Preliminary research development of mathematics learning devices based on problem-based for student at the senior high school

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Abstract. This article discusses the preliminary stage of research on the development of problem-based learning (PBL) tools for high school student. At the preliminary stage of the research, observations and interviews were conducted with mathematics teachers and high school student in class XI. Based on the results of the observation and interviews, the learning device used are still of a general nature and have not allowed the student to improve their mathematical problem-solving skills. Student rarely use the LKPD and if the teacher does not do so, the content contains little material and many questions that did not allow the student to chat with friends or groups and present contextual problems. In the RPP, there is no step in the learning model used, so sometimes it does not meet the conditions and needs of the student.

1. Preliminary
Education has a very decisive role in the development and realization of individual self, especially for the development of the nation and state because from there will be quality human resources. In accordance with Republic of Indonesia Law No. 20 of 2003 [1] concerning the national education system states that education is a conscious and planned effort to realize the learning atmosphere and learning process so that student actively develop their potential.

Effective learning is characterized by the learning process in the student. According to Slametto (2002: 1) [2] learning is a process that is carried out routinely which is marked by changes in a person who is getting better on the day, not getting worse. Therefore learning activities are the most basic activities in the process of education in schools.

Mathematics is one of the subjects taught at all levels of education, is expected to contribute in order to develop the ability to think critically, systematically, logically, creatively and the ability to be able to work together effectively. Abdurrahman (2003: 252) [3] argued that mathematics is a way to find answers to problems faced by humans, a way of using information, using knowledge about shapes and sizes, using knowledge about counting and the most important thing is to think in humans. alone in seeing and using relationship relationships.

The purpose of mathematics learning is based on Permendikbud Number 58 of 2014 [4], namely:
1. Understanding mathematical concepts
2. Use patterns
3. Use reasoning on properties.
4. Communicate ideas
5. Having an attitude of respect for the usefulness of mathematics in life
6. Having attitudes and behaviors that are consistent with the values in mathematics and learning
7. Perform motoric activities that use mathematical knowledge.
8. Uses simple props

According to Wena (2011: 52) [5] "Problem-solving is not just a form of ability to apply rules that have been mastered through previous learning activities, but more than that is a process to get a set of rules at a higher level". If someone has obtained a combination of rules that are proven to be operated according to the situation at hand, he not only can solve a problem, but also has succeeded in finding something new.

Ruseffendi (2006: 291) [6] suggests that a problem is a problem for someone if: first, the problem is unknown. Second, the student must be able to solve them, both their mental readiness and knowledge of their attitudes; regardless of whether or not he finally arrived at the answer. Third, something is a problem-solving for him, if he has the intention to solve it.

Student will try to find a solution if there is a problem with changing the problem into their ideas and knowledge so that the ability to solve problems develop optimally through the problem-solving process. To be able to solve a problem, a method or step of completion is needed.

The fact that occurs based on the experience of researchers teaching in SMAN 1 Lubuk Alung student have difficulty in solving mathematical problems. When the student is given problem-solving problems, student experience difficulties in solving the problems presented, ways of solving that are less systematic and there are no strategies / plans in solving the problem. Difficulties experienced by student in solving problems are due to:
1. Students are less familiar with the problem at hand, they do not read the question carefully so they are not aware of what is known and what is being asked, but immediately start with the calculation;
2. Students do not plan a solution, they do not start with what is asked, do not see important similarities or connect general theories or problems they face;
3. Students do not solve the questions in detail, they ignore the units used because they start the calculation too early;
4. Students do not judge again the truth of the calculation, they do not check again whether the answers they obtained were correct, reality, and in accordance with what was asked or not.

Student are not familiar with problem-solving problems and teachers are accustomed to teaching using conventional learning. Student only get passive learning from the teacher. In general, student do not have experience in solving mathematical problems and experience difficulties when faced with problems that require a high level of thinking. Learning activities like this will have an adverse impact on the student. As a result it can inhibit the development of student mathematical problem-solving abilities.

Based on observations and experience of researchers, the teacher has tried to apply learning models that can motivate and activate student in the learning process. But the learning objectives are still not achieved because of the low problem-solving ability. The teacher has not attempted to create and develop a learning device that can facilitate student in problem-solving because the teacher still depends on the existing source book.

