Analysis of Mathematic Multiple Representations Ability by Applying the Problem-Based Learning Model (PBL) at Tenth Grade Students of SMA N 1 Pegagan Hilir

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ABSTRACT
This study aimed to analyze the ability of multiple representations of mathematical students through the approach of Problem- Based Learning (PBM). The research subject was the students of X MIA 2 SMA Negeri 1 Pegagan , consists of 32 students. The research instrument is a mathematical multiple representations ability test and an interview guide. Data analysis was carried out using the Miles and Huberman model analysis. The results showed: (1) The ability of multiple representations of mathematical students through the approach of PBM obtained that as many as 8 students or 28.125 % in the low catagory , as many as 11 students or 34.375% in the medium catagory and as many as 12 students or 37, 5% in high catagory . Indicators of multiple representations used in this reasearch were explaination, visualitation and mathematical expression. While multiple representations indicators in the form of visualitation indicator was more dominant controlled by the student in completing the test of the ability of multiple representations that have been given by the teacher with the percentage as much as 78.43%, while the explanation indicator from 32 students found that 67.19% of students are able to master the indicator , while the mathematical expression indicator from 32 students found that 55,93% of students are able to master the indicator, and (2) difficulties experienced by students in solving mathematical problems through the approach of PBM is the difficulty of understanding the concept, the difficulty in applying the principle, as well as difficulties in verbal problems.

Keywords: *Mathematical Multiple Representations Ability, Problem-Based Learning.*

1 INTRODUCTION

Education has a very strategic role in the development of a country because the progress of a nation can be measured through progress in the field of education in that country. With education, it will improve one's way of thinking for the better . According to data from the Human Development Index (HDI) in 2017 released by [1] which measures the success of education, the economy, and the quality of the nation that "The quality of education in Indonesia has a score of 0.694 which is still below the world average of 0.728. " Therefore, improving the quality of Indonesian education should continue to be pursued to generate resources human resources quality . High human resources are characterized by the presence of human resources who have reliable capabilities in adapting to face the changing times that are getting faster and have the ability to master science and technology . One of the fields of science that has an important role to master is mathematics .

Cockroft [2] shortly explain that:

> Mathematics needs to be taught to students because (1) it is always used in all life; (2) all fields of study require appropriate mathematical skills; (3) is a means of communication that is strong, concise and

clear; (4) can be used to present information in a variety of ways; (5) improve the ability to think logically, accuracy and spatial awareness; (6) give satisfaction to the effort to solve challenging problems.

To be able to realize the learning of mathematics required a standard process of mathematical ability. The National Council of Teachers of Mathematics [3] states that the ability to represent is one of the standard processes in learning mathematics. "The next five Standards address the processes of problem solving, reasoning and proof, connection, communication, and representation". NCTM determines that there are five standard process of mathematical ability that students need. The abilities that need to be possessed by students include problem solving skills (Problem Solving) , the ability to argue (Reasoning and Proof) , communication skills (Communication) , the ability to use connections (Connections) , and the ability to represent (Representation) .

Representations are expressions of mathematical ideas or ideas that are displayed by students in their efforts to find a solution to the problem they are facing (NCTM, 2013). Dewanto [4] suggests that the impact of dynamic mathematical thinking or learning skills such as reasoning, communication, connection, modeling, and mathematical problem solving, requires a vehicle for communication in verbal or written form. The means of communication can be in the form of single or multiple representations arranged in mathematical language that express or communicate one's ideas to others or themselves verbally or in writing, through graphs, tables, pictures, equations, or other forms.

According to Ainsworth [5] there are three main functions of multi-representation, namely as a complement in cognitive processes, helping to limit the possibility of other misinterpretations, and building a deeper understanding of concepts. In addition to the three main functions above, multi-representation also serves to explore differences in the information expressed by each interpretation. Multiple representations tend to be used to complement each other where a single representation is not sufficient to contain all the information conveyed. There are at least five important reasons why multi-representation is very good for use in learning mathematics, namely: 1) Multi-representation learning helps learners who have different intelligence backgrounds. 2) Quantities and concepts of a physical nature can often be visualized and understood better by using representations. 3) Help construct other, more abstract representations. 4) Qualitative reasoning is often helped by using concrete representations. 5) Abstract mathematical representations can be used for quantitative reasoning where mathematical representations can be used to find quantitative answers to questions.

