STUDENTS’ ERRORS ON THE CIRCLE CONCEPT IN BASIC MATHEMATIC LECTURES

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ABSTRACT
This study aims to examine student errors on the concept of circles. Researchers conduct explorative study by giving individual written tests (two description questions) to students after learning the concept of circles in basic mathematic lectures. The participants of this study are 46 students of 2015/2016 batch in the Department of Biology Education of a university in Indonesia. Based on the results of data analysis, more than 75% of the participants experienced errors in the concept of circles. The number of students who experienced errors in problem number 1 in the error categories err1, err2, and err3 respectively 5, 33, and 0 people. While at number 2 error err1, err2, and err3 respectively 1, 37, and 1 person.

KEYWORDS
Error, basic mathematic, circle concept, explorative study, qualitative research

INTRODUCTION
Student errors in a concept must be immediately handled by the lecturer. Usually serious misunderstandings arise when students are introduced to new mathematical concepts (Orhun, n.d.). Some of the reasons are because they are not so ready to explore new mathematical concepts or because of abstract concepts. To avoid serious misunderstandings, the need to assess students’ understanding of new concepts by observing the use of their own terminology (Lansdell, 1999).

Circle are one of the important concepts students must learn. In the concept of circle, students learn visual abilities and other high-level mathematical abilities (Budiman, 2014). But students’ understanding of the concept of circle is low. Evidently there are errors of students in determining the center point and radius of the circle (Imswatama and Muhassanah, 2016). And in general students experience misconceptions in correlational concepts and theoretical concepts simultaneously in determining the equation of the circle (including determining the center point and radius of the circle) (Wardani, Mardiyana, Subanti, 2016). In addition, students cannot determine the tangent equation of a circle with certain conditions as much as 38.18% of a particular class (Rumasoren and Sugiman, 2014).

This study examines student errors in the concept of circle. The research questions from this study are: What kind of errors were shown by students when solving problems in the circle concept?

LITERATURE REVIEW
Harper (2010) defines that errors are deviations from accuracy or truth. Whereas Luneta (in Luneta (2015)) explains that errors are simple symptoms of difficulties faced by students during the learning experience. The source of errors (errors) from researchers in geometry learning according to Makhubele, Nkhoma, and Luneta (2015) are prior knowledge; faulty reasoning; procedural and conceptual knowledge; educators; faulty schema; and content knowledge.
Many studies identify mathematical difficulties experienced when students solve mathematical problems is not new. For example in 1963, Donaldson (in Kiat, 2005) explained three types of errors that occur when students learn mathematics, namely: (a) structural due to failure to appreciate relationships involved in the problem; (b) arbitrary errors arising from the student failing to take account of the laid down constraints in what was given; and (c) executive involving failure to carry out manipulations despite having understood the principles involved. Avital and Libeskind (1978) also mention three types of difficulties faced by students in their research, namely: conceptual difficulties, mathematical difficulties, and technical problems. The error classification according to Makhubele, Nkhoma, and Luneta (2015), namely: slip (err1), concept error (err2), and procedural error (err3).

Previously researchers have analyzed student errors in the concept of points and lines in fields in analytic geometry lectures. Error classification used according to Makhubele, Nkhoma, and Luneta (2015). The results reported the number of students who experienced errors in question number 1 in the err1, err2, and err3 error categories respectively 0, 26 and 1 person, while in question number 2 were 6, 4, and 1 person (Sudihartinih, 2018). Furthermore, in this article the researcher examines student errors in the circle concept also uses the error classification from Makhubele, Nkhoma, and Luneta (2015).

**RESEARCH METHOD**

This research is exploratory research. This research was conducted to explore a phenomenon / phenomenon that is still relatively new with the aim of developing basic ideas about new topics, and providing a basis for further research (Priyono, 2016). This research was conducted at the Department of Education Biology, Faculty of Mathematics and Sciences Educational at one of the universities in Indonesia. The participants of this study were students with a total of 46 people (10 men and 36 women) in the class of 2015/2016 who were studying circle concepts in basic mathematics courses.

Data collection was carried out by giving a written circular concept test of two questions to the participants. Questions made by researchers. Furthermore, corrected by researchers to be grouped in right and wrong answers. Answers are incorrectly classified in several categories. The following error classification according to Makhubele, Nkhoma, and Luneta (in Sudihartinih, 2018).

