Errors Analysis of Students in Mathematics Department to Learn Plane Geometry

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Abstract. This article describes the results of qualitative descriptive research that reveal the locations, types and causes of student error in answering the problem of plane geometry at the problem-solving level. Answers from 59 students on three test items informed that students showed errors ranging from understanding the concepts and principles of geometry itself to the error in applying it to problem solving. Their type of error consists of concept errors, principle errors and operational errors. The results of reflection with four subjects reveal the causes of the error are: 1) student learning motivation is very low, 2) in high school learning experience, geometry has been seen as unimportant, 3) the students' experience using their reasoning in solving the problem is very less, and 4) students' reasoning ability is still very low.

1. Introduction
The reality is not everything is easy to understand and easy to do. Through logical thinking, analytical, systematic, critical, innovative and creative many difficult problems can be solved and simple solutions can be found. Such capabilities can be grown and developed in geometry learning. This ability can be grown in geometry learning. According to NCTM, geometry is a basic and important subject area of school mathematics and conceptually, the basis. In geometry class, students learn characteristic features and the relations among them with geometric shapes and structures. Spatial visualization, thinking of two or three dimensions of a geometric shape in space and looking at various aspects is the most important part of geometric thinking [1]. On this basis geometry is given at every level of education from elementary school to college. However, in geometry learning there are many problems so that the great benefits that exist in geometry cannot be possessed by students. The real facts have been said by Telima Adolphus: Some of the findings that emerged are: (1) the foundation of most mathematics teachers in geometry is poor. (2) The students have poor foundation in mathematics. (3) The teaching and learning environment is not conducive. Based on the findings, it was recommended that (a) The State government should as a matter of urgency send mathematics teachers for training and seminars for effective teaching and learning. (b) The government should endeavor to provide the necessary infrastructures and facilities that will motivate teaching and learning of mathematics [4].

Some researches in Indonesia, especially in West Sumatra have revealed that geometry is often avoided, either by students or by the math teacher itself. This is because the foundation of most mathematics teachers in geometry is poor. On the findings of Zuya, H. E. and Kwalat S.K. seen the problem of plane geometry learning, especially related to the angles on parallel lines [7]. The study
revealed that most of the teachers were unable to identify the student’s missing knowledge with respect to angles in parallel lines. The teachers were also unable to help the students, as they could not suggest specific ways that would help remove the student’s difficulties. This problem also exists in students of Mathematics Education Study Program of Universitas Negeri Padang. If this is not resolved, then surely the problem of geometry learning will continue to be a problem in learning mathematics, both in college and in school because these students will teach in school later. As a result, the purpose of mathematics learning will not be achieved.

According Soedjadi, difficulties of students can be seen from the error of them [3]. Therefore, to overcome this problem, must be started from the lecturer as the spearhead of learning. The lecturer should identify the errors that occur and diagnose the cause as a guide in setting the solution. According to NCTM, all students should have the opportunity and the support necessary to learn significant mathematics with depth and understanding [1]. This is necessary to give them the ability to think logically, analytically, systematically, critically, innovatively and creatively, as well as the ability to solve relevant problems. A learned concept or principle will be meaningful if both can be applied in problem solving. This fact makes problem-solving skills very important in mathematics learning. In accordance with Wilson's statement, Problem solving has a special importance in study of mathematics. A primary goal of mathematics teaching and learning is develop the ability to solve a wide variety of complex mathematics problems [6]. The famous problem-solving stage proposed by Polya, that is 1) understanding the problem, 2) devising a plan, 3) carrying out the plan, and 4) looking back [2].

Errors of students in solving problems can be a clue to know the extent of student learning problems. Experience when students solve a problem they will show errors in each of problem solving stages. To find a solution to this problem, the lecturer identifies the types and causes of the errors. Hidatay in Widodo said that the errors made by students can be classified into four types, those are (1) factual errors, ie errors related to the material in question; (2) concept errors, ie misunderstanding of concepts related to matter; (3) operation errors, ie errors in calculations; and (4) the error of principle, that is, the error of misunderstanding the principle or applying the principle in the matter [5].

