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Exploration of Vocational School Students' Misconceptions of Circle Material

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ABSTRACT

Misconceptions are ideas not following scientific understanding or understandings coined by experts in a field and can be in the form of an inaccurate understanding of concepts, use of wrong concepts, wrong classification of examples, or confusion of incorrect concepts. Understanding the correct concept is essential because there are still many misunderstandings (misconceptions); therefore, information about misconceptions is needed to avoid continuing misconceptions. This study aims to describe the misconceptions and causes of misconceptions in class XI AP 1 students at a private school in the city of Cirebon on the subject of circle equations. The form of research carried out in this study is qualitative research, with case study research methods. The data collection techniques used are 1) the test method, 2) the method of documenting the results of the answers of students who experience misconceptions, and 3) the interview method carried out on students who experience misconceptions. Based on the data analysis and discussion, it is concluded that 1) There is a misconception about a) the concept of a circle, b) the concept of the radius of a circle, c) the concept of the equation of a circle, and the position of a point on the circle. 2) The causes of misconceptions come from the teacher and the students themselves.

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1. INTRODUCTION

Mathematics education has an essential role in life because mathematics is a basic science widely used in various aspects of life. It is undeniable that all the sciences that exist today are almost all branches or applications of mathematics. With the learning of mathematics, students are expected to develop critical, logical, systematic, careful, effective, and efficient thinking skills in solving problems. The success of the goals of mathematics education itself can be seen from the results of students' understanding of

mathematics in solving mathematical problems or other scientific problems related to mathematics.

Mathematics is a collection of concepts with a systematic structure, sequence with a clear, logical flow, and a hierarchy between one concept and another, meaning that one concept and another are mutually supportive and related [1]–[4]. Mathematics is a field of study that has an important position in education. This can be seen from the number of hours of mathematics lessons in schools compared to other subjects. In addition, mathematics subjects in the implementation of education are given to all levels of education, from kindergarten to university [5]–[8].

According to Herawati et al. [9], the importance of understanding mathematical concepts is seen in the first goal of learning mathematics according to the Ministry of National Education, which is to understand mathematical concepts, explain the relationship between concepts, and apply concepts or algorithms in a flexible, accurate, efficient and precise manner. In problem solving. Following the learning objectives above, students are expected to understand a mathematical concept after learning to use these abilities in dealing with mathematical problems. So it can be said that understanding the concept is the most crucial part of learning mathematics. In learning mathematics other than cognitive, students must be involved effectively and psychometrically to learn the studied concepts [10]–[12]. If this is not included in the learning process, it can result in the mastery of mathematical concepts in students being less in-depth and will lead to low student understanding, resulting in low quality of education.

Seeing the importance of mathematics, there is ironic that mathematics has been a problem for some students until now. According to some students, mathematics is a complex subject with only a set of formulas. Often students only memorize the formulas contained in mathematics without understanding the meaning. So that when students are given questions that are different from those exemplified by the teacher or contained in books. As a result, students find it challenging to work on the problem. This impacts the achievement of learning mathematics and teaching mathematics which is still relatively low.

According to Frengky [13], the cause of concern for mathematics is that people who are worried about mathematics believe that they cannot solve math problems correctly, and they have adverse emotional reactions to mathematics. Like they are afraid and do not like mathematics continuously. This affects the perception that tends to be hostile towards mathematics, such as dislike and even hatred of mathematics. It can reduce students' understanding of mathematics. Misunderstanding mathematics can lead to misunderstanding concepts or misconceptions in solving math problems.

In addition to this, difficulties in understanding mathematics can also be caused because students do not pay close attention when the teacher explains mathematics subjects, teachers do not explain the basic concepts of mathematics, lack communication between teachers and students [14]–[16], mixing between students' preconceptions with new concepts taught by the teacher as a result of the teacher's lack of attention to understanding students' initial concepts (preconceptions) which are not necessarily correct, resulting in wrong concepts, or the lack of supporting facilities for mathematics lessons so that they can lead to

mathematical misconceptions in students. Difficulties in understanding mathematical concepts have an impact on further mathematical understanding.

According to Nurul Wafiyah [17], one of the indications of not achieving the objectives of learning mathematics optimally is the problem of students' conceptions. Conception is students' understanding or interpretation of concepts that already exist in students' minds as a result of the teaching and learning process. On the other hand, learning mathematics means learning mathematical concepts. According to Soedjadi [18], the notion of a concept is an abstract idea that can be used to classify or classify, which is generally expressed by a term or a series of words.

