The development of mathematics learning devices for junior high school students: a preliminary research

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Abstract. Students’ problem solving skills (PSS) at SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan still low. This type of research is descriptive research with a qualitative approach. This preliminary research aims to know, review and explain: (1) Students’ PSS at grade viii of SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan (2) The Conditions of mathematics learning devices was used by teachers (3) whether to continue the development of research based on problem based learning to improve PPS. Based on observations from SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan, concluded that the learning devices used have not been able to facilitate students to learning mathematics. So it is necessary to develop learning tools based on problem based learning.

1. Introduction
Mathematics has an important role in human life’ aspects. According to Susanto, mathematics can improve thinking and argumentative abilities, contribute to solving problems of daily life, and play a role in science and technology development [1]. In addition, based on Permendikbud No 58 of 2014 [2], mathematics subject needs to be given to students. Because by studying mathematics, they get used to think logically, critically, innovatively and creatively so that they have foundations and ability to face the development of education and technology in the future.

The learning of mathematics has 8 learning objectives [2]. To achieve these learning objectives, students are expected to be able to develop four cognitive abilities, one of which is mathematical PSS. The mathematical PSS is very important for students because PSS is a general goal of learning mathematics. PSS Given the importance of mathematical PSS, students are expected to master all indicators of PSS so learning mathematics’ goals can be achieved.

In fact, the mathematical ability of Indonesian students at all levels of education, from elementary schools to tertiary institutions was still far from satisfactory [5-16]. However, based on the results of a survey PISA, it was found that the mathematical PSS of the students in Indonesia was still far lagging behind the ability of students in other countries. In 2018, Indonesia ranked 73 from 78 countries who participated and the mean mathematical score was 379 compare to 487 as an international mean score [17].

The fact of the low mathematical PSS of students was also obtained when conducting an initial observation at SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan. It was also found that the students' learning outcomes in mathematics was still low. The low achievement of students’ mathematical PSS because there were still many facts found that students often assume there is only one way to solve the problem correctly, which is presented by the teacher in class and learning mathematics at school is less
related to students’ daily lives [18]. Therefore, the students’ mathematical PSS needs to be improved to understand various kinds of problems, so that they can create and interpret mathematical models of problems and solve them correctly and implement in their daily lives.

In addition, according to Sumarmo [19], several causes of students’ difficulties in learning are (1) Students are accustomed to imitating PSS from their teachers, (2) Mathematics learning approaches are less interesting, (3) Teachers have difficulties in develop learning devices with innovative new approaches.

Learning success is influenced by several factors, including learning models, learning strategies, instructional media, and also teaching materials [20]. The selection of appropriate learning models and appropriate teaching materials will help students to improve their mathematical PSS. However, based on observation it was found that the existing learning devices such as lesson plan (known as RPP) and students worksheet (known as LKPD) were still lacking in helping students develop their PSS. Many students have difficulty in understanding the LKPD that prepared and published by certain institutions. Such LKPD is not close to the situation and natural conditions that exist around students [20].

Based on this, it is necessary to have an improvement in the learning process, especially about increasing mathematical PSS. One of the efforts that must be done is through an update on the learning model applied in the classroom and learning devices, especially RPP and LKPD which can facilitate students to develop their mathematical PSS. In addition, RPP and LKPD that link concepts with the real situation of students will make learning more meaningful and will be more easily understood by students so that they can improve their mathematical PSS.

Moreover, according to experts, learning devices are a number of materials, tools, instructional media, and guidelines that will be used in the learning process [21]. Permendikbud Number 22 Year 2016 [22] explains that RPP is a plan of face-to-face learning activities for one or more meetings. Meanwhile, LKPD is a printed teaching material consisting of sheets of paper containing material, summaries, and instructions for implementation that refer to KD [23]. According to Prajitno [24] LKPD is a facility that contains instructions for students in learning. Majid [25] states that LKPD is the steps contained in the sheet of paper used when learning by students. Based on these opinions, it is concluded that LKPD is a printed teaching material that contains learning material, exercises, and instructions or steps for completing a task and refers to basic competencies, so that learning objectives are achieved.

