An initial observation of learning devices and mathematical problem solving ability of senior high school students

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Abstract. A good learning devices will deliver students to have good mathematical problem solving skills. This type of research was a descriptive research by qualitative approach. The initial observation was aimed at finding out, reviewing and explaining problem-solving ability of high school students in mathematics learning and condition of learning devices used and developed by teachers, then whether it was necessary to continue research development based on realistic mathematics education to improve the mathematical problem solving ability. The results of observations at SMAN 14 Padang and SMAN 15 Padang, can be concluded that the learning devices used do not link to real life problem that the instructional becomes meaningless. Learning devices used were still general and have not been able to facilitate the students to find their own concepts and did not help the students to improve problem solving ability. An approach that can accommodate it is a realistic mathematics education. The result needed to follow-up in form of research on development of realistic mathematics education based learning devices to improve the mathematical problem solving ability of senior high school students.

1. Introduction
Mathematics is one of the subjects that play an important role in the world of education today. Mathematics subjects need to be given to all students starting from elementary school, to equip students with the ability to think logic, analytic, systematic, critic, innovative and creative, as well as the ability to cooperate [1]. Mathematics is important, both as a tool, as a science, as a guide to mindset, as well as forming attitudes [2].

One of the abilities that is important to be developed and owned by students is mathematical problem solving skills [3]. However, after the initial observations at two schools in Padang: SMAN 14 Padang and SMAN 15 Padang, it was found that the problem cannot be resolved correctly. Mathematical problem solving ability is low, and it makes the students’ mark low. Several causes of students’ difficulties in learning are 1) Students are used to copying and recording problem solving from teachers, 2) Approach to mathematics learning that is less interesting and boring for students, 3) Teachers’ difficulties in compiling teaching materials with innovative new approaches [4]. With such conditions, the researcher try to find solutions or solutions to the inequality of a problem that is found by conducting a research later which starts from the initial observations that have been carried out and supported by appropriate and relevant theories.
The mathematical problem solving ability of students need to be improved, trained more to understand various kinds of problems, in order to make and interpret the mathematical model of a problem and solve it correctly [5]. The effort made by the teachers is by using learning devices that are Lesson Plan (LP) and Student Worksheet (SW), that can facilitate students to find their own concepts and develop them to analyze and solve problems, and the questions given can train students to solve problems. Nevertheless, the existing learning devices are still general. The existing LP and SW are still not helpful for students in developing problem solving skills.

As for the experts, the learning devices is LP as a guidance in the form of steps that can be used by teachers in teaching and learning activities which are arranged in the form of learning scenarios [6]. LP is a per-unit lesson learning plan that will be implemented by the teachers in classroom learning activities [7]. The same thing with other experts LP as a plan that describes the procedures and management of learning to achieve one or more basic competencies specified in the content standard and described in the syllabus [8]. The learning device in the form of SW is a sheet of intra curricular and co-curricular activities to facilitate students' understanding of certain material [9]. SW is sheets that contain instructions or steps to complete a task that must be done by students [10]. SW is in the form of textbooks or non-textual lessons [11]. The intended SW is printed teaching material in the form of sheets of paper containing instructions for the implementation of learning tasks that are used by the teachers to facilitate students to discover or understand the material concepts and applications.

Based on a literature study conducted one way that can be done to overcome these problems is to develop learning devises that are more meaningful and enjoyable, which are related to the daily lives of students. The approach that can accommodate learning devices in the form of LP and SW is one of them is a realistic mathematics education (RME) approach, because in this RME approach students themselves construct their own knowledge, so that the learning done is more meaningful. This was also stated by other researchers, that in RME, contextual problems that are used should be realistic, which means, the problem should be easily portrayed in students’ life, and it is specially functioned as tool for re-invention, or to shape model, even though, further, in other part of learning process, there will be discussion about contextual problem as an example of mathematics implementation [12].

Before conducting the research on the development of mathematical learning devices based on a realistic mathematics education to increase the problem solving skills of high school students, the initial observation was done to review the processes that occurred in learning at SMAN 14 Padang and SMAN 15 Padang.

