Student’s mathematical understanding ability based on self-efficacy

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Abstract. Materials in mathematics are provided not only as an ability to memorize, but also to train the ability of mathematical understanding. Students’ mathematical understanding ability is influenced by the students’ belief in solving the given problems. This research aims to determine the mathematical understanding ability of junior high school students. This research is descriptive qualitative research. Data collection was done through a test, questionnaire, and interview. The result showed that students with high self-efficacy category could master the three indicators of students' mathematical understanding ability well, namely translation, interpretation, and exploration. Students with moderate self-efficacy category can master translation indicator and able to achieve interpretation indicator but they unable to reach exploration indicator. Students with low self-efficacy category only master the translation, but they cannot achieve the interpretation and exploration indicators. So, the students who have high, moderate or low self-efficacy master the indicator of mathematical understanding based on the level of understanding capabilities on each student.

1. Introduction

Mathematics is the science for developing scientific situations, drawing conclusions as well as solving problems. Mathematics also promotes the habit of accuracy, logical, systematic and order arrangements \cite{1}. Currently, not a few students who view mathematics as a subject that is boring and terrifying. Many students find difficulty to understand mathematics. It affects students’ low achievement. The absorption capacity of junior high school students in Karanganyar District has the lowest absorption of 42.01% at the district level, 40.26% at the provincial level, and 47.19% at the national level \cite{2}. Mathematical understanding is a very important part in understanding mathematical problems and problems in daily life \cite{3}. A meaningful understanding of learning mathematics should be directed at developing the mathematical connections between different ideas, understand how mathematical ideas are interrelated to one another there by building a thorough understanding and use of mathematics in contexts outside of mathematics \cite{4}.

Students' difficulties in proving, most of them were caused by their lack of understanding of mathematical concepts and definitions so that they were unable to construct a mathematical proof and to write mathematical notation or to use mathematical language correctly. It is obvious that students' mathematical proving abilities are associated with their mathematical understanding abilities \cite{5}. Bloom divides the aspects of understanding into three kinds of understanding, namely: translation,
interpretation, and exploration [6]. Translation is an ability to understand an idea expressed in another way from the original statement. For example, students can change the story into a mathematical sentence, interpretation is an ability to understand and connect the material or ideas that have been known then explain the problem in detail, and exploration is an understanding that expects a person can make conclusions and provides views on the problem. Knowing the ability of students' mathematical understanding is an indispensable thing because by knowing the ability of the student's, the teacher knows the difficulties faced by students. Based on that case, the teacher can design the right learning so that the subject matter can be delivered well and student achievement can increase. This is by Tambychik's opinion that understanding of difficulties faced by students is crucial and attention on specific mathematics skills may lead to more meaning teaching and learning process [7].

Many students consider that mathematics is a difficult subject so that students do not think deeply in receiving the material. The difficulty of a mathematical problem depends on how students' belief in dealing with it. One important part about self-belief is self-efficacy. Self-efficacy is the reflection of an individual's belief in his or her capabilities to complete tasks [8]. Self-efficacy is the expectation of how far one can perform one behavior in certain situations [9]. Thus, it can be concluded that self-efficacy is a person's belief in certain abilities and how to overcome obstacles. According to Bandura, self-efficacy influences human action through cognitive, motivational and affective processes and are specific to a given domain or context. When people believe that they possess the required capability to accomplish a given task, greater effort and perseverance will be made for goal achievement [10]. Self-efficacy can be grown and studied through four main sources of information, the namely experience of success, vicarious experience, verbal persuasion and physiological state [11]. While Bandura explains that self-efficacy consists of several dimensions, namely Magnitude, Strength and Generality [12]. Magnitude focuses on whether the individual believes that the task begins with a difficulty level of the task, from the moderate up to the most difficult level. Strength reflects an individual's confidence at completing the various components of the task or at various levels of difficulty. Generality is the extent to which self-efficacy on one task generalizes to other tasks or domains. Generally, It is important to understand how self-efficacy estimates on one task generalize to other related tasks, such as academic domains [13].

