Assessment Of Problem Solving Abilities And Student Learning Activities Based On Learning Tools: The Basis Of Problem Based Learning Development

Novrita Hidayati, Dony Permana

Abstract: This study purpose to see, observe, study and explain the ability of problem-solving and learning activities of students in learning mathematics and the conditions of learning tools used and developed by teachers. The study used a sequential exploratory design and sampling using a purposive sampling technique. Data collection is done through interviews, observations, and giving tests. Data analysis techniques used descriptive techniques for observing and interviewing data results, and scoring rubrics for mathematical problem-solving skills for test result data. The results showed that the ability to solve mathematical problems and learning activities of students was still not optimally developed. Some of the factors causing this are 1) the difficulty of the teacher in compiling learning devices related to the real-life of students so that learning becomes meaningless, 2) students are accustomed to copying and recording formulas provided by the teacher, 3) mathematical learning models that have not directed the participants students to be actively involved in the learning process and have not guided students to construct their knowledge in improving mathematical problem solving abilities. Based on these results, further action is needed in the form of research into the development of mathematical learning tools based on Problem Based Learning (PBL) to improve students’ problem-solving abilities and learning activities.

Index Terms: PBL, Problem Solving Ability, Learning Tools.

1. INTRODUCTION

The existence of the industrial revolution 4.0 era that emphasizes robotic patterns, digital economy, artificial intelligence, and so on [1], the Indonesian government has tried to prepare Human Resources (HR) which are expected to be able to compete in increasingly sophisticated technological developments. One of the sciences that has an important role in the development of science and technology is Mathematics. Mathematics is seen as a structured and integrated science of study patterns and relationships, and the science of thinking to understand the world around. One of the mathematical abilities that is very important to be achieved by students in learning mathematics is the ability to solve problems [2], [3]. Problem-solving ability is a skill or potential possessed by students in solving problems and applying in daily life [4]. In other words, if a student is trained to solve a problem, he will be able to make a decision, because he has been skilled at how to gather relevant information, analyze that information, and realize how necessary to re-examine the results obtained. With this problem-solving ability, it will become a means for students to hone careful, logical, critical, analytical and creative reasoning so that it is expected to contribute to the development of science and technology in the industrial revolution era 4.0But in reality, when viewed on an international scale, the problem-solving ability in Indonesia is still relatively low. This can be seen from the results of the International Mathematics Competence, the PISA (Program for International Student Assessment) in 2015 concluded that the quality of students in learning mathematics in Indonesia is still ranked 64 out of 72 participating countries [5], [6]. Based on the data obtained that Indonesian students are very good when working on theoretical and rote questions, but when working on problems that have high-level aspects such as reasoning and problem-solving problems they have difficulty to solve them [7]. These results indicate that the ability of students in Indonesia is still below the International average score of 490.

<table>
<thead>
<tr>
<th>Year</th>
<th>Class IX or lower</th>
<th>Class X or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Score</td>
<td>Percentage</td>
</tr>
<tr>
<td>2015</td>
<td>363</td>
<td>53%</td>
</tr>
<tr>
<td>2012</td>
<td>354</td>
<td>48%</td>
</tr>
<tr>
<td>2009</td>
<td>347</td>
<td>55%</td>
</tr>
<tr>
<td>2006</td>
<td>360</td>
<td>52%</td>
</tr>
<tr>
<td>2003</td>
<td>340</td>
<td>64%</td>
</tr>
</tbody>
</table>

Source :PISA Results in Focus

In every learning process activities are needed [8]. This means it can be said that without the activity of the students, the learning process will not occur. Learning activities in schools are very complex and varied. Therefore, teachers must be able to help students develop their behavior patterns, improve their behavior standards, and implement rules as a tool to enforce discipline in every activity. The more diverse activities students develop, the learning process will be more effective and learning outcomes will be optimal [9]. But in reality, in general, mathematics learning in Indonesia is still dominated by activities aimed at achieving mathematical basic skills alone [10]. Learning like this is what ultimately causes mathematics learning activities to merely memorize formulas without being accompanied by thinking skills and problem-solving. Based on these problems, many efforts have been made to improve students’ mathematical problem-solving abilities. Among the research that has been done by Deswita. This research is a development of learning tools in the form of modules that aim to improve student learning outcomes [11].