To develop problem-solving skills, a supporting learning tool is needed. Starting from this it is a challenge for teachers to be able to develop their own learning device that are emphasized in Permendikbud Number 22 of 2016 [7] concerning process standards. To meet these process standards, learning must be planned, assessed, and monitored.

Learning devices that teachers can develop in mathematics learning are Student Worksheet (LKPD) and RPP. LKPD is one of the right alternative learning for student because it can help student to add information about concepts learned through systematic learning activities. LKPD contains complete and clear material and contains questions, especially questions of high level or known as HOTS (Higher Order Thing Skill) questions can improve student' mathematical problem-solving.

LKPD that can improve problem-solving skills is problem based LKPD or PBL (Problem Based Learning) which provides opportunities for student to express their abilities in developing their affective skills (M.Iqbal 2017: 6) [8]. The following are specific components of PBL-based LKPD, namely:
1 Non-routine problems with supporting pictures or illustrations
2 Work steps in the form of elaboration of problem-solving steps include:
   a. Understanding the problem (understand the problem)
   b. Planning a settlement (devising a plan)
   c. Student are asked to write down the steps used to solve the problem given.
   d. Resolve problems according to plan (carry out the plan)
   e. Re-checking (looking back)

Every educator in the education unit is obliged to compile a complete and systematic RPP. According to Permendikbud No. 103 of 2014 [9] about learning in primary and secondary education, learning is carried out using RPP. The RPP development that was designed was RPP based on Problem Based Learning (PBL). RPP is tailored to the principles and characteristics of PBL-based learning. In the core activities the RPP must contain 5 processes, namely:
1. Orient student on problems
2. Organizing student to learn
3. Guiding individual and group investigations
4. Develop and present work
5. Analyze and evaluate the problem-solving process.

In fact, student rarely uses LKPD and if there is nothing it is not made by the teacher. The LKPD does not present contextual problems that stimulate student to learn. It contains a little material and many questions that haven't given student the opportunity to discuss with friends or groups. Dala m RPP is not visible step learning model what it is used so often does not correspond to the conditions and needs of student.

If this situation is allowed then student do not have the enthusiasm to learn mathematics and the problem-solving ability of student is less trained so that the creation of learning involves student passively. As a result the student' mathematics learning outcomes are low and mathematics is always considered a difficult and unpleasant lesson. This means that this situation makes learning goals not well achieved.

The selection and use of appropriate learning device in a learning process is a very important factor in directing student to gain learning experience. The way teachers teach is strongly related to the devices used, the preparation of the right RPP and how the students are related to the use of LKPD. With a good learning tool, student will become more active and the learning process will be more meaningful for student. The development of a learning device, among others, the lesson implementation plan and student worksheets must refer to a learning model that can be used in an effort to develop the ability of the problem. One learning model that is thought to be in line with mathematical characteristics is problem based learning (PBL).

In accordance with the opinion of Sanjaya (2007: 214) [10] "Problems in PBL is a matter which is open means that the answer to the problem is not sear for sure". Problem is used to associate a sense of curiosity and analytical abilities of student and the initiative on the subject matter. So PBL is a learning model that uses real-world problems as a context for student to learn about how to improve problem-solving skills and help students succeed in learning.

PBL-based learning device not only helps the student understand problems, but also help student understand the application of matter into everyday problems. In accordance with Sanjaya's opinion, (2007: 218) [11] PBL-based learning can "improve the learning activities of student, help student how to transfer their knowledge to understand problems in the real world and encourage student to self-evaluate the results and learning process". Through PBL-based learning, student think to solve problems, find ideas and make decisions. Student will understand better because they are directly involved actively in fostering new knowledge, so they will remember more about all concepts and principles.

Based on the description of the problem, researchers will develop mathematics learning device in the form of LKPD and RPP based on Problem Based Learning (PBL) in order to help the availability of learning device that support the improvement of student' mathematical problem-solving abilities. This research is summarized in a title "Development of Mathematics Learning device Based on Problem
Based Learning (PBL) Model to Improve Mathematical Problem-solving Ability of Student in Class XI Science in High Schools.