The results of Lambertus’s research shows that the ability of mathematical understanding of students learning to use open-ended approach significantly better improvement of the ability of students' mathematical understanding using conventional learning [3]. Tambychik’s research show that respondents lacked in many mathematics skills such as number-fact, visual-spatial and information skills. Information skill was the most critical [7]. Pirie and Martin’s show that a teacher must realises that students have different strategies and abilities for finding, collecting, and using their previous understandings, is in a position to consider the best of actions [14]. In addition, Zedan and Bitar’s research show that a strong positive correlation between mathematical self efficacy and achievements in mathematics [15]. However, Lilian’s research show that effort failed to predict academic achievement, effort could only be regarded as an indirect factor but not a necessary factor in bridging the relationship between attitude, self-efficacy and academic achievement [16]. Based on the explanation above, the purpose of this study is to describe the achievement of each indicator of the mathematical understanding ability of 8th-grade senior high school students based on self-efficacy category, namely high, moderate, and low self-efficacy.

2. Method

Type of this research used is descriptive qualitative in the form of a description explaining on how students’ understanding ability based on their self-efficacy. The study was conducted in the even semester of the academic year of 2016/2017 in SMP Negeri 3 Karangunyar. Research subjects taken used purposive random sampling technique based on students’ self-efficacy category given in class VIII A which amounted to 32 students. Selected three research subjects each one subject from high, moderate, and low self-efficacy categories. The subject of the study was given a test of students’ mathematical understanding ability and conducted an interview to find out how the students'
mathematical understanding ability. Subject one is symbolized (S1), subject two is symbolized (S2), and subject three is symbolized (S3), while the test error is symbolized by (F). Table 2.1 is a way to determine high, moderate, and low self-efficacy.

Table 2.1 Measurement Scale of Students’ Self-Efficacy Category [17]

| No. | Interval                        | Category |
|-----|---------------------------------|----------|
| 1   | \( x_i > \bar{x} + 0.5s \)    | High     |
| 2   | \( \bar{x} - 0.5s \leq x_i \leq \bar{x} + 0.5s \) | Moderate |
| 3   | \( x_i < \bar{x} - 0.5s \)    | Low      |

Note:
- \( x_i \): Students’ self-efficacy scores of each respondent
- \( \bar{x} \): Average self-efficacy score of all sample students
- \( s \): Standard deviation of the entire sample

3. Result and Discussion

The self-efficacy category was obtained based on the total score of the self-efficacy measurement scale. Based on that measurement, the score \( x_i > 99.57 \) is a high self-efficacy, \( 99.57 \leq x_i \leq 90.31 \) is a moderate self-efficacy, and \( x_i < 90.31 \) is a low self-efficacy. The test of students’ mathematical understanding ability in this research is a test used to find out how the students' mathematical understanding ability is based on the aspect of translation, interpretation, and exploration of the material of cube and beam. Interviews were conducted to confirm the answers to students' mathematical understanding test so that the researcher could find out whether between test answers and interviews is consistent. The following is items to measure students' mathematical understanding skills.

1. Father will make a cube box made of wood. If the father has wood which its surface area is 1.350 cm\(^2\), then how long is the length of the cube that should be made by the father?
2. Amira has a rectangular box with a length of 15 cm, height 10 cm, and volume 900 cm\(^3\). If Amira would cover the box using paperboard, then how much paperboard does Amira need?
3. Ibnu has a cube aquarium with a surface area of a cube base 1.6 m. If Ibnu will fill up as much water as \( \frac{3}{4} \) of the entire volume of the aquarium, then how many liters of water is needed by Ibnu?

The students’ mathematical understanding test is based on the students' mathematical comprehension aspects of translation, interpretation, and exploration. Interviews were conducted to confirm and obtain more in-depth information. Following will be presented an answers analysis of students’ mathematical understanding and interviews toward research subject based on high, moderate, and low self-efficacy categories.

