Analysis of student error in completion analytical geometry problems in circle and sphere material

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Abstract. The purpose of this study is to identify student errors in solving the matter of circular material and spherical analytic geometry. The subject of this research is the 2nd semester students of the Mathematics Department at Universitas Negeri Padang. The type of this research is descriptive research. The type in this study is a qualitative approach. The data collection were obtained through documentation, tests and interviews. Data analysis was carried out in a qualitative descriptive. The results showed that the learning difficulties of students in the circle and sphere materials in terms of concepts, principles, and algorithms were: (a) Inability to remember, (b) Misclassification, (c) Error strategy, (d) Error calculation, (e) Difficulties in using algorithms. Teachers' efforts to overcome student learning difficulties, namely: (a) provide training in varied questions (b) make a personal approach to students (c) repeat the questions that have been learned (d) provide direction to students to remember the formula learned (e) guiding and directing students to use the algorithm correctly. So that the teacher needs to use the right strategies and methods in teaching mathematical concepts.

1. Introduction

Analytical geometry is an advanced course of geometry that studies the plane and space. The purpose of this course is to develop the ability of students understanding concept and apply it in the form of practice questions [1]. Analytical geometry in fields and spaces is one of the compulsory subjects in the Faculty of Mathematics and Natural Sciences, Padang State University, which must be studied by Mathematics education students. In the curriculum structure, courses in semester one, especially the subject matter in the circle and sphere chapters found various problems for students because the course material was considered difficult for students.

Based on interviews, in the 2017/2018 Academic Year, the number of students who graduated in the field of analytical geometry is less than 70% of the 42 students who took the Analytical Geometry course. Students said that they have difficulties in applying concepts. Student learning outcomes that do not meet expectations indicate problems. The problem is the low value and information from several first semesters 2018/2019 academic students at Padang State University, who had difficulty when spelling analytic geometry questions, they revealed that in the process of analytic geometry learning, students had difficulty in proving theorems, working on verification questions, using symbols, applying answers to images and understanding the geometric concepts of analytics and accuracy in solving systematic problems in the algebra.
Geometry is a science that deals with the shape and size (size) of objects [2]. The geometry is an axiomatic system and a collection of generalizations, models, and evidence about the forms of objects in the field and space which is used to work on the questions given, difficulties in choosing the steps to work out the questions given and understanding the purpose of the questions given [3].

Based on the explanation above, the purpose of this study is to identify student errors in solving the matter of circular material and spherical analytic geometry. With the identification of these errors, there will be types of student errors in understanding the concept of circular and spherical material analytical geometry. The results of this study are expected to provide guidance and solutions about the students’ difficulties in understanding the concepts of analytic geometry as well as preliminary research in the development of analytical geometry teaching materials.

2. Methods
The type of this research is qualitative descriptive research. This research was conducted on students of the Mathematics Study Program in the first semester of the 2018/2019 academic year at the Faculty of Education and Natural Sciences at Universitas Negeri Padang. The technique that used in data collection in this study is documentation including the results of student tests in Final Examination and semi-structured interviews. Where in determining the subject of the interview is taking some first semester students who obtain poor results on the Semester Final Examination in the Field and Space Analytical Geometry courses and students who have high abilities.

The students taking Analytical Geometry in the Mathematics Education Study Program totaled 42 people. The students are separated into high group and low group. The results of the test are analyze randomly based on students’ difficulties. The technique of data analysis is qualitative in a descriptive way.

3. Result and discussion
The following is an analysis of the difficulties made by students in the use of concepts, principles, and algorithms, in the circle and spherical material, namely:

3.1. Difficulties in using concepts

3.1.1. Inability to remember. The inability of students to remember, this happens when students are asked about the equation of the circle and sphere. Students still think for a long time in determining formulas and the difficulty of applying concepts to problems. This aspect is closely related to the mastery of the material possessed by students. From mastering the material that is already owned, students are expected to be able to remember the right concepts to solve the problems given by the lecturer. The inability of students to remember concepts is a mistake made by students because of the weak mastery of concepts. The weak concept mastered by students can be caused by a lack of active participation in lectures. In analytic geometry lectures, some students only get information and do practice questions given by the lecturer. So, to improve understanding of concepts, students must actively participate in lectures and lecturers must give assignments in the form of problems and questions about the concept of analytical geometry [4].

3.1.2. Misclassification. A misclassification carried out by students when students are asked to write a circle equation, and a circle tangent equation if it is known the center of the circle and touches a line. Students who make mistakes in the concept are not only caused by students' lack of understanding of the concept, because these errors can also be caused by methods or strategies used by lecturers that are not appropriate, lack of lecturers in delivering material, too using languages that students do not understand, and errors Other errors can cause students to experience difficulties in using concepts in circle material. This can be seen in the student exam answers in Figure 1 below:
Based on Figure 1 it is known that students are mistaken in using the concept, students should first find the value of the radius in a circle. Furthermore, students experience difficulties in using concepts in sphere material. This can be seen in Figure 2 below:

**Figure 2.** Examples of conceptual errors in sphere material.

### 3.2. Difficulties in using principles

#### 3.2.1. Strategy error.

Strategy error is an error that occurs because students choose the wrong way to do it. This error occurs due to the understanding of the concept of a weak student. When working on a problem students confused in determining the next step that must be taken, even though the student knows the concept or formula used. To minimize these errors students can multiply the practice so that an understanding of the concept can be mastered. Examples of answers to students who are wrong in choosing the strategy in the circle material can be seen in Figure 3 below:

**Figure 3.** Example of a strategy error in circle material.

Based on Figure 3 it is known that students are still mistaken in choosing the right formula in determining the equation of the circle. Students use a circle equation formula which if known 2 points.
Furthermore, students experience difficulties in choosing strategies for sphere material. Examples of student answers that are wrong in choosing a strategy for spherical material can be seen in Figure 4 below.

![Figure 4. Example of a strategic error in sphere material.](image)

Based on Figure 4 it is known that students are still mistaken in determining the tangent field of the sphere. Students directly substitute the origin into the equation.

3.2.2. Calculation error. Calculating errors is an error in doing mathematical operations. This calculation error is caused by the inaccuracy of students in working on the problem even though the students have mastered the concepts given. There are still many students who cannot complete mixed multiplication and there are even students who are not able to multiply decimal numbers. Calculations made by students may occur because students do not understand the basic concepts that are based or contained in these calculations. Students who do not have a concept that is used to develop principles as a basic knowledge item will result in students having difficulties in calculating.

3.3. Difficulties in using algorithms

Students' difficulties in using algorithms are the inability of students to formulate steps in solving systematic and logical problems. Algorithm errors made by students when answering question number 2 about circles, that is students immediately enter the center point values into the equation. After that, look for the value of the radius. The corresponding circle equation is correct, but not solved algebraically. This can be seen in Figure 5 below.

![Figure 5. Example of difficulties in using algorithms in circle material.](image)
4. Conclusion
From this study, it can be identified that there are some mistakes made by students in working on the analytical geometry questions, the circle material, and the spheres are as follows: 1) Conceptual errors namely mistake made by students because they do not understand the concept well. 2) Principle error, which is an error that occurs because students choose how to do the wrong and make mistakes in the calculation. 3) Error algorithm, namely the inability of students to formulate steps in solving systematic and logical problems.

5. Suggestion
To minimize mistakes made in analytic geometry problems in the field of circle material and spatial analytic geometry on spheres, students must play an active role in lecture activities, as well as increase problem training so that it will improve understanding of concepts about circles and spheres.

References
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