2. Method and Design
This study is a qualitative descriptive research to reveal the types and causes of the errors made by students of Mathematics Education Study Program in solving problems on the topic of plane geometry. For this, the data collection and analysis techniques are as follows.

First, provide written test to 59 subjects to diagnose the location and types of students errors. The tests provided in this study include the understanding of mathematical concept level (question 1) and mathematical problem solving level (questions 2 and 3). This is because all of the geometry tests that student follow, the errors that occur include all levels of mathematical ability. The questions are as follows. Question 1: Write definitions for the following concepts: a median of a triangle, a perpendicular bisector of a segment, a parallelogram, a parallel lines, and a concurrent lines. Question 2: If a segment connecting the midpoints of two sides of a triangle, then write the two properties that the segment has, and then prove your answer! Question 3: Given $\overrightarrow{DR}$ and $\overrightarrow{ES}$ are the median of $\triangle DEF$. If $\overrightarrow{DR}$ and $\overrightarrow{ES}$ are intersect in point $P$ and the lengths of $\overrightarrow{DP}$ and $\overrightarrow{SP}$ are 8 and 5, then determine the lengths of $\overrightarrow{EP}$ and $\overrightarrow{PR}$.

Student errors are expressed through an analysis of student answer sheets for the three questions. This analysis aims to determine the types of student error in understanding the concepts and errors in applying these concepts at each step of problem solving. The types of errors in this study consist of concept errors, principle errors and operational errors. The indicators of concept errors are (a) the student is wrong in interpreting the terms and concepts, (b) the student is wrong in using terms and concepts, (c) the student does not adjust the use of the definition to the conditions of the prerequisites, and (d) the student does not write the definition to answer the problem. The indicators of the principle errors are (a) the student is wrong in interpreting the principle or theorem, (b) the student is wrong in
using the principle or theorem, (c) the student does not adjust the use of the principle or theorem to the condition of the prerequisites, and (d) the student does not write principle or theorem to answer the problem. The indicators of operational errors are (a) the steps of problem solving of students are not hierarchical and (b) the student is unable to manipulate the steps to answer a problem.

Second, interview the subject to find out the cause of the error on the student answer sheet. Subjects interviewed were defined by the rules: two persons called subject 1 (S1) and subject 2 (S2) with characteristics still experiencing errors in expressing the definition of concepts and two persons called subject 3 (S3) and subject 4 (S4) with characteristic of having errors only at the stage of applying the concepts in problem solving.

3. Findings and Discussion

3.1. Description of Student Errors

In this study the test was answered by 59 students. The result, an average 67.80% of students have not been able to reveal the definition of the concepts given in question 1. This shows the student has an error in understanding the concept of plane geometry. These conditions have a real impact on their ability to apply the concept in solving problems. At the stage of understanding the problem, on average 32.20% of students do not write what is given by the problem, 37.29% of students do not write what is asked, and 64.41% of students have not been able to declare the problem into a more operational form. Furthermore, in the devising a plan, on average 69.49% of students have not been able to perform any activities to look for possibilities that can occur on the problem. This means, there are 30.51% of students can express the possibilities that can occur on the problem. In general, this student understands the concept and principles well. From this situation, on average only 23.73% of students are successful in solving problems on questions 2 and 3. This means, 76.27% of students fail to solve the problem.

3.2. Types of Student Errors

The first type of student error is a concept error. These errors range from their errors in interpreting terms and concepts to errors in using concepts. For example, a student interpreting the term concurrent line is the same as a congruent line and there are also students interpreting transversal line as a special line on a triangle. These unreasonable student interpretations resulted in their failure to write the definition of a given concept.