3.1. High Self-Efficacy Subject Analysis

![Figure 1. S1N1’s answer](image1)

![Figure 2. S1N2’s answer](image2)

![Figure 3. S1N3’s answer](image3)
Figures 1, 2 and 3 show that students write what is known by symbolizing the area of the surface using the symbol \( L_p \), the symbolized length \( p \), the symbolized height \( t \), the symbolized volume \( p \), and the symbolized surface area by the kell. S1 can write down what is being asked correctly. This shows that translating the story into another language to make the problem can be more easily understood by using a certain symbol so that students can determine the right concept to solve the problem correctly [6]. By Patrick’s opinion that a variety of internal representations; verbal/syntactic, imagistic, symbolic. We link together these separate representations to create a more complex understanding of that concept [18]. At the time of interview, S1 can explain again the meaning of the symbols and visible to understand the purpose of the three questions.

Students are required to be able to interpret the problem and connect the things that are known with the concept that will be used in finding solutions to the problem. In the beam and cube material, there are several concepts of surface area and volume as well as concepts related to cube beams, for example, the surface area and circumference of square and rectangle. Based on students' answers, students can interpret and define concepts used in solving problems. By Anderson's opinion that interpreting occurs when students can convert information from one representation to another representation. Interpretation involves the conversion of words into words, images into words and so on [3][18]. Answer number 1, S1 uses the concept of surface area to find the length of the cube frame. S1’s answer in solving problem number 2 that is to search the width first using the concept of the beam volume. After the width is obtained then look for the surface area of the beam. While the answer number 3, S1 answer by changing the circumference unit from m to dm because it is asked in the form of a liter. Then by using the concept of a rectangular circumference, the length of the base of the cube is obtained. After that S1 looking for the required volume of water is 3/4 times the cube volume. At the time of the interview, S1 can explain again the answer process in order on each answer. Students can explain why they choose to use that concept in solving the problem.

Students calculate by applying the things that are known and the concepts that have been determined. Based on the three questions answered by the students, students are able to determine the exact concept that obtains the correct results on the three questions. As Tambychik’s opinion that the ability to create meaningful perceptions for logical thinking and effective use of memory is an important factor in learning skills and problem-solving [7]. At the time of the interview, students can explain the results of the answer; it means that students understand what has been done. When the researcher asks questions about the surface area and the volume of cubes and beam, S1 can answer them correctly and give examples of other real-life problems. Based on the above explanation can be seen that the student persistence in working on the problem so that students with high self-efficacy can master these three indicators, namely translation, interpretation, and extrapolating the research corresponds to Pintrich found that there are positive correlations between self efficacy and persistence [15].

3.2. Moderate Self-Efficacy Subject Analysis

![Figure 4. S2N1’s answer](image1)

![Figure 5. S2N2’s answer](image2)

![Figure 6. S2N3’s answer](image3)
Figure 4, Figure 5, and Figure 6 show that students can understand the problem well because S2 can write down what is known, what is questioned by using a particular symbol. It means that S2 can reinterpret the story in a simple language using certain symbols. Kilpatrick stated that representations could be used to understand the mathematics [19]. Similar to S1, S2 also uses Lp for surface area, p for length, t for height, V for volume and kel for circumference. At the time of the interview, S2 said that he understands what is being asked. No words are not understood on the item.