One of the causes of failure in learning mathematics is that students do not understand or misunderstand mathematical concepts (misconceptions). Misconceptions in mathematics can be a severe problem if not corrected immediately because mistakes in even one basic concept can lead a person to continuous errors. Student misconceptions occur at all levels of education. Misconceptions originating from students (preconceptions) who have been wrong will continue. The success of each level of education is influenced by the success of students' success in mastering competencies at the previous level. A good understanding will be used as a basis or foundation for the next level. Some information states that low concept mastery and misconceptions in students affect the KKM (Minimum Completeness Criteria) value in these concepts and fields of study

One of the teachers at one of the private Vocational schools in the city of Cirebon said that mathematics is a complex subject for students. This impacts the number of students who fail when doing mathematical calculations, both during class practice and exams. This causes low student achievement, especially in mathematics. The difficulties experienced by students in understanding mathematical concepts are often continuous. This is because students do not understand the initial concepts or preconceptions of the material being taught. Of course, every student has different preconceptions, which are incorrect. The student may have a wrong concept (misconception). This is not the only cause, but there are many things such as books, learning methods that are not appropriate to the material, learning media that are not appropriate to the environment, or teachers who teach less professionally.

Paul Suparno [19] explains that misconceptions are inaccurate understanding of concepts, use of wrong concepts, wrong classification of examples, confusion of different concepts, and hierarchical relationships of incorrect concepts. Misconceptions are a situation that every student may experience, but that does not mean they are allowed to happen just because it is expected. It is imperative for teachers to always know misconceptions in their students early on so that they can make remediation efforts or reduce misconceptions. This is useful to provide direction on how to deal with misconceptions that occur in students effectively and efficiently so that student learning outcomes can be more optimal. Therefore, developing instruments that can reveal the occurrence of misconceptions is very important. Instruments obtained through research with in-depth studies will produce good instruments to reveal misconceptions that occur in students and assist teachers in carrying out remedial activities to improve students' conceptual understanding. This certainly contributes positively

to improving the quality of mathematics learning and students' mathematics learning outcomes.

Based on information from the mathematics teacher of class XI at one of the private Vocational schools, Cirebon City, one of the materials that students have not mastered is the circle material. Especially in the matter of circular equations. This material is advanced material that has been taught at the previous level. In class XI, the material will be studied in depth, which of course, must understand the concept of the circle at the previous level because it will be interrelated between the material that has been studied and will be studied the material. The concept of learning mathematics material is sustainable. For example, in the material of building space, students must first understand the concept of flat shape. The inability of students to understand the initial concept is a significant factor in the occurrence of misconceptions or misconceptions.

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2. METHOD

This research is qualitative. According to Sugiyono [20], qualitative research is a method based on postpositivism philosophy, used by researchers in natural object conditions (as opposed to experiments). In this study, there is no hypothesis, and the generated data is descriptive in the form of written or spoken words. This research is qualitative and does not use calculations (non-statistical), so the research subject is taken with a purposive sample.

The determination of subjects in qualitative research is not based on statistical calculations. The selected subjects are intended to obtain complete information, not to be generalized. Therefore, the unique characteristics of purposive samples, namely 1) Emergent design / temporary, 2) Serial selection of sample units / rolling like a snowball, 3) Continuous adjustment or 'focusing' of the sample / as needed, 4) Selection to the point of redundancy / selected until saturated [21].

So the determination of subjects in qualitative research is done when the researcher begins to enter the field and during the research (emergent sampling design). The trick is that the researcher selects people who are considered to provide the data needed later based on the data or information obtained from the previous sample. The researcher can determine other samples that are considered to provide more complete data (serial selection of sample units).

This study will use a sample of purpose. The subjects studied are class XI AP 1 of the private Vocational School in Cirebon. Students will be given a test, and documentation is taken in the form of student answers, and then several people are selected to be interviewed. Students will be interviewed until the required data or information is saturated, so there are no standard criteria for respondents to be interviewed.

The data collection methods used in this study are the test method, the documentation method, and the interview method. Then after the data has been collected, it will then be combined and analyzed so that it can be concluded whether the student has misconceptions or not in mathematics.