Problem Based Learning (PBL) is a learning model that confronts students to practical problems as a foothold in learning, where the syntax of PBL is: (1) learners’ orientation to problems, (2) organizing students to learn, (3) guiding individual and group investigations, (4) develops and presents the work, and (5) analyzes and evaluates the problem solving process [26]. In other words, students learn through the problems they have, where PBL provides the opportunity for students to solve problems, and find alternative solutions to problems, so that they are seen as appropriate learning models to develop mathematical problem solving abilities.

The PBL model is perfect for improving and developing students’ mathematical ability, especially problem solving ability. This is consistent with Eggen's opinion [27] that PBL is a learning that uses problems as a focus to develop problem-solving abilities. This was proved by a research conducted by Kodariyati and Astuti [28] which showed that the PBL model has a positive and significant effect on improving students' mathematical PSS.

Before conducting a research on the development of PBL-based mathematics learning devices to improve the mathematical PSS of junior high school students, an initial observation was conducted to review the process that occurred in learning at SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan.

2. Materials dan Methods

The data collection techniques used were observation, semi structured interviews and documentation aimed at identifying and reviewing the learning devices used by the teachers, the students’ mathematical PSS and the level of the teachers’ active role during the learning process. The data collection in this research was done by a direct observation. By doing the observation, the researcher recorded what was seen to provide a complete picture of the object to be studied. The data analysis was performed by using
three main components in the analysis phase, namely the data reduction phase, the data exposure phase and the conclusion phase. These three phases were raised by Miles and Huberman. Reducing the data was an activity to summarize, choose the main things, and focus on the things that are important in accordance with the problem under study. Next, in the data exposure phase the researcher described the problem. Conclusion as the result of research can be obtained in accordance with the expected objectives. In this case, the researcher made an initial observation regarding learning processes and mathematical PSS at SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan.

3. Result dan Discussion
The data obtained from the initial observation conducted at SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan regarding the learning devices (RPP and LKPD) and the results of the mathematical PSS tests. Based on the observation, it was obtained that the learning in schools has used the 2013 curriculum and the teachers have tried their best during the learning process, but the students have not been actively involved in the learning process. In the learning process, it appeared that the students' interest and motivation in learning mathematics subject was still low. During the learning process students were rare to ask questions or give their opinions about the material being studied, and most of them only accepted what was explained by the teachers. This was also supported by the results of interviews with the teachers that if the students were given a story problem most of the students have been able to identify the elements that were known and asked but they have not been able to choose or make strategies to solve the problem. As a result, the students have difficulties in answering these problems and assume that Mathematics Subject is a difficult subject so that they are not interested and they feel bored.

Moreover, the observation was also done by administering tests to Grade 8 of SMPN 1 Teluk Kuantan and SMPN 3 Teluk Kuantan to see the students' mathematical PSS. Obviously, the tests contains the questions that have indicators of mathematical PSS. One example about the mathematical PSS that researchers provide is as follows.

Andi sedang bermain pesawat-pesawatan. Mula-mula pesawat Andi berada pada posisi (0,0). Andi menggerakkan pesawatnya mengikuti pola berikut : (1)1 satuan ke kanan dan 2 satuan ke atas; (2)2 satuan ke kanan dan 3 satuan ke atas, (3)3 satuan ke kanan dan 4 satuan ke atas, dan seterusnya. Tentukanlah koordinat posisi pesawat Andi sekarang jika telah digerakan sebanyak 5 kali dan tentukan berapa jarak titik terakhir posisi pesawat Andi terhadap sumbu-x.

Based on the results of the students' answers in the initial observation, only four students answered the above questions accurately and correctly. The following are some examples of the students' answers to the questions above.

![Figure 1. One example of answer sheet of students who do not understand the problem](image-url)
Based on the figure 1, it shows the students cannot understand the problem because they cannot describe the elements that are known. The students only wrote what was known, and they did not write what is asked and went directly to the answer. Furthermore, for the indicators presenting mathematical problem formulation in various forms, the students also have not correctly presented problems in graphical form.