**Table 1. Classification of student errors**

| Category | Error Type | Description |
|----------|------------|-------------|
| Err1     | Slip       | Mistakes, small mistakes made by students because students are in a hurry. skills. |
| Err2     | Concept error | Lack of knowledge about concepts caused by students' mastery of basic facts, concepts and inadequate. |
| Err3     | Procedural error | Students know the concept but cannot apply it to problems. Implement the procedure without really knowing what the student is doing. |
RESULTS AND DISCUSSION

The following data from the results of research that has been carried out.

Table 2. Number of students who answer right and wrong

| Category | Question Numbers |
|----------|------------------|
|          | 1                |
| Correct  | 8                |
| Incorrect| 38               |
| Total    | 46               |

Based on table 2, it is known that many students answered correctly the number 1 question as many as 8 people and one of the 38 students. While in question number 2 as many as 7 people answered correctly and as many as 39 people answered incorrectly. This shows more than 75% of participants were wrong in answering questions. Then the wrong answers are classified in the categories err1, err2, and err3.

Table 3. Error categories

| Category | Question Numbers | Total |
|----------|------------------|-------|
|          | 1                | 2     |
| Err1     | 5                | 1     | 6    |
| Err2     | 33               | 37    | 70   |
| Err3     | 0                | 1     | 1    |

Based on Table 3, it is known that the number of students who experienced err1, err2, and err3 errors in number 1 were 5, 33 and 0 respectively. While in number 2 as many as 1, 37, and 1 person. The following are examples of students’ incorrect answers to question number 1.

Problem: Determine the distance of the center of the circle \(2x^2+2y^2-4x+4y-17=0\) from the y axis.

The following is one of the student answers with Err1 error category.

Figure 1. Student answers to question number 1 with Err1 error category
Based on Figure 1, students make a calculation error in the fourth row should be (1,1). So this belongs to the err1 category, because of small mistakes made when students are in a hurry. Next is an example of student answers that are wrong in the err2 category.

**Figure 2. Student answers to question number 1 with the Err2 error category**

In Figure 2 it is known that students enter the wrong E and F values. Students should divide the equation $2x^2+2y^2-4x+4y-17=0$ (because of the general equation of circle $x^2+y^2+Ax+By+C=0$). So the correct value is $E = \frac{-1}{2}$ and $F = 1$. Besides that the second conceptual error is that students write the distance -2, distance should always be positive.

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The following will be presented with an example of students’ wrong answers to question number 2.

**Problem:** Determine the equation of the circle through (-3,0), (-3,3) and (0,0)!

**Figure 3. Student answers to question number 2 with Err1 error category**

Based on Figure 3, the students incorrectly copied the final results (last line). So this includes the err1 error category.
In Figure 4, it can be seen that students experience a wrong concept. Students solve the circle equation through three points but use the concept of tangent circles. So it belongs to the err2 category.

In Figure 5, it is known that students make procedural errors, should be the second row \((-3) 2\). This includes err3 errors.

The number of students who experience errors in the circle concept is more than 75% of all participants. So that lecturers must choose ways and methods so students understand mathematical concepts, improve reasoning skills, and perfect skills (Legutko, n.d). Lecturers are responsible for students' mistakes in concepts in mathematics, so they must create an environment where students have meaningful learning experiences (Kim, 2002). And it is necessary to develop special didactic assistance to treat learning difficulties and certain errors (Radatz, 1980). Teaching materials that have been designed by the design researchers (Sudihartinih, Purniati, 2016a). In addition, you can also use manipulatives. Because the use of teaching aids can help students understand mathematical concepts (Cavender and Stevens, 1994; McGee, et al, 2012; Sudihartinih and Purniati, 2017). The manipulatives that we have designed are in the article (Purniati and Sudihartinih, 2015; Sudihartinih and Purniati, 2016b; Sudihartinih and Purniati, 2018; Sudihartinih, Purniati, Rohayati, 2018).
CONCLUSION

The concept of circles is a concept learned from elementary school to college. This shows this concept is very important. However, the reality is still found student errors in completing the concept of the circle. So that a model, method, media, strategy or technique is needed to help students understand the concept of circles. Teaching materials are also needed that can facilitate students to reduce mistakes in the concept of circles. So that further research is needed to improve students' understanding of the concept of circles.

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