3. RESULTS AND DISCUSSION

This research was conducted in class XI private Vocational School in Cirebon. This study aims to determine students' misconceptions and their causes in learning mathematics on the subject of circle equations. Data about the factors that cause misconceptions experienced by students on the subject of circle equations are obtained from the results of observations in teaching and learning activities. The data is concluded about the most dominant causal factors for misconceptions about circle equations. Data on misconceptions experienced by students were obtained from the results of description tests and interviews conducted with teachers and students.

3.1. Test Result Analysis

From the description of the alleged misconceptions, the researcher will only investigate further and will only analyze questions number 2, 3, 4, 6, and 8. Furthermore, test results analysis will be deepened by conducting interviews with related students. In this study, interviews will be conducted with five research subjects. The interview method is the primary method in data collection. Through this interview method, it can be known whether the students suspected of being in the test have misconceptions or not. Through this interview, the causes of these misconceptions can also be searched. The S is for the subject, and the P is for the researcher.

1. Questions number 2

   Look at the fragments of students' answers to question number 2 below:

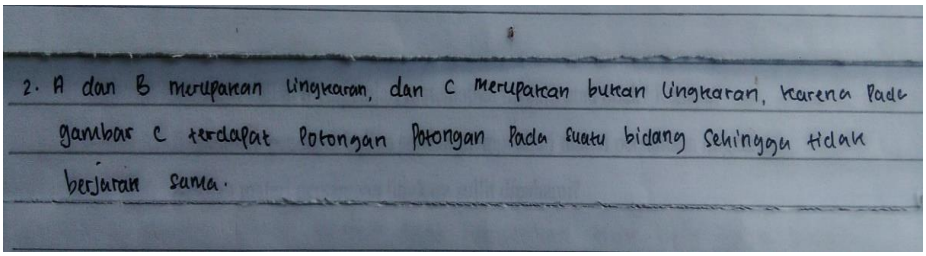

Figure 1. Subject's answer fragment 1 Number 2

Based on the fragments of students' answers above, students experience misconceptions. Some of the students' concepts were correct regarding the concept of a circle that must have the same distance from a point, but students misinterpreted that a circle and a ball were the same and that a circle must have a perfectly round shape without being cut off by lines or having blemishes. So that students consider a picture that is not a circle as a circle image.

Based on the results of interviews, students experienced misconceptions that were thought to be caused by a lack of emphasis on prerequisite concepts. The teacher did not mention the concept related to the equation of a circle, namely the circle itself. The teacher assumes that the material has been studied at the previous level so that it goes directly to the material to be taught. In addition, students lack of communication between students and teachers causes students to tend to ask their friends about material that is not understood. This is one of the causes of students experiencing misconceptions.

2. Questions number 3
   Look at the fragments of students' answers to question number 3 below:

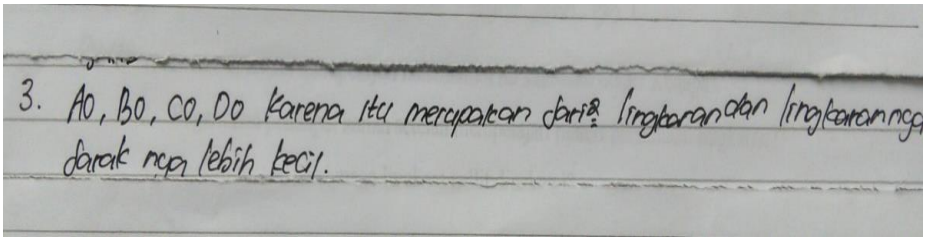

Figure 2. Subject's answer fragment 2 Number 3

From the fragments of student answers above, students understand some of the concepts of the radius of a circle. Students have been able to show the part that is considered the radius of a circle but are wrong in explaining the meaning of the radius of the circle itself. From the interviews, students experienced misconceptions about the meaning of the radius by saying that the radius is half of the diameter. The misconception about the circle's radius did not get clarification from the teacher because he thought the material was challenging to teach beforehand, so students only understood according to their thoughts.

