Analysis of Students Mathematical Understanding Viewed from Visual and Visual-Auditory Learning Styles

Mustika Annisa¹*, Hasanah Aan², Herman Tatang³

¹Program Studi Pendidikan Matematika, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia.
²Program Studi Pendidikan Matematika, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia.
³Program Studi Pendidikan Matematika, Sekolah Pasca Sarjana, Universitas Pendidikan Indonesia, Jl. Dr. Setiabudi No. 229, Bandung 40154, Indonesia.

*annisamustika@upi.edu

Abstract. Student learning styles can determine the level of mathematical understanding. Skemp categorized two types of mathematical understanding based on student's abilities, namely relational understanding and instrumental understanding. This research aimed to determine the student's mathematical understanding of quadratic equation concept based on Skemp's mathematical understanding theory viewed from visual learning styles and auditory learning styles. The method used in this research was a qualitative approach and the subjects in this research is two senior high school students in grade 10 with visual and auditory learning style. The instruments used in this research were learning style tests, mathematical understanding concept tests and interviews. The results of the research showed that the level of conceptual understanding of student with visual learning styles was similar to student with visual-auditory learning styles which were on relational understanding. Student with visual learning styles wrote the answers briefly, this was because the student first imagined or provided illustration images before writing each step in solving the problem and able to explain the reason for each answer, while student with visual-auditory learning styles directly apply each formula that they remembered in solving questions with longer answers and preferred to explain each answer written instead of using words in solving problems. Therefore student with visual learning styles and student with visual-auditory learning style had good abilities in understanding mathematical concepts. They not only memorized formulas but also provided reasons for each formula used. This research is expected to provide additional information to the teacher about the student's mathematical understanding viewed from the differences of learning style so that the teacher can adjust to the appropriate learning methods.
1. Introduction

Education is one of the absolute needs that must be developed in line with the demands of developing a country. Education that is well-managed, orderly, organized and efficient will accelerate the achievement of the progress of the nation both in terms of generation and technological development. Every teacher must be able to prepare students who can encounter problems that will occur in the Industrial Revolution 4.0. Students are required to have good problem solving skills and accustomed to critical thinking. This ability was seen from the process of students’ success to be managed mathematical concepts that have been mastered with the context of the problems they have.

Learning was focused on mathematical understanding is fundamental and important to make students able to complete new forms of every problem they encounter both now and in the future.

The importance of understanding mathematical concepts is seen in the objectives of mathematics learning according to Permendiknas No. 22 of 2006, namely understanding mathematical concepts, explaining the interrelationships between concepts and applying concepts or algorithms flexibly, accurately, efficiently and precisely in problem solving. In accordance with the learning objectives of mathematics students are required to be able to understand a mathematical concept and apply it to each mathematical problem solving. Therefore it is very important for the teacher to be able to really know how far the students understand.

Mathematics emphasizes concepts, meaning that in mathematical learning students must first understand mathematical concepts in order to complete and apply the learning to the real world. The concept as a form of words used to determine the concept itself, one can learn concepts through memorization or meaning, and through similar previous concepts (Tall, de Lima & Healy, 2014; Philip, 2000; Didis, 2018). Furthermore Skemp (1976) explains that mathematical understanding is the ability to associate mathematical notations and symbols that are relevant to mathematical ideas and combine them into a series of logical reasoning. Thus mathematical understanding is a behavior that students have to be able to understand, understand, interpret and explore well a concept that he has received into his memory, so students can apply it and restructure it using words or symbols of their own choosing.

One theory of mathematical understanding that can be used by teachers to be able to distinguish which students really understand students who actually do not understand is the theory of understanding Skemp. According to Skemp so that learning becomes more useful for each student, the general traits of a student's experience must be integrated to form a conceptual structure or a scheme (Skemp, 1987). Students build schemes to connect what they already know with new learning and knowledge. Skemp categorizes two understandings, namely relational understanding and instrumental understanding. Relational understanding occurs when students can determine the outcome of a problem and can explain the reason for the answer. While instrumental understanding occurs when students can only find the results of a problem but cannot explain the reason for the answer. According to Skemp the very appropriate category in the concept of understanding is relational understanding (Skemp, 1976).