2. Research Methods
The data collection was carried out through observation, semi-structure interviews and documentation. In this case, the researcher did the observations by studying and collecting data and files or events related to learning at SMAN 14 Padang and SMAN 15 Padang. This type of research was a descriptive research by qualitative approach. The data analysis was carried out by using three main components in the analysis stages: data reduction, data display, and conclusion [13]. Reducing data is an activity summarizing, choosing the main things, focusing on the things that are important appropriate with the problems studied. Furthermore, at the data decomposition stage the researcher describes the problem. Drawing conclusions is the result of research that answers the focus of research based on the results of data analysis.

3. Results And Discussions
The data obtained from the initial observations carried out at SMAN 14 Padang and SMAN 15 Padang were in the form of learning devices (LP and SW) as well as student learning test results specifically on mathematical problem solving ability.

Based on the initial observations that had been done, It obtained the data that the students’ desire and interest in learning mathematics were still not visible. This can happen because the students have the notion that mathematics is a difficult lesson and is not so important to learn so that the students do
not take mathematics seriously. The facts in the field showed that the students' mathematical problem solving ability in senior high school was still relatively low. It can be seen from the fact that there are still many students who have not been able to answer the questions containing stories that are non-routine in nature, unable to present a problem formulation systematically in various forms because they are too focused on the examples of problem solving given. As a result, the problems cannot be resolved correctly, so the students' mathematical problem solving ability is low.

The initial observations carried out were also in the form of giving a mathematical problem solving ability test for grade XI in the 2nd semester on April 2019-2018/2019 academic year held in one class at SMAN 14 Padang with 33 students and 15 students at SMAN 15 Padang. To see the mathematical problem solving ability of the students of grade XI, there were three test questions for the students' mathematical problem-solving ability, with the following explanation: one question with derivative material and two questions about arithmetic and geometry. The material being tested has been studied and was taking place in the second semester of 2019. The following researchers describe one of the problems of mathematical problem solving ability that researchers have given is:

A company produces $x$ product with a cost of $(9000+1000x+10x^2)$ rupiah. If all of the company's products are sold for IDR 5,000 for one product. Determine the maximum profit earned by the company!

Based on the data analysis of the initial observation that the researcher did on question one there was not one single student who could answer the question correctly. This can be seen in several student answer sheets on Figure 1:

**Figure 1.** The answer sheets of student a and b for the first question of mathematical problem solving ability test

Based on several of the students’ answer sheets in Figure 1, representing the answers of other students, the researcher can explain that there are indicators of the students’ mathematical problem solving ability that have not been achieved, including the students unable to understand the problems and organize the data and choose the information that is relevant in identifying the problems well because the students cannot explain the elements that are known correctly and completely. The students did not write down the information needed, starting from what was known, what was asked, but they just wrote down the answers. While the indicators present a problem statement mathematically in various forms, they did it incorrectly. It can be seen that the students in answering did not multiply the cost of good sold, 5000 rupiah, with the $x$ product produced. From the answers of one of the students that can be observed, the students are only authors of profit $= 5000 - (9000+1000x+10x^2)$. Supposedly for the cost of the good sold of all products, the students multiply 5000 with the $x$ product produced. As a result of the next indicator, which is to plan and to
choose the right strategy to solve the problem, the students have done it correctly, namely the formula used in searching for profit is the cost of the good sold - the cost used. In addition, the students knew if the problems given could be solved with the first derivative concept. Nevertheless, on these problems, the number of products (x) obtained by one student is negative. Thus, when implementing the plan the students cannot do it well because they do not organize the data on the problem correctly, and they do not present the problem in a mathematical form correctly. Because the previous indicators were not achieved and the students did not take steps to solve the problem correctly, so that in interpreting the results of the answers obtained to solve the problems and figure out the problems, the students could not do it correctly and the final results obtained by the students were not correct.