**Figure 2.** One example of answer sheet of student who already understand the problem

Based on the figure 2, it can be seen that the students are able to present a mathematical problem formulation in graphical form and have been able to choose the right strategy to solve the problem. However, students have not been able to organize data and choose relevant data because they cannot describe the elements that are known, what was asked and they immediately wrote answers, so they misunderstood the problem. They are also asked to determine the distance of Andi’s last plane position with the axis-x. As a result, the final results obtained were not entirely correct.

The above evidence shows that the students have low mathematical PSS, which shows that the students have not fulfilled several indicators of mathematical PSS. The low achievement of students’ mathematical PSS made learning outcomes become difficult to achieve and can have a negative impact on the students’ learning outcomes. This matter can be seen from the percentage of the students in achieving the mathematical PSS’ indicators as presented in Table 1.

| Tabel 1. The Percentage of the students in achieving indicators of mathematical PSS at Grade VIII SMP Negeri 1 Teluk Kuantan and SMP Negeri 3 Teluk Kuantan in 2019/2020 Academic Year |  |
|---|---|---|---|---|---|---|
| Indicators of Mathematical PSS | Question No. | 1 | 2 | 3 | 4 | 5 |
| SMP Negeri 1 Teluk Kuantan | 25% | 41.67% | 38.33% | 31.67% | 11.67% | 1 |
| SMP Negeri 3 Teluk Kuantan | 26.67% | 35% | 38.33% | 30% | 20% |  |
| SMP Negeri 1 Teluk Kuantan | 22.5% | 27.5% | 25.83% | 27.5% | 22.5% | 2 |
| SMP Negeri 3 Teluk Kuantan | 19.17% | 35.83% | 35.83% | 30.83% | 25.83% |  |

Based on Table 2 above, it can be seen that the percentage for each indicator of mathematical PSS was still low, all of which were less than 50%. This indicates that the students’ mathematical PSS was still not fully developed. If this happens continuously, it is feared that the aim of mathematics learning has been formulated by Permendikbud No. 58 of 2014 will not be achieved.

Based on the observations at the schools it showed that the students were not active during the learning process. The students only listened to explanations from the teachers and did not construct their
knowledge independently. In addition, when doing an observation in studying the LKPD, LKPD used by the students was not sufficient to train the students' problem solving ability. Studying the LKPD did not help the students construct their knowledge independently in understanding concepts. In addition, the questions contained in LKPD were still routine and only train the students' numeracy skills. It is rare to find story problems in LKPD that relate mathematical problems to the students' daily lives.

Based on this, it is necessary to have an improvement in the learning process, especially about improving the ability to solve mathematical problems, one of which is through an update on the learning model that is applied in the classroom and learning devices, especially RPP and LKPD. The selection of RPP was done because the RPP is one of the learning devices that must be prepared by the teachers so that learning takes place interactively, inspirational, fun, meaningful and efficient. The selection of LKPD was based on the reasons in which it contained a series of activities in solving a problem. Thus, through the development of the RPP and LKPD, this is expected to facilitate the students to be able to improve their mathematical problem solving ability. The right solution to solve these problems is developed learning devices (RPP and LKPD) that can assist the teachers and students in achieving learning goals and supporting the implementation of learning fun and meaningful. A learning model that can accommodate the problems that have been described previously, also to facilitate the students to learn meaningfully, is PBL.

PBL is a learning model that confronts students to practical problems as a foothold in learning, where the syntax of PBL is: (1) learners' orientation to problems, (2) organizing students to learn, (3) guiding individual and group investigations, (4) developing and presenting works, and (5) analyzing and evaluating the problem solving process. In other words, students learn through the problems they have, where PBL provides the opportunity for students to solve problems, and find alternative solutions to problems, so that they are seen as appropriate learning models to develop mathematical problem solving abilities.

Therefore, using a PBL model based learning device is expected to improve the students' understanding of a mathematical problem and make mathematics learning fun and meaningful that is capable of supporting students' mathematical PSS.

4. Conclusion
An initial observation conducted at junior high school revealed that the learning devices used by the teachers in schools were still general, so that the mathematical PSS of the SMP students in learning was still low. Based on this, further action needs to be taken in the form of research into the development of mathematical learning devices based on the PBL approach to improve the mathematical PSS for junior high school students.

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