However, in reality the mathematical representation ability of students in Indonesia is still low. This is shown from the results of a study conducted by PISA [6] in which the ability to represent one of the aspects measured in the mathematical literacy test states that the results of mathematical literacy for Indonesian students are 40.6% below level 1; 31.3% at level 1; 18.6% at level 2; 6.8% at level 3; 2.3% at level 4; 0.4% at level 5 and 0% at level 6. From the PISA data it can be seen that 40.6% are below level 1; 31.3% at level 1 means that as many as 71.9% of Indonesian students have low representation abilities because at level 2 it is measured for representation abilities.

The fact that students' mathematical representation skills are still low is also in accordance with the results of research conducted by Minarni, Napitupulu and Husein [7] which states that the mathematical representation ability of junior high school students in North Sumatra is still relatively low. The low ability of students' mathematical representation is because teachers still use conventional learning models, teachers have not used innovative learning approaches such as PBM which can improve mathematical representation skills.

This is also in accordance with a preliminary study that has been conducted by researchers at the SMA Negeri 1 Pegagan Hilir school to determine the initial abilities of students regarding the ability of representation in the school. one test of mathematical representation ability given by researchers to class X students of SMA Negeri 1 Pegagan downstream as follows:

An officer repairs a lamp on the side of the hiking trail. The officer leaned the ladder against the power pole so that it formed a triangle between the ladder, the pole, and the road. The inner and outer angles between the end of the ladder and the electric pole x^0 and $5x^0$. The angle between the stairs and the road 53^0. What is the angle between the road and the electric pole? What types of triangles are formed by stairs, roads and power poles?

a. Explain what is known and asked in the above situation
b. Draw a picture that can help you solve the problem above.
c. Write down the steps to solve the problem above in your own words

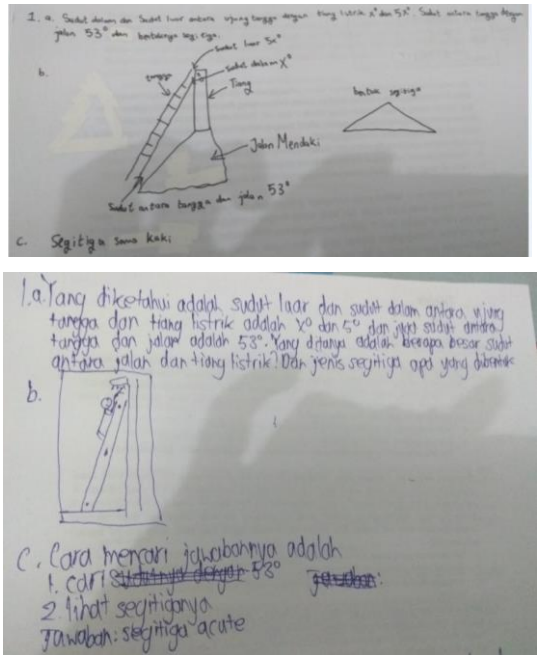

Figure 1. The answer

From the answer process above, we can see that the multi-representation ability of students is still low. From the answer process, it can be seen that students have not been able to make image representations correctly and at the same time students have not been able to represent problems with word representations. Based on data from the low ability students' mathematical representation of the above, it is also menanunjukan that the low ability of multi-representation of students (multiple representation). This is because using multiple representations requires an understanding of the concept to bridge one representation to another . The difficulty of students in learning mathematics contextually is caused by the learning process that is not in accordance with the characteristics of students and is still conventional. The learning process that is not suitable will cause the students' mathematical abilities not to increase, including the ability to mathematical representation. In addition, the learning process applied is still teacher-oriented so that it is not able to make students active in learning, does not encourage students to develop mathematical abilities including their mathematical representation abilities, and does not support students' self-efficacy .

From the description of the problem above, efforts are needed in learning mathematics. To have the ability to have multiple representations and good self-efficacy in learning, it is necessary to make efforts to train and cultivate it in students. Therefore, the teacher must find the right learning to overcome this problem . One of the learnings that can be assumed to be able to increase the ability of multiple representations and self-efficacy of students is through the Problem Based Learning (PBM) approach .