The low mathematical problem solving ability of the students causes the goal of mathematics learning is difficult to achieve and has a negative impact on student learning outcomes. An overview of the student learning outcomes for problem solving ability that has been given, it can be seen from Table 1 below.

Table 1. The students’ achievements in mathematical problem solving ability based on indicators according to the minister of education and culture number 59 of 2014 on answers given each question of grade xi mipa SMAN 14 Padang and SMAN 15 Padang in 2018/2019 academic year

| Indicators MPSA | Problem 1 | Problem 2 | Problem 3 |
|-----------------|-----------|-----------|-----------|
| SMAN 14 Padang  | 12 9 5 1 - 8 4 4 - - 11 14 3 3 | |
| SMAN 15 Padang  | 9 7 3 - - 9 5 3 2 - 17 12 5 1 1 |

Based on Table 1, it can be seen that there are still few students who can achieve indicators of mathematical problem solving ability. Based on the three questions given, it can be seen that indicators 1, 2 and 3 can be achieved by several of the students. However, for other indicators, the students have not been able to fulfill it for each question. This can also be seen from the percentage of the students in achieving indicators of mathematical problem solving abilities for the 3 questions given. It can be seen from Table 2 below.

Table 2. The students’ percentage in achieving indicators of mathematical problem solving ability according to the minister of education and culture number 59 year 2014 of grade xi mipa SMAN 14 Padang and SMAN 15 Padang in 2018/2019 academic year

| Indicators of Mathematical Problem Solving Ability | 1     | 2     | 3     | 4     | 5     |
|---------------------------------------------------|-------|-------|-------|-------|-------|
| SMAN 14 Padang                                   | 31,31%| 27,27%| 15,15%| 4,04% | 3,03% |
| SMAN 15 Padang                                   | 38,89%| 26,67%| 12,22%| 3,33% | 1,11% |

Based on Table 2, it can be seen that the students’ percentage of Grade XI of SMAN 14 Padang and SMAN 15 Padang in achieving each indicator of mathematical problem solving ability for the three questions given is still below 50%. This shows that the students’ mathematical problem solving ability is still low.

Based on the results and discussion of the three problems analyzed based on indicators of problem solving ability which are guided by the Minister of Education and Culture number 59 of 2014, this study only uses five indicators. Where indicator one is not used because it is difficult to measure students' understanding of a given problem if it is only seen from the answers to the written test results. Then indicators four and five are combined into one indicator. So that the indicators of problem-solving ability used in this study are as follows: organizing data and selecting information that is relevant in identifying problems, presenting a mathematical problem statement in various forms, choosing and using the right approach and strategy for solving problems, solving problems and
interpreting the results of answers obtained to solve problems then it can be concluded that the students of SMAN 14 Padang and SMAN 15 Padang still have a low problem solving ability.

The low mathematical problem solving ability of the students of SMAN 14 Padang and SMAN 15 Padang can occur because the learning devices developed by mathematics teachers have not been able to increase the students’ motivation and interest in learning mathematics, resulting in mathematical ability of the students in particular mathematical problem solving ability. At the time of observation, it was observed that the teachers had tried to improve the mathematical ability of the students by designing learning tools that facilitated the students in the teaching and learning process. Nevertheless, the learning devices (LP and SW) that teachers have are still general. The device designed was seen not using a learning approach that was specific or in appropriate with the conditions and conditions of the participants.

LP is the main reference in implementing classroom learning. Therefore, it is expected that the LP contains clear and systematic learning paths or steps so that it is easy to be used and understood by the teachers. The chosen learning steps should be able to guide the students to build their own knowledge and so that learning is more meaningful, problems designed in the lesson plan that will be given to the students to relate to real life every day. In the learning device in the form of LP, there are learning resources in the form of Student Worksheet (SW). The Student Worksheet used contains a summary of the material and practice questions in the form of routine questions. This condition has not been able to improve the students’ mathematical problem solving ability. It would be better if the SW given was related to real life and the problem was adjusted to the seven indicators of mathematical problem solving abilities that have been described previously. In addition, the SW used is expected to be able to guide the students to find and construct their own knowledge. Thus, learning experienced by the students becomes more meaningful and learning objectives can be achieved optimally. Figure 2 below is the result of the initial observations that have been made to the teachers of Grade XI of SMAN 14 Padang, which is a snapshot of the SW used.