2. Research Methods

The development model used in this study is the Plomp model developed by Tjeerd Plomp. The author uses this model because it is more systematic, directed, analytical, suitable for learning and relevant devices. According to Plomp (2013) [12] The development model consists of three stages: preliminary research, which is a preparation stage consisting of analysis of needs, curriculum analysis, and concept analysis, the development phase or prototyping stage, namely the design process and development of learning tools in stages by using formative evaluation to improve and improve the developed prototype, assessment phase in the form of semi summative evaluation to conclude whether the final prototype or product is in line with the desired and submit recommendations for product development.

During the initial investigation phase (Preliminary Research) there were several analyzes carried out namely : 1) Needs analysis is done to get information about the problems found in school learning both those faced by educators and student. Information gathering was carried out by conducting interviews with several student and mathematics teachers, class XI of Lubuk Alung 1 Public High School and SMAN 1 Enam Lingkung. The results of the needs analysis are used as a consideration in designing PBL-based RPP and LKPD. 2) Analysis of student is carried out to determine the characteristics of student as a basis for designing learning devices. Characteristics of student include the overall pattern of behavior and abilities that exist in student. 3) Curriculum Analysis was carried out on the curriculum used by schools for the eleventh-grade high school mathematics subjects for specialization mathematics subjects in the odd semester of trigonometric equations and the number and difference of sine and cosine. The results of this analysis are used as guidelines in the development of PBL-based mathematics learning device. The activity carried out in the analysis of this curriculum is to review the 2013 curriculum for specialization mathematics subjects in class XI IPA SMA. The activity is conducting a review of content standard analysis and basic competencies in the specialization mathematics subjects contained in the 2013 curriculum in the eleventh grade of Natural Sciences. Next describes basic competencies into indicators of achievement of competencies and learning objectives. In addition to determining the material to be taught, in the 2013 curriculum analysis there are 3 learning principles that must be considered, namely learning activities (Learning Activities), the Scientific Approach and Authentic Assessment. 4) Concept analysis aims to determine the content and subject matter needed in developing learning device. The Material is needed to achieve indicators of achievement of competence. At this stage, activities are identified to identify concepts, detail, and systematically organize the material that student will learn. Concept analysis aims to determine the content and material of mathematics lessons needed in the learning device.

In general, the details of activities carried out at the Preliminary Research stage are presented in the following table:
Through interviews and observations, an analysis of the needs and to conduct curriculum analysis and concept analysis can be carried out with documentation.

3. Results And Discussion

The initial condition test results are student' mathematical problem-solving abilities.

| No | Indikator | Persentase Perolehan Skor |
|----|-----------|--------------------------|
| 1  | Mengidentifikasi unsur-unsur yang dicakup, ditanyakan dan kecakapan unsur yang diperlukan | 42,86 | 11,43 | 8,57 | 8,57 | 28,57 |
|    | Merumuskan masalah matematika | 48,57 | 11,43 | 5,71 | 5,71 | 14,29 |
|    | Menerapkan strategi untuk menyelidiki masalah | 51,43 | 8,57 | 5,71 | 5,71 | 5,71 |
|    | Menginterpretasikan hasil sesuai permasalahan asal | 54,29 | 8,57 | 2,86 | 5,71 | 5,71 |
| 2  | Mengidentifikasi unsur-unsur yang dicakup, ditanyakan dan kecakapan unsur yang diperlukan | 20,00 | 57,14 | 22,86 | - | - |
|    | Merumuskan masalah matematika | 22,86 | 62,86 | 14,29 | - | - |
|    | Menerapkan strategi untuk menyelidiki masalah | 45,71 | 22,86 | 20,00 | 5,71 | 5,71 |
|    | Menginterpretasikan hasil sesuai permasalahan asal | 85,71 | 11,43 | 2,86 | - | - |

It can be seen from the table that there is still a small percentage of student who achieve the highest score for each indicator. This shows that the mathematical problem-solving abilities of student are still not optimal as expected. Student' mistakes can be seen from the understanding of problems, errors in making mathematical models, imperfections in solving problems and inaccuracy in interpreting the solution.
This situation also has an impact on student low learning outcomes in mathematics. Of the questions above, only 10 people obtained scores above the KKM and 25 more people got scores below the KMM, where the KKM in the row and series material was 75.