3. Questions number 4
   Look at the fragments of students' answers to question number 4 below:

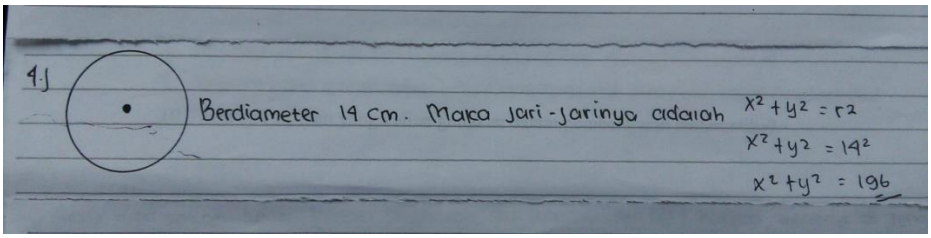

Figure 3. Subject's answer fragment 3 Number 4

From the fragments of students' answers above, students find the circle's radius using the wrong formula. It has not been identified whether students have misconceptions or not. From the results of the interviews above, students experienced conceptual errors in finding the radius of a circle using the wrong formula. It is suspected that the cause is the lack of giving varied questions. So they do not know whether students understand the basic concepts related to the equation of a circle or not.

4. Questions number 6
   Look at the fragments of students' answers to question number 4 below:

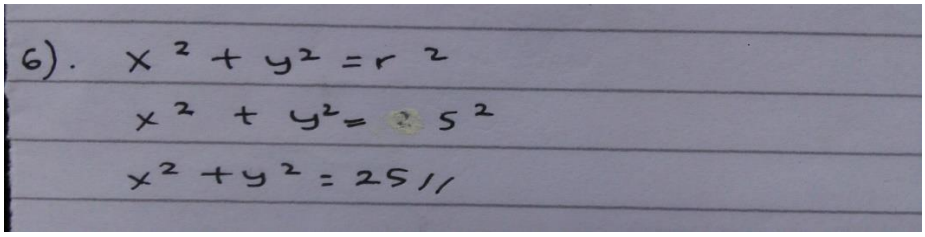

Figure 4. Subject's answer fragment 4 Number 6

From the fragment of the student's answer, the student was wrong in applying the formula. It has not been identified whether students have misconceptions or not. From the interview results above, students apply the wrong formula in working on question number 6. It is suspected that students are confused in determining the mathematical formula that will be used, so they are careless in answering questions. In addition, misconceptions also occur because the material taught by the teacher is considered too fast in its delivery, so students only draw conclusions from the material being taught, which is not necessarily true. In addition, students do not dare to ask questions about the material they do not understand, so students do not get the correct concept. In this case, students do not experience misconceptions but do not know the concept.

5. Questions number 8

Look at the fragments of students' answers to question number 8 below:

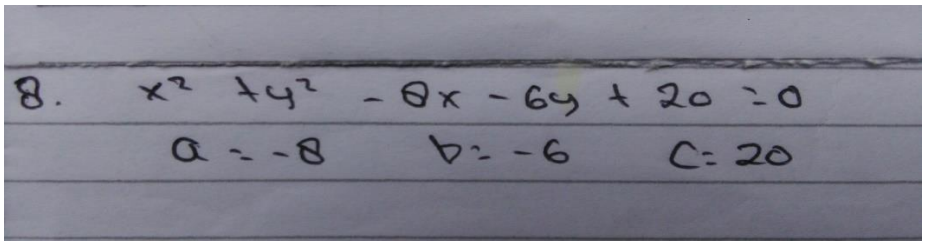

Figure 5. Subject's answer fragment 5 Number 8

From the fragments of student answers above, students only rewrote the question so that it cannot be identified whether students have misconceptions or not. From the results of the interviews above, students did not understand the material, so they could not answer the questions asked and only rewritten the questions. Students' perception that mathematics is complicated is a factor that causes them to be unable to understand the materials taught by their teachers. In this case, students do not experience misconceptions but do not understand the concept.

3.2. Discussion

Based on the study results, some students experienced misconceptions about the circle topic. The causes of misconceptions that occurred in students could be seen from the various misconceptions. The misconceptions experienced by students include misconceptions about the concept of a circle, the circle's radius, the equation of a circle, and the position of a point on a circle.

In misconceptions about the concept of a circle, students assume that a circle, a sphere, and a circle are the same. Students assume a circle is said to be a circle if it has no

gaps or the line is unbroken. The student says that circles and spheres must be perfectly round. In this case, the cause of the misconception is the teacher's lack of emphasis on the concept. The teacher immediately proceeds to the material to be discussed without first discussing the material or concepts related to the material to be taught. Most students define the meaning of a circle according to their understanding which is not necessarily true. In addition, the teacher never gives a correct understanding of the meaning of the circle itself, so the misconceptions among students continue. The students' wrong reasoning, according to Suparno [19] misconceptions are also caused by incomplete or incorrect student reasoning. Even if the teacher has explained the material clearly and well, sometimes students still cannot understand what the teacher is saying because of low student understanding.