There are seven indicators of relational understanding according to Skemp and researchers only take three indicators, namely, (1) the ability to restate the concepts learned; (2) Ability to
provide examples of concepts learned; (3) The ability to present concepts in the form of mathematical representations. In addition to seeing relational understanding, researchers will also look at the categories of student understanding that are still in the stages of instrumental understanding, students who understand instrumentally will be able to recall things about basic facts, terms or routine things. For example students can recite clearly the concepts that he has previously learned, can write, simplify, solve routine and other questions even though he does not understand why the concept should be used.

The inability of students to be able to absorb well each mathematical concept can be caused by several factors, one of which is the learning style possessed by students. Every child has the characteristics of different brain abilities in absorbing, processing, and conveying information. The absorption of information will depend on experience during the learning process. According to Wyatt & Lopper (1999) a person can absorb 10% of the information he reads, 20% of what he hears, 30% of what he sees, 50% of what he sees and hears, 70% of what was presented and 90% was obtained from what was said and done. Thus the absorption of a person will increase if the process of receiving information is done by seeing, listening, being able to express any information obtained and being able to do direct simulations in processing meaningful information.

Since the 1980s until now there have been many ways to do to recognize and categorize learning styles. In the 90s, emphasis was placed on the way teachers know students’ learning styles through adjustments to the curriculum that combines each style and provides equal opportunities for students to learn (Sreenidhi & Helena, 2017). According to DePorter & Hernacki (2010), learning styles are a combination of ways a person absorbs information, then organizes information, and processing that information becomes more meaningful. Information will be more quickly received by the brain if it is in accordance with a person’s learning style or recipient of information.

Venugopal & Swapna (2009) suggest that students who are aware of learning styles will use different learning styles to get better learning outcomes. Therefore it is very important for a student to know his learning style, so that he can adjust to a more effective learning process. There are three types of learning styles, namely visual, auditory and kinesthetic. Visual learning styles tend to be more interested in color, prefer writing, see pictures of things they learn. Auditory learning styles have a tendency to easily capture material through sound form, discuss with friends and memorize. Kinesthetic learning styles have a tendency to involve movement and touch (hands-on activity) in learning something, such as exploring in an experiment.

One of the mathematics lessons that involves a lot of understanding of concepts, procedures and computation that is very much needed in other mathematical material is quadratic equations. The success of students in solving the problem of quadratic equations can be seen if students can solve the problem correctly and according to the concept. The standard definition of quadratic equations is usually only presented in its general form, namely \(ax^2 + bx + c = 0\), where \(a\), \(b\), and \(c\) are coefficients and \(x\) is an unknown variable. Based on the results of the study of Zakaria & Maat (2010) which states that students experience errors in solving quadratic equations in the transformation process and problem solving skills. Didis & Erbas (2015) revealed students had difficulty in solving symbolic problems related to algebraic and arithmetic manipulations.
In contrast to the above research, several recent study researchers focused their research on student conceptions to gain insight into student understanding rather than finding and categorizing errors (eg Lopez, Robles & Martinez-planell, 2016; Tall, et al., 2014).

Didis (2018) stated the results of his research in the form of students who did not have sufficient knowledge about the concept definition of quadratic equations, limited concept drawing of students and lack of prerequisite knowledge of students to understand quadratic equations. Therefore the researcher wants to examine the ability to understand students 'mathematical concepts based on Skemp's theory of understanding in terms of students' visual and visual-auditory learning styles. This research is expected to be additional information for each student to know their learning style, so that they can better organize the learning process. In addition, it is expected to help teachers also provide information about student learning styles and student understanding.

2. Method

The type of research that will be used is descriptive research using a qualitative approach. The data are descriptive, because the data collected is in the form of a series of words, images and certain symbols and is explorative, because it carries out a careful and in-depth examination to obtain student learning styles and understanding of concepts that will be revealed through the giving of tests. Subjects in this research is student high school. Students will be analyzed and described the concept of understanding based on Skemp's theory of understanding in the process of solving mathematical questions reviewed based on students' visual and auditory learning styles. Data in this study were obtained using research instruments in the form of student learning style questionnaires, student mathematical understanding tests, and interview guidelines.