Answer number 1, S2 uses the concept of the surface area of the cube to look for the length of the frame. At the time of the S2 interview can also explain again about the test answers. Students also answered that 15 were derived from root 225. This type of problem is an easy item category and usually exemplified by the teacher. The answer number 2, S2 uses the concept of surface area of the beam. Researchers suspect because the question is the surface area, so S2 directly apply the concept of surface area of the beam, meaning S2 does not understand the meaning of each concept on cubes and beams material. Another error is indicated by F2 indicating that the positive 150 which lies on the right side when moving to the left segment remains positive, it should be the switching of the segment changes so that it becomes 450 - 150. At the time of the interview indicates that S2 understands what is being asked. S1 knows that width is unknown, but S2 is confused how to find width using which concept. When the researcher asks the surface area formula, and the volume of the beam S2 can answer correctly. This means that students use memory in memorizing a concept so when they faced with problems that only use one concept, S2 can do correctly, but when faced with problems that use some concept which S2 have not understood. This is in by the Nathan opinion which says that inability to connect conceptual aspects of math, difficulty to make sense of connection between information, incomplete understanding of mathematical language and difficulty in comprehend and visualizing mathematical concept might result in difficulties [7]. When the researcher asks questions that lead to solving problem solutions, students can follow well. This means that students understand the elements of each concept, the students are just lazy to think well. According to the opinion of Pirie as saying that students realize that they have understanding or bills but not immediately accessible, then it should be repeated back to a more basic understanding [14].

Figure 6 shows that S2 writes what is known and questioned but S2 can not provide the right solution in solving the problem number 3. S2 writes V = p × 1 × t, meaning that S2 knows the concept of finding the volume is the length multiplied by the width multiplied by the height. S2 has also changed 1.6 m to 16 dm, but S3 looks confused on how to determine the solution so that S2 answer 3/4 × 16 = 12. Based on the results of the interview, it shows that S2 understand what is asked but S2 confused to determine the solution in solving the problem. Students cannot determine the right concept in solving the problem, because students do not think well about the elements are known and unknown. So students cannot determine the right conclusions in determining the solution of each problem. When doing an interview, students are not able to make a right conclusion in solving mathematical problems. So the students must do more practice.

3.3. Low Self-Efficacy Subject Analysis

![Figure 7. S3N1’s answer](image1)
![Figure 8. S3N2’s answer](image2)
![Figure 9. S3N3’s answer](image3)
Figure 7, Figure 8, and Figure 9 show that students can write down what is known and asked well. S3 write the same symbols with S1 and S2. At the time of the interview, S3 said that he understood the purpose of the three problems and there are not difficult words.

The process of answer number 1, on the third line the researcher is unsure the result of S3 because S3 immediately writes root 225. At the time of the interview, S3 looks difficult in explaining again the process of the S3 answer. S3 cannot answer where the root 225 comes from. Figure 8 shows that S3 cannot solve the problem. S3 writes surface area = p x 1 x t, it supposed to the concept of surface area of the beam namely 2 x (p x 1 + t + p x t). Figure 9 shows that S3 writes 3/4 x 16 = 48/4 = 12. Students with low self-efficacy categories indicate that students cannot relate the things that are known to be able to determine the concepts used in solving mathematical problems. By Kadir's opinion that students feel difficult in mathematics because they have difficulty understanding and retrieving concepts, formulas, facts, and procedures [20]. When the interview was conducted the students also cannot mention the concepts of the cube beam material. When the researcher leads the students to get the right solution in solving the problem, the students cannot follow it well. S3 just smiled and replied "oh, yes ma'am. I forgot ma'am ", so it is clear that students cannot make conclusions in determining the right solution in solving the problem.

4. Conclusions and Suggestions

Based on the results of research on students' mathematical understanding in class VIII, it can be drawn some conclusions, as follows. Students with high self-efficacy category can master the three indicators of students' mathematical understanding ability well, namely translation, interpretation, and exploration. Students with moderate self-efficacy category can master translation indicator and able to achieve interpretation indicator but they unable to reach exploration indicator. Students with low self-efficacy category only master the translation, but they cannot achieve the interpretation and exploration indicators. The results of this study are expected to give information to the school, especially for the teachers about the ability of students' mathematical connections. Related to the findings that exist, students, mathematical connection ability is very important to have. Therefore, with this research, the teacher can design a good learning process to improve students' mathematical connection ability so that students’ achievement will be achieved well.

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