The second type of error is a principle error. These errors include errors in interpreting principles or theorems, to errors in the use of principles or theorems. For example, in answer to question 2, some students say that the diagonals of a parallelogram are bisectors from their angles. In the student's answer to question 3, on ΔDEF with three segments DR, ES, and FT intersecting at a point P, some students say that two isosceles triangles will be formed, ie ΔDPF and ΔEPF.

Furthermore, many students also do not adapt the use of principles or theorems to the conditions of their prerequisites. For example, in question 3, there are students who say that if two sides one triangle are equal to two sides of another triangle, then the triangles are congruent. In ΔDEF, there is any ΔDPS. Some students apply Pythagoras's theorem to this triangle. Likewise on two lines that are not necessarily parallel, which is cut by a transversal, some students say that the number of two same sides interior angles is 180°. So there are students who say that if two lines are cut by a transversal, then same-sides interior angles are supplementary. In applying the principle of corresponding angle are equal, the student also does not notice the prerequisites are two parallel lines cut by a transversal. Furthermore there are also some students do not write the principle or theorem to answer the problem.
The third type of error is an operation error. Some students who understand the principle or theorem well fail in solving the problem because the student is unable to manipulate the steps to answer a problem. This is shown by some student answers that do not arrive at the expected solution.

3.3. Causes of Student Errors

Reflections with subjects S1 and S2 reveal that the main cause of student problems in studying plane geometry is a poor past experience. In the junior and senior high schools, teachers often delay the learning of this geometry even many of these geometric sections are not studied. This fact makes students see geometry as less important so they ignore it. Recognized by S1 and S2, they still ignore geometry today. This means that students do not have good motivation in learning of geometry. Furthermore, reflections with S3 and S4 reveal that past learning experiences in secondary school are the same as those delivered by S1 and S2. However, after becoming a student at a college, they realize that geometry must be mastered as a provision to become a teacher later. The problem is that they always have difficulty in solving geometry problems. According to them, learning geometry demands a high reasoning ability, unlike other courses they have undergone such as algebra and trigonometry courses.

3.4. Discussion

This research has revealed that most (67.80%) students experience problems in learning plane geometry. The problems start from understanding the basic concepts of plane geometry to apply them to problem solving. These students will become teachers later. Therefore, this is seen as a serious problem that must be resolved soon. The lecturer must increase the motivation of the students. Students must have a high awareness to understand the geometry well. Furthermore, learning must be re-planned to be more complete, details ranging from the introduction and understanding of facts and concepts, the invention of principles or theorems, and its application in problem solving. Because geometry is a science that demands a high reasoning, then the lecturer must develop the learning materials with a focus on the arrangement of students' reasoning. On reflection with upper level students (S3 and S4), it is recognized that geometry training is needed to improve students' reasoning skills so they have adequate skills in solving geometry problems. For this the students can be challenged to be more careful in formulating the statement and the correct reason for every step of problem solving. Every statement must be followed by the correct reason, which is proved by theory. There is no justification for a statement without a clear reason. This learning is known as the Statement and Reason technique.

References

[1] NCTM (2000). Principles and Standards for School Mathematics. Reston: Virginia.
[2] Polya, G. 1973. How to Solve It: a New Aspect of Mathematics Method 2nd Edition. New Jearsey: Princeton University Press.
[3] Soedjadi, R. 1996. Diagnosis Kesulitan Siswa Sekolah Dasar dalam Belajar Matematika. Team
[4] Telima Adolphus. 2011. Problems of teaching and learning of geometry in secondary schools in Rivers State, Nigeria
[5] Widodo, Sri A. 2013. Analisis Kesalahan dalam Pemecahan Masalah Divergensi Tipe Membuktikan. Jurnal Pendidikan dan Pengajaran, Jilid 46, Nomor 2, Juli 108 2013, hlm.106-113
[6] Wilson. 1993. Mathematical Problem Solving. New York: Macmilan Publishing Company.
[7] Zuya, H. E. dan Kwalat S.K. (2015). Teacher Knowledge of Students about Geometry. International Journal of Learning, Teaching and Educational Research. Vol 13, No 3. , pp. 100-114