3. Result and Discussion

In this study, the subject of the study was determined based on student learning styles, from 6 students there was 1 student with a visual learning style and 1 student with a student's visual-auditory learning style. Next, the researcher gave a test of mathematical understanding to see the categories of student understanding namely instrumental understanding or relational understanding in the metari of quadratic equations. After conducting the test the researcher will conduct an interview to find out more in understanding the students.

3.1 Example of Figure Visual

Student 1 with a visual learning style, when reading a question students spell each sentence in the question well and can save every actual word in their mind. The initial stage of Student 1's is to make a triangular drawing illustration, without making a preliminary description of what is known and questioned. Students are able to associate the concept of quadratic equations with phytagoras. Through the concept of phytagoras students can find a quadratic equation, then to find the roots of students 1 using the abc formula. Because one of the characteristics of students who have a visual learning style is to write short answers, so that Student 1 does not complete the answer with sentences that will strengthen the answer. As Student 1 does not provide an explanation in choosing the value of x that meets the requirements to be used as a determination
of the length of one side of the triangle. The following is an overview of Student 1 answers.

![Figure 1. Student Visual](image1)

Based on the results of interviews, Student 1 can answer correctly from each question. The obstacles that are almost faced are only in the formation of a quadratic equation, because Student 1 does not answer with confidence but must try it first to be able to confirm the answer.

![Figure 2. Student Visual](image2)

At the interview stage students 1 understanding of can be categorized as instrumental understanding, this can be seen from the absorption and good memory of each of the concepts of quadratic equations. Student 1 mentions that there are three ways to solve quadratic equations, namely, the method used by factoring, another way is by the formula abc and perfect square.
Figure 3. Student Visual

In addition students are also able to mention the terms of an equation that has twin roots, different real roots and not real roots along with one example.

3.2 Example of Figure Visual-Auditori

Student 2 with a visual-auditory learning style, when reading questions students spell well every sentence in the question while moving their lips. Process The initial stage carried out by Student 2 is the same as Student 1, which is making an illustration of a triangle image, without making a preliminary description of what is known and questioned. Students are able to associate the concept of quadratic equations with phytagoras, looking for the roots of the quadratic equation using the abc formula. The difference that is seen is the illustration of a different triangle image and Student 2 writes a little explanation of the value of x that fulfills and gives symbolic to each corner of the triangle by writing the letters ABC. Even the long-term answers become clearer to the reader, except that the writing of the answers is less regular.

Figure 4. Student Visual-Auditory

Based on the results of the interview, Student 2 was able to answer all the questions of the researcher. Student 2 is able to provide quick answers on how to solve quadratic equations and resolve confidently about forming quadratic equations if only the roots are known.
Student 2 also answers very clearly about the conditions that must be met to determine which equation has the roots of real twins, different real roots and not real roots.

Without taking a long time, Student 2 is able to give an example of one type of root found in a quadratic equation.

4. Conclusion

Based on the results of the above research, it was found that students N and A students could be categorized as having a relational understanding. This means that Student 1 and Student 2 are not only in instrumental understanding but are also able to have a deeper understanding. Relational understanding can be seen from indicators that fulfill, namely being able to rewrite a concept, represent and provide another example of a quadratic equation. Students with visual learning styles write answers briefly, this is because they first plan the completion path before writing each step in solving the problem and being able to explain the reason for each answer. The disadvantage of Student 1 is that it does not provide clear information on the answer sheet about choosing the appropriate root equation as determining the length of the triangle side, even though Student 1 really understands. Whereas students with visual-auditory learning styles in addition to making triangular illustrations and naming each side in their triangles, he immediately applied each formula he remembered in solving questions with longer answers and inserted several sentences to explain the answers he wrote. But the drawback is that Student 2 doesn't write the answer neatly like Student 1.

5. Acknowledgments

In this study kekurangn researchers are only doing research on 6 students who are selected based on the best mathematical value in their class, so that the learning style obtained is more dominant in the visual-kinesthetic learning style. Researchers expect that in the future research
can be carried out with a greater number of subjects in order to get better results.

6. References