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Besides, based on experimental research conducted by Padmavathy, R.D shows that problem-based learning has an effect in teaching mathematics and increasing the ability to understand concepts, so students can use these concepts in problem-solving [12]. But this research also has not been able to create active learning in the classroom. Based on literature studies, one way to overcome this problem is to develop learning tools in the form of Learning Implementation Plans and Student Worksheets that are more fun and meaningful for students. The reason for researchers to develop these learning tools is because by making Learning Implementation Plans and Student Worksheets that are prepared by the teacher themselves, learning will be more directed and can optimize learners’ learning activities through activities that have been arranged in the Participant Worksheets Students. Learning models that can accommodate learning tools in the form of Learning Implementation Plans and Student Worksheets, one of which is Problem Based Learning. The choice of Problem Based Learning is driven by several arguments. First, Problem Based Learning is a learning model that helps teachers to relate material to the real situation of students [13], [14]. Second, Problem Based Learning is a learning model that presents real problems that stimulate students to learn [15]. Third, Problem Based Learning can create conditions for students to develop and maintain independent learning skills so that learning is more meaningful, characterized by critically processing subject matter [16]. Fourth, the characteristics of Problem Based Learning focus on problem-solving so that it can help students develop thinking skills and problem-solving skills [17]. The novelty of the research to be carried out can be seen in the following Table 2.

### 2 REVIEW OF LITERATUR

#### 2.1 Mathematics Learning

In essence, learning is an effort made to achieve the development of the potential that exists in individuals who are learning. In mathematics, two objects can be obtained by students, namely direct objects and indirect objects [18]. Direct objects include the ability to investigate and solve problems, learn independently, and know-how to learn. While indirect objects are in the form of facts, skills, concepts, and rules. Based on these theories it can be concluded that mathematics learning is a process of getting the ability to think, reason, communicate, investigate and solve problems. Mathematical learning has a function and purpose [19]. Mathematical learning functions as a tool, mindset, and science. The purpose of learning mathematics is to emphasize the arrangement of the setting and the formation of students' attitudes.

#### 2.2 Problem Solving Capabilities

Problems in mathematics as a problem that students themselves can solve without using a routine method or algorithm [20]. The characteristics of problem-solving problems are as follows:

- **a.** Problems that occur in the real world (the problem is that there aren't problems that are made up).
- **b.** Not routine (questions that have never been solved by students before).
- **c.** Open-ended (problems that can be solved by many strategies but have the same solution or problems that can be solved by many strategies and the solutions obtained also vary).

Mathematical problem-solving abilities of students can be seen through several indicators. In this study the problem-solving indicators used are: 1) Understanding the problem, 2) Planning for problem-solving, 3) Resolving the problem, and 4) Interpreting or concluding solutions to problems.

#### 2.3 Learning Tools

The learning device is a learning component that must be prepared by the teacher as the organizer of the learning so that the learning carried out can run effectively, efficiently, and obtain optimal results. To support the learning process, the component in learning that must be carried out by the teacher is to create a learning tool that can be developed using several learning models, methods, or learning approaches [21]. The learning device component is then adjusted to the needs of the teacher and students who are the users.

### 3 METHOD

This research is part of research and development (Research and Development). The study uses a sequential exploratory design, namely the first stage of data collection using qualitative methods and the second stage of data collection using quantitative methods [22]. The study was conducted at SMAN 2 Siak Hulu with a sample of 30 people. Sampling using a purposive sampling technique. Data collection is done through interviews, observations, and giving tests. The interview was conducted by asking various questions about the problems that occurred during the learning process to several mathematics teachers at SMAN 2 Siak Hulu. Then the observation is carried out by observing the learning process that occurs in the classroom and also to see the learning tools used by the teacher to match the information provided by the teacher with the actual situation and analyze the existing learning devices. Furthermore, an initial test consisting of 2 questions is performed to reveal the problem-solving abilities of students in solving real-life problems on the material they have learned. The analysis technique used will be explained as follows:

#### 3.1 Data Analysis of Interview and Observation Results

Data analysis using descriptive techniques carried out through three stages, namely reducing data, presenting data and drawing conclusions [23]. Reducing data is the process of selecting things or important information by the problem under study. After reducing the data, the data is presented and conclusions are drawn.

#### 3.2 Data Analysis Test the Problem Solving Ability

The answer sheet is checked using the rubric of scoring ability
to solve mathematical problems as shown in Table 3.

4 RESULTS AND DISCUSSION
Based on the results of interviews and observations that have been conducted at the State Senior High School 2 Siak Hulu shows that the ability of mathematical problem solving and learning activities of students is still not optimally developed. Some of the factors causing this are 1) the difficulty of the teacher in compiling learning devices related to the real-life of students so that learning becomes meaningless, 2) students are accustomed to copying and recording formulas provided by the teacher, 3) mathematical learning models that have not directed the participants students to be actively involved in the learning process and have not guided students to construct their knowledge in improving mathematical problem-solving skills, 4) In addition, researchers also obtained data showing that the mathematical problem-solving ability of students at the school is still relatively low. This data was obtained by researchers based on the results of tests of mathematical problem-solving abilities. Overall, the results of these tests can be seen in the following Table 4.