In reality at school students rarely use LKPD and if there is it is not made by the teacher, the contents are little material and there are lots of questions that student have to do as an exercise. The problems that exist in LKPD are not questions that provide opportunities for student to discuss with friends or groups and do not present contextual problems that stimulate student to learn. This means that the questions presented are not HOTS but LOTS (Lowers Order Thinking Skill) or low-level questions so that student can directly or easily solve the questions in the LKPD. These problems cannot be said to be a problem. This situation has not been able to make student to improve mathematical problem-solving skills.

Examples of LKPD that student use as a reference for learning in mathematics learning in class can be seen from the picture below!

The picture above is an example of one of the LKPD sheets used by student about understanding the derivative material. LKPD gives a little material and goes directly to the sample problem. After the explanation from the teacher and seeing the description of the material from LKPD student work on the existing practice questions in LKPD on the next sheet as individual assignments. So in learning it is not seen working in groups and it is difficult to see the ability of student mathematical problem-solving.

In addition, the conditions that occur in the RPP that are made and used are not as expected. Although the core activities of the teacher have made the steps in the 2013 curriculum such as observing, questioning, reasoning, associating and communicating but not seen what learning model steps are used so that sometimes it is not in accordance with the conditions and needs of student and consequently learning activities do not match what planned. In the RPP it is not seen whether student learn from a problem and student make their own discoveries and make a project. This can be seen in the picture of RPP examples commonly used by teachers as follows.
From the picture above shows that RPP has not seen the syntax or steps of the learning model what the teacher uses. Explanation of the steps of observing, asking, reasoning, associating and communicating is unclear and difficult to understand so that when the teacher is unable come to the other teacher is difficult to replace even though there is already a lesson plan that is seen. RPP should be a reference for teachers in implementing learning activities to be more directed. RPP not only contains teacher activities but also contains student activities to connect mathematical concepts in solving problems.

4. Conclusion

Learning device users are still general in nature and have not been able to make student to improve mathematical problem-solving skills. Participants student rarely use LKPD and if it is not made by the teacher. The LKPD does not present contextual problems that stimulate student to learn. It contains a little material and many questions that haven't given student the opportunity to discuss with friends or groups. Dala m RPP is not a visible step learning model what it is used so often does not correspond to the conditions and needs of students.

References

[1] Undang-Undang Republik Indonesia. 2003 No 20. Sistem Pendidikan Nasional. Jakarta: Depdiknas
[2] Slametto. 2002. Belajar dan Faktor-faktor yang Mempengaruhinya. Jakarta: Rineka Cipta
[3] Abdurrahman, Mulyono. 2003. Belajar Matematika. Jakarta: Bumi Aksara.
[4] Permendikbud. 2014 No 58. Tujuan Pembelajaran. Jakarta: Depdiknas
[5] Wena, Made. 2011. Strategi Pembelajaran Inovatif Kontemporer. Jakarta : Bumi Akasara
[6] Ruseffendi, HET. 2006. Pengantar Kepada Membantu Guru Mengembangkan Kompetensinya
dalam Pengajaran Matematika untuk Meningkatkan CBSA. Bandung: Tarsito.

[7] Permendikbud. 2016 No 22. Standar Proses Pendidikan Dasar dan Pendidikan Menengah. Jakarta: Depdiknas

[8] M. Iqbal. 2017. Penegmbangan LKPD dengan Pendekatan Kontekstual Ditinjau dari Pemahaman Konsep dan Disposisi Matematis. Lampung: Universitas Lampung

[9] Permendikbud. 2014 No 103. Pembelajaran pada Pendidikan Dasar dan Pendidikan Menengah. Jakarta: Depdiknas

[10] Sanjaya, Wina. 2007. Strategi Pembelajaran Berorientasi Standar Proses Pendidikan. Jakarta: Kencana

[11] Sanjaya, Wina. 2007. Strategi Pembelajaran Berorientasi Standar Proses Pendidikan. Jakarta: Kencana

[12] Plomp, Tjeerd. 2013. Educational Design Research: an Introduction. Dalam Tjeerd Plomp dan Nienke Nieven (Ed.). An Introduction to Educational Design Research. Enschede: SLO•Netherlands Institute for Curriculum Development