2 LITERATURE REVIEW

2.1 Mathematical Representation Ability

Mathematical ability is the ability to deal with problems both in mathematics and in real life. Mathematical abilities must be possessed by students to be able to solve a problem. Lestari & Yudhanegara [8] state that mathematical representation ability is the ability to present notations, symbols, tables, pictures, graphs, diagrams, equations or mathematical expressions consisting of visual representations, images, text, equations or mathematical expressions . Mathematical ability is defined by NCTM (1999) as, " Mathematical power includes the ability to explore, conjecture, and reason logically; to solve non-routine problems; to communicate about and through mathematics; and to connect ideas within mathematics and between mathematics and other mathematics. intellectual activity " . Furthermore, based on the purpose of learning mathematics in Indonesia implied that the mathematical abilities include: 1. The ability to problem solving (problem solving), 2. ability to argue (reasonning) , 3. ability to communicate (communication), 4. The ability to make a connection (connection), 5. The ability to represent (representation).

Hudiono [9] states that the ability of representation can support students in understanding the mathematical concepts studied and their relationships; to communicate students' mathematical ideas; to get to know the connections (connections) between mathematical concepts; or apply mathematics to realistic mathematical problems through modeling. Hutagaol [10] mentions that the mathematical representations raised by students are expressions of mathematical ideas or ideas displayed by students in their efforts to understand a mathematical concept or in their efforts to find a solution to the problem they are facing. Thus , representation can be used as a means for students to understand certain concepts and to communicate mathematical ideas to solve problems. The role of representation is described by NCTM (2000: 280) as follows:

> "Representation is central to the study of mathematics. Student can develop and deepen their understanding of mathematical concepts and relationships as they create, compare, and use various representations. Representations also help students communicate their thinking".

According to the NCTM (in Teacher Professional Development and Classroom Research Across the Curriculum), representations help describe, explain, or extend a mathematical idea by focusing on its important

features. Representations include symbols, equations, words, pictures, tables, graphs, manipulative objects, and actions as well as mental, internal ways of thinking about mathematical ideas.

Students' mathematical representation ability can be measured through several indicators of mathematical representation ability. The indicators of students' mathematical representation according to Amelia [11] are as follows:

a. Visual representation.
b. Mathematical equations or expressions.
c. Written words or text.

2.2 Mathematical Mutiple Representations Ability

Darmastini [12] states that multi-representation is the use of various representations in solving a problem. Ainsworth [5] stated that some researchers found students failed to understand the importance of connecting various representations. This explains that to solve a problem sometimes it is not enough just to have a single representation but several forms of representation are needed. Lesh [13] suggests 3 stages of the procedure for solving mathematical problems, the first stage is translating the problem into mathematical form, the second stage changing the mathematical form into arithmetic symbols, and the last stage explaining the solution by writing words or explanations. Lesh emphasizes the importance of multi-representation skills in problem solving. Dewanto (2008) states that in the process of its formation, multiple representations do not occur in an isolated space, but are formed in a structured system. For example, one or several mathematical objects, through the help of mathematical tools such as language, symbols, graphics and artifacts, form a multiple representation of these mathematical objects which then form a more meaningful mathematical understanding for students. As an implication to gain a meaningful mathematical understanding, they should be trained to be able to represent a problem in a variety of different ways and then proceed with being trained to solve problems or find solutions to problems from a point of view or perspective. From some of the opinions above, it can be concluded that the ability of multiple mathematical representations is a mathematical ability possessed by students by using more than one representation to solve mathematical problems or problems.

2.3 Problem Based Learning (PBM)

According to Tan in Rusman [14]"Problem-based learning is the use of various kinds of intelligence needed to confront real-world challenges, the ability to face everything new and existing complexities". While Wena [15] argues that, "Problem-based learning strategy is a learning strategy by confronting students with practical problems as a foothold in learning or in other words students learn through problems". According to Zainal Aqib [16]: Problem Based Learning (PBL) is a learning approach that uses real-world problems as a context for students to learn through critical thinking and problem-solving skills in order to acquire knowledge and concepts that are essential from learning materials.

Based on the theory developed by Barrow, Min Liu in Muiz [17], explains the characteristics of PBM, namely:

a. Learning is student-centered

   The learning process in PBL focuses more on students as learning people. Therefore, PBL is also supported by constructivism theory where students are encouraged to be able to develop their own knowledge.

b. Authentic problems form the organizing focus for learning

   The problem presented to students is an authentic problem so that students are able to easily understand the problem and can apply it in their professional life later.

c. New information is acquired through self-directed learning

   In the problem solving process, students may not know and understand all the prerequisite knowledge, so students try to find their own through the source, either from books or other information.

d. Learning occurs in small groups

   In order for scientific interaction and exchange of ideas to occur in an effort to build knowledge collaboratively, PBM is carried out in small groups. The group created demands a clear division of tasks and clear goal setting.

e. Teachers act as facilitators.