**TABLE 3**
**SCORING RUBRIC ON MATHEMATICAL PROBLEM SOLVING ABILITY**

<table>
<thead>
<tr>
<th>Troubleshooting Indicators</th>
<th>The Details</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Understand the problem</td>
<td>There is no identifying elements that are known, asked, and the adequacy of the data needed</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>There are identifying elements that are known, asked, and the adequacy of the elements needed, but incomplete</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>All elements that are known, asked, and the adequacy of the required elements are completely identified</td>
<td>2</td>
</tr>
<tr>
<td>Planning Problem Resolution</td>
<td>There is no problem-solving plan</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>There is a problem-solving plan, but there are errors</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Prepare a problem-solving plan correctly</td>
<td>2</td>
</tr>
<tr>
<td>Solve the problem</td>
<td>There is no answer at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>There was a settlement but it was not following the settlement plan and the results were wrong</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>There was a settlement that is following the plan but is incomplete</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>There was a settlement that was following the plan but the results were wrong</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>There is a settlement that is following the plan and the results are correct</td>
<td>4</td>
</tr>
<tr>
<td>Interpret or conclude the solution obtained</td>
<td>There are no answers or interpretations at all</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Proof of answers and interpretations but not following the problem</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Proving the answer and interpretation is correct following the problem</td>
<td>2</td>
</tr>
</tbody>
</table>


**TABLE 4**
**PRELIMINARY TEST RESULT OF MATHEMATICAL PROBLEM-SOLVING ABILITIES**

<table>
<thead>
<tr>
<th>Question</th>
<th>Indicator</th>
<th>Achievement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Understand the problem</td>
<td>25%</td>
</tr>
<tr>
<td></td>
<td>Planning problem solving</td>
<td>48%</td>
</tr>
</tbody>
</table>

Based on Table 4 above it can be seen that there is still a small percentage of students who reach the highest score for each indicator. This shows that the ability to solve mathematical problems owned by students is still not optimal as expected. From the results of this observation, the researcher believes that the right solution to overcome this problem is the need to develop learning tools, especially the Learning Implementation Plan and Student Worksheets that can help teachers and students achieve their learning goals and create meaningful learning by providing students with a learning experience. One learning model that can stimulate students to engage in learning experiences so that learning activities are centered on students and can develop their thinking skills in mathematical problem solving is by applying a problem-based learning model or Problem Based Learning or abbreviated with PBL. PBL was first developed by Arrends [24], [25], [26]. The basic principle of the PBL model is to emphasize the importance of context in the given problem. The problem given serves as a starting point in integrating knowledge and developing students’ abilities to solve mathematical problems such as problem-solving skills and critical thinking. The characteristics of PBL are: using problems at the beginning of learning, focusing on interdisciplinary linkages, authentic investigations, producing learning products, and displaying them and working together [27], [28], [29]. Giving a problem based on five important criteria among others: authentic, which means real world, defined with a little loose, nuanced mystery and puzzles, meaningful for students and in accordance with the level of intellectual development of the students, broad enough to allow teachers to confirm learning objectives and benefits the group, and does not impede group efforts [30]. In applying the PBL model, the teacher acts more as a facilitator and encourage each student to participate in learning activities. The teacher as a facilitator may intervene given in the plan but not overdo it. The usual form of problem-based learning is the provision of examples, investigative steps for doing work [31]. The steps in implementing this PBL model: 1) Orienting students to the problem; this aims to provide motivation students in learning in activities to obtain the desired learning objectives, 2) Understanding the problem; this aims to make students actively involved in the learning process, 3) Organizing and presenting the work, and 4) Analyzing and evaluating problem-solving [32], [33]. Based on the description above, PBL can be an alternative solution to improve students’ mathematical problem-solving abilities and learning activities. Synchronization of the two is expected to create superior Indonesian Human Resources (HR) and able to contribute to
the development of science and technology internationally.

5 CONCLUSION
The results revealed that the mathematics learning tools used by teachers in schools are still general and have not been able to facilitate students to develop their concepts, develop thinking skills and improve problem-solving abilities. This is caused by the identification of learning tools used that do not link the subject matter with the lives of students so that learning becomes meaningless. The learning tools used by teachers cannot help students think logically, actively and provoke curiosity to learn mathematics. Based on these results, further action is needed in the form of research into the development of mathematical learning tools based on Problem Based Learning to improve the problem-solving abilities and learning activities of students.

ACKNOWLEDGMENT
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