase point in the average score of student problem solving skills. Furthermore, the improvement of each problem solving indicator indicates that there is an average of problem solving ability of 0.02 points in problem understanding indicator, 0.09 points in completion plan indicator, 0.08 points on the problem solving indicator and 0.05 in the checking indicator. This shows the students' mathematical problem solving by using developed learning tools based on realistic approach has increased from trial I to trial II

3. STUDENTS' ANSWERING PROCESS IN COMPLETING THE STUDENTS' MATHEMATICAL PROBLEM SOLVING TASKS .

The student answering process on trial I and II aims to see the ability of mathematical problem solving in maths task problems. The trial II completion process gives a more perfect result from trial I.

Thus it is known that the realistic approach encourages students to think for self-thinking, self analyze so that they can find general principles based on material or data that provided by the teacher.

V. CONCLUSIONS

1. The effectiveness of learning tools based on realistic approach in improving the problem solving ability of mathematics has been effective to be applied in learning, which includes 1) the mastery learning in classical, 2) the achievement of learning objectives, 3) time allocation achievement and 4) students' positive responses.
2. The improvement of students' mathematical problem solving abilities after using learning tools based on realistic approach on comparative material is the

average achievement of students problem solving abilities in trial I of 79.50 increased to 81.69 in trial II. In addition, the average of each problem solving indicator increases from trial I to trial II.

3. Student responses to the components of learning tools and learning activities are positive.
4. The student answering process on trial II is better than the answering process on trial I.

REFERENCES

- [1] Hasratuddin. 2015. "Mengapa Harus Belajar Matematika?." Medan: Perdana Publishing
- [2] Vettleson Jr, L. 2010. "Problem Solving Based Instruction in the High School Mathematics Classroom," Bemidji, Minnesota, USA
- [3] Hough, D. 2005. "Evolution of a Teacher's Problem Solving Instruction: A case Study of Aligning Teaching Practice with Reform in Middle School Mathematics". Research in Middle Level Education Journal, Vol.29, No 1
- [4] Edi surya. 2015. "Peningkatan Kemampuan Visual Thinking Pada Pemecahan Masalah Matematis dan Pembelajaran Siswa Aktif. Makalah disajikan dalam Seminar Nasional Pendidikan Matematika HIPPMI. Medan 21 November 2015
- [5] Raudatul, husna, Sahat Saragih, Siman. 2013. "Peningkatan Kemampuan Pemecahan Masalah dan Komunikasi Matematik Melalui Pendekatan Matematika Realistik pada Siswa SMP Kelas VII Langsa". Jurnal Pendidikan Matematika PARADIKMA, Vol 6 Nomor 2, hal 175-186
- [6] Sugiman dan Yaya. "Dampak Pendidikan Matematika Realistik terhadap Peningkatan Kemampuan Pemecahan Masalah SMP. Jurnal. "Online. (indoMs J.M.E). Vol 1 no.1 hal 41-51. Edisi 1 Juli 2010.
- [7] Dickinson, P, Eade, F, Gough, S, Hough, S. 2010. "Using Realistic Mathematics Education with Low to Middle Attaining Pupils Secondary Schools. Proceedings of The British Congress For Mathematics Education."
- [8] Anderson. 2013. "Student Critical Mathematical Thinking Skill and Character. " IndoMS. J.M.E. Vol.4 no.1
- [9] Thiagarajan, S. Semmel, DS. Semmel, M. 1974. "Instructional Development for Training Teachers of Exceptional children." A Source Book. Indiana: Indiana University.
- [10] Sinaga, B. 2007. "Pengembangan Model Pembelajaran Matematika Berdasarkan Masalah Berbasis Budaya Batak (PBMB3)". Disertasi. Unpublished. Surabaya
- [11] Thiagarajan, S. Semmel, DS. Semmel, M. 1974. "Instructional Development for Training Teachers of Exceptional children." A Source Book. Indiana: Indiana University.
- [12] Trianto. 2010. "Mendesain Model Pembelajaran Inovatif-Progresif. Jakarta: Kencana.