   In the implementation of PBM, the teacher only acts as a facilitator. However, even so the teacher must always monitor the progress of student activities and encourage students to achieve the targets to be achieved.

3 RESEARCH METHODS

The type of research used in this study is qualitative research with a descriptive approach, meaning research that describes what it is about a variable, symptom, or situation [18]. This research was conducted at SMA Negeri 1 Pegagan Hilir. Subject penel itian are class X

students who are 32 students. Criteria for making the subject by using criteria that is berdas arkan indicator of the ability of students and cases Alahan answers . In terms of indicators, students' answer sheets are grouped into three categories of answers, namely high, medium and low abilities . The third category of student answer sheets each were analyzed by p ola dominant answers to selected students as subjects interviewed. The object of this research is the ability of multiple mathematical representations and students' Adversity Quotient through a Problem Based Learning approach . The instruments of this research are multiple representations mathematical ability tests , self-efficacy questionnaires and interview guidelines. Data analysis was carried out using the Miles and Huberman model.

To find out the students' mathematical multiple representations ability, it can be done by analyzing the answer sheets of all students. The analysis was carried out by referring to the scoring guidelines adapted from Facione [19] which consisted of four indicators of representational ability as well as information and scores obtained. The guidelines for giving scores can be seen in Table 1 below

Table 1 Guidelines for Scoring Multiple Representation Skills

Score	Indicator		
	Explain	**Describing**	**Mathematical expression**
0	There is no answer, even if there is it only shows a lack of understanding of the concept so that the information provided does not mean anything.		
1	Only a few of the explanations are correct.	Only a few of the pictures or diagrams are correct	Only a few of the mathematical models are correct
2	The explanation is mathematically plausible but only partially complete and correct	Draw a diagram or picture but it is not complete and precise	Finding the mathematical model correctly but wrong in getting the solution
3	The explanation is mathematically plausible, even if it is not logically structured or there are few grammatical errors	Complete and correct diagrams or drawings	Find mathematical models and perform calculations or get correct and complete solutions
4	Mathematical explanations are reasonable and clear and logically and mathematically arranged	Painting diagrams or pictures completely, correctly and systematically	Find the correct mathematical model then perform calculations or get a correct and complete and systematic solution.

To determine whether students meet each indicator of mathematical representation ability or not in solving problems contained in math problems, it can be seen from the following percentage values.

$$\text{Percentage Value} = \frac{\text{Skor Perolehan}}{\text{Skor Maksimal}} \text{x } 100\ \%$$

The percentage value of mathematical representation ability obtained from the calculation is then categorized according to the following table.

Table 2 Category Percentage of Multiple Representation Ability

Value Intervals (%)	Category
$81{,}25 < X \leq 100$	Very high
$71{,}50 < X \leq 81{,}25$	High
$62{,}50 < X \leq 71{,}50$	Medium
$43{,}75 < X \leq 62{,}50$	Low
$0 < X \leq 43{,}75$	Very low

4. RESULTS AND DISCUSSION

In the learning process that has been carried out for four meetings in class X MIA 2 SMA N 1 Pegagan Hilir that the ability of multiple representations and self-efficacy of students is getting better after the implementation of the Problem Based Learning approach compared to conventional learning that has been taught to students before because during learning every students are able to change the context of the real world into mathematical models, then each student gives his/her ideas to the group in solving math problems, then most students interact between students and teachers if there is a misunderstanding experienced by students. During learning through the Problem-Based Learning approach, students' self-efficacy is better than before because of the good fighting power shown by students in solving given contextual problems and being able to survive in difficult conditions and not easily give up in solving these problems.

Based on the explanation above, the Probem Based Learning approach can be used as an alternative learning that can develop students' mathematical multiple representations skills and students' self-efficacy . This can be seen from the following explanation.

The multiple representations ability test was carried out by students individually and supervised directly by the researcher and fellow mathematics teachers at SMA N 1 Pegagan Hilir. The level of ability for multiple representations can be seen in Table 3.