In the misconception about the radius of a circle, most students cannot explain the meaning of radius. Students only mention the part that is considered the circle's radius with their understanding which is still wrong. Students also find it challenging to calculate the radius of a circle with a diameter whose value is sought first. Most students find it difficult to draw a circle with a known radius. The possible cause is that students are only used to working on problems in the form of descriptions, not in the form of commands to describe circles or observe pictures by first looking for the circle's radius. Teachers who do not provide varied questions contribute to the cause of these misconceptions. So that students only understand what is exemplified or explained by the teacher, and if they get questions that are not similar to what they have learned, they will find it challenging to do it. Even students cannot answer questions that are categorized as easy questions. This is because students only memorize the formulas they know.

In working on the problem of the equation of a circle and the position of the point on the circle, students tend to enter the numbers in the problem directly. Students work on the problem according to their understanding. Students experience misconceptions about using the right formula or using the formula according to their understanding. Things like this are caused by the lack of student abilities, lack of varied practice questions, intuition or feelings of students, and the way the teacher teaches, which are the causes. According to Suparno [19], the lecture method without allowing students to ask questions often continues the misconception. When students do not understand what the teacher explains, students tend to ask their friends, not the teacher who teaches. Students feel embarrassed to ask. Some are even reluctant to ask questions but do activities not included in learning activities, such as chatting and drawing. When students do not ask about the material being studied, the teacher assumes that the student has understood it, so he goes straight to the following material. The lack of communication between teachers and students is one of the causes of misconceptions [22]–[25].

The cause of misconceptions is not only caused by the students themselves but also by the teacher. The monotonous method makes students less enthusiastic about participating in mathematics learning. Many students were sleepy when mathematics learning occurred, and some chatted with their friends. Students feel bored and less interested in what is conveyed by the teacher. However, most students pay attention to what is being conveyed. In addition, the teacher is too fast in delivering the material. So

that, students who have a slightly slow understanding will be left behind and find it difficult to understand the material being taught. So that students immediately summarize or conclude the material taught by the teacher with an inappropriate understanding or misconception. The teacher also sometimes has his back to the blackboard, so students cannot see clearly what material is being conveyed by the teacher.

When going to the following material, the teacher only briefly discusses or does not mention the material or concepts related to the material to be taught. The teacher assumes that when the material has been studied in the previous lesson, the student is considered to have understood the material. This reason is reinforced by the lack of learning time because it is approaching UAS (School Final Examination) and PKL (Field Work Practice). So that the teacher speeds up learning mathematics from one material to another so that with the remaining time, all the material has been conveyed. Nevertheless, in reality, students do not understand what the teacher conveys. The teacher also does not do a pretest to determine whether the student has understood. The teacher only gives assignments to be done but rarely discusses them together, appointing students to come forward and work on questions or form study groups to determine students' abilities and understanding.

So the cause of misconceptions does not only come from the teacher but partly from the students themselves. Inappropriate lecture methods make students feel bored and not pay attention when the teacher explains. The lack of varied practice questions and the teacher being too fast when teaching can cause students to experience misconceptions because they are not trained to work on questions and do not catch what the teacher says well.

4. CONCLUSION

From the data obtained and analyzed that has been done, it can be concluded that only some students can determine the part that includes the circle's radius. Most students are wrong or even have misconceptions in defining the meaning of the radius of a circle. Students assume that the radius of a circle is half of the diameter. In addition, students find it challenging to describe a circle with the circle's radius that is sought first for its value. In addition, students assume the formula for finding the equation of a circle, and the position of the point on the circle is the same. Students use the same formula to work on different problems. Some answers only enter numbers in the questions and then operate them according to their understanding.

Based on interviews, it can be concluded that one of the causes of misconceptions is that students' low ability is one of the dominant problems in that causes misconceptions. Students will tend to memorize existing formulas without understanding the meaning. When the student does not understand what the teacher explains, the student prefers to ask friends rather than the teacher because they feel embarrassed. In addition, students' lack of motivation to learn sometimes makes students less interested in learning mathematics. This is reinforced by monotonous learning and learning media that are rarely applied so that students will do activities that are not learning activities when they feel bored or bored.

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