![Figure 2. The snapshot of students worksheet](image)

From Figure 2 it can be seen that the SW used is a summary of the material and questions only. The specific approach used in the SW does not yet appear. This affects the interest and motivation of the students in the learning process, so that in the end it will affect the students' problem solving ability and result in low learning outcomes of the students.

Whereas based on the results of interviews with mathematics teachers at SMAN 15 Padang, the information was obtained that the learning resources used by the teachers were only from printed books. They do not use learning tools in the form of SW. They take the reference to be taught from the existing printed book, so even with the questions given, they sort out the questions that are already in the printed book.
The initial observation that has been made reveal that the learning device used by the teachers is in the form of LP and SW at school, not yet able to facilitate the students to find their own concepts and develop them to analyze and solve problems. The existing learning devices are still general. The existing LP and SW still do not help the students in developing problem solving skills. This is because the learning devices that are applied do not associate material with real life everyday, and also the SW used is not interesting. Learning design has not been able to help students to think logically, be active and provoke students’ curiosity.

Based on the problems found in the initial observations conducted at SMAN 14 Padang and SMAN 15 Padang, the problem needs to be followed up. The right solution to overcome these problems is the need to develop and develop learning tools (LP and SW) that can help the teachers and the students to achieve learning goals and support the implementation of fun and meaningful learning by linking the concept of learning to problems in everyday life. Learning design must be able to help students to think logically, be active and provoke curiosity of students. The role of the teacher can be maximized by designing learning so that the learning atmosphere becomes comfortable, effective and right on target. Learning design must be able to help students to think logically, be active and provoke curiosity of students. So that students can build their own knowledge to develop their ability to solve mathematical problems. Therefore, the problems used in mathematics learning must have relevance to real situations in everyday life that are easily understood and imagined by the students, so that they can solve problems thoroughly, and they have good mathematical problem solving skills. The learning approach that can link learning material with everyday life and can facilitate the students to have meaningful learning is a realistic mathematics education (RME) approach.

The five characteristics of RME: using contextual problems (The Use of Context), using vertical instrument such as models, schemes, diagrams, and symbols (use models, bridging by vertical instruments), using student contributions (student contribution), an interactive learning process (interactivity), and related to other topics (intertwining) [14]. Based on the characteristics of the RME, then to study the material begins by exposing students to mathematical problems related to real life contexts. This is done to help students construct their own knowledge, thus mathematics learning will feel more meaningful and inherent in heart, so students can solve and figure out the existing problems. The characteristic of the realistic mathematics education (RME) approach applying that the learning process begins with things that are close to students [15]. Realistic mathematics education (RME) is an approach that can be applied to learning devices, namely LP and SW that direct students’ learning more to real problems that exist in everyday life, which can improve the students’ mathematical ability, especially mathematical problem solving ability [16]. Realistic mathematics education approach have been used by many researchers to improve students' mathematical abilities and development of mathematics learning devices, for example see [17], [18], [19], [20].

The problems in the initial observations described above will be followed up in the form of research on the development of mathematical learning devices based on the realistic mathematics education (RME) approach to improve the mathematical problem solving ability of high school students.

4. Conclusion
The initial observation that has been made reveal that the learning devices used by the teachers is in the form of LP and SW at school, are still general which is not yet able to facilitate the students to find their own concepts and to develop them to analyze problems. Learning devices that are applied do not associate material with real life everyday so not interesting to students. Learning devices has not been able to help students to think logically, be active and provoke students’ curiosity. The existing LP and SW still do not help the students in developing problem solving skills. So that the mathematical problem solving abilities of high school students in learning are still low. Based on this, further action is needed in the form of research on the development of mathematical learning devices based on the realistic mathematics education (RME) approach to improve the mathematical problem solving ability of high school students.
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