Table 3 Students' Mathematical Multiple Representations Ability Level

Value Intervals (%)	Many Students	Percentage	Category
43.75 - 62.50	9	28.125%	Low
62.50 – 71.50	10	31.25%	Medium
71.50 – 81.25	13	40.625%	High
amount	**32**	**100%**	

Based on the table, it can be seen that the level of students' mathematical multiple representations ability through the Problem Based Learning approach is good because 11 people are in the medium category and 12 people are in the high category. However, there are still 9 people who are in the low category.

Meanwhile, to find out the percentage of each multiple representations indicator for the 5 questions that have been given, it can be seen in Table 4 below.

Table 4 Percentage of Each Indicator Multiple Representations

Multiple Representations Indicator	Total score	Percentage
Explain	430	67.19%
Describing	502	78.43%
Mathematical Expression	358	55.93%

In Table 4, it can be concluded that the describing indicator is more dominantly controlled by students in completing the multiple representations ability test that has been given by the teacher with 78.43%, while the indicator explaining from 32 students it was found that 67.19% of students were able to master the indicator. , and for the mathematical expression indicator 55.93%

Then to determine s when self-e fficacy can dil Ihat of questionnaire answers 35-point declaration consists of 20 statements positive and 15 negative statements. The scoring for each response choice is given a score of 1,2,3,4 and 5 for the answer choices strongly disagree (STS), Disagree (TS), Doubtful (RG), agree (S) and strongly agree (SS) on negative statements, while for positive statements scores of 5,4,3,2, and 1 for the choices strongly agree (SS), agree (S), Doubtful (RG), Disagree (TS), and strongly disagree (STS). The Self-Efficacy Scale is given after the implementation of learning using the Problem-Based Learning approach. The results of Self-Efficacy can be seen in the appendix. This Self-Efficacy Scale is given to determine the Self-Efficacy of students after the implementation of learning. The following will explain the analysis of the results of the Self-Efficacy scale in Table 5

Table 5 Percentage of Student Self-Efficacy Criteria

No.	Score Range	Total students	Percentage	Criteria
1.	X > 140	6	18.75%	Very high
2.	116<X≤ 140	16	50%	High
3.	93< X 116	10	31.25%	Medium
4.	70< X 93	0	0%	Low
5.	X 70	0	0%	Very low

from the table it can be concluded that from the results of the self-efficacy questionnaire that as many as 6 students are in the Self-Efficacy score range of 140 belonging to the very high self-efficacy criteria with a percentage of 18.75%, as many as 16 students are in the score range 116<X≤ 140 with high self-efficacy with a percentage of 50% , then in the score range of 93 < X 116 there are 10 students for moderate self-efficacy criteria with a percentage of 31.25% .

5. CONCLUSION

Based on the results of the analysis and discussion in the study, several conclusions were put forward as follows.

1. The ability of students' mathematical multiple representations through the Problem-Based Learning approach was obtained that the number of students who obtained a score interval of 43.75 – 62.50 in the low category was 9 students or 28.125%. Then the number of students who are in the interval 62.50 – 71.50 with the medium category as many as 11 students or 34.375%. Furthermore, for the interval value of 71.50 – 81.25 in the high category, there were 12 students or 37.5%. For students with high multiple representations ability , they are able to know the meaning of the problem in the problem and can represent data/information from the problem, are able to make visual representations that are already able to sketch pictures about the problem, and are able to write mathematical expressions in the form of appropriate trigonometric concepts and solve problems. . Meanwhile, students with moderate multiple representations ability are able to verbally represent the data/information in the problem although it is still not precise and complete, able to represent visually by making sketches of the problem, and able to use mathematical expressions to solve problems but are less precise so that errors occur. Meanwhile, the ability of multiple

representations with low ability has not been able to meet the indicators of the ability of multiple representations such as not being able to write/represent verbally problems, and being able to make image representations but it is still not correct.

2. The multiple representations indicator in the form of describing is more dominant with a percentage of 78.43% achieved by students for this indicator, this proves that students are more likely to easily represent a problem visually through pictures than to explain it again in their own words or make mathematical expressions from other representations. . Then on the indicator explaining as much as 67.18% of students were able to explain verbally through written information on the problem and for the indicator of mathematical expression it was found that the percentage of 55.93% of students was able to be able to express mathematical expressions in the form of trigonometric concepts that were in accordance with the problem.

CONTRIBUTING PARTIES

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