Analysis of Junior High School Students' Errors in Solving Mathematical Problems for The Topic of Circle

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Abstract

This research aims to determine the type and percentage of errors that junior high school students do in solving math problems on the subject of the circles. This research is an expost facto research. The population of this study is all students of grade VIII of one of the junior high schools in Purworejo as many as 182 students. Then by randomly selecting from the entire student, selected as many as 94 students as research samples. Research instruments are used in the form of diagnostic tests. Based on the results of the research, the students' errors have done in solving math problems on the topic of circle are errors in comprehension (16,93%), transformation (27,39%), operation (26,30%), and drawing conclusion (71,55%). So, the most dominant error done by grade VIII students of one of the junior high schools in Purworejo is an error in the drawing of conclusions. Based on the results of this study, teachers need to design more effective learning to minimize the errors that occur, especially errors in drawing conclusions.

Keywords: circle, errors, mathematical problems

INTRODUCTION

Students learn mathematics from the elementary to high school level. Mathematics learned by junior high school students includes numbers, algebra, geometry and measurement, statistics and probability. Mathematics is one of the subjects taught in schools with a higher number of hours of study than other subjects. However, students still think of mathematics as subjects that are difficult to understand (Abdurrahman, 2003: 251; Siregar, 2017: 224; Supriyanto, 2014: 166).

Achieving the objectives of mathematics learning is not always successful due to obstacles (Hamalik, 1983: 112). Some things cause a failure to achieve learning objectives. Not all student outcomes meet the standard because of the students' errors have on the math problem. Students' errors in doing math problems because students have difficulty understanding certain topics. This is stated in Depdikbud (1982: 37) "if a student has difficulty then the student will make errors in resolving the questions".

According to Tong & Loc (2017), students do many errors in resolving problems such as subjectivity, carelessness, misapplication of calculation rules, identification of incorrect types of problems, and wrongs in calculations. Meanwhile, according to Wijaya et al. (2014), the type of error in solving context-based math problems consists of comprehension error, transformation error, mathematical processing error, and encoding error.

Based on the results of a research interview with class VIII mathematics teacher of one of junior high schools in Purworejo, obtained information that students in grade VIII still make errors in solving math problems. Students do not dare to ask questions about the topic that is not yet understood or in working on the question given by the teacher. The student initiative is lacking, it appears when the teacher gives the opportunity to ask not to be utilized well by the students.

Based on the mid-semester test even the submission of student mathematics is still lacking. A total of 81 students from 182 grade VIII students of one of junior high schools in Purworejo got the test result of mathematics under the minimum submission criteria set by the school of 70. The mid-semester test presents questions about circles. After analysis of the results, the student encountered an error in resolving the matter about the circumference and area of the circle, the area of the sector, and the length of the inner and outer fellowship line of two circles.

Considering students as one of the determining factors of education, there is an error solving the math problem that the students need to get attention. This error can be further researched regarding the cause of the error. The cause of the error must be found out as soon as possible by analyzing the root cause of the problem caused by the student's error (Pamungkas & Wicaksono, 2019). The teachers have to know where the errors and parts of the topic are still poorly understood by the students to smooth the next learning process. Information about the students' errors in solving math problems can be used as a teacher's consideration to make a teaching improvement for example by giving remedial learning by emphasizing things that are poorly mastered. So, it is expected to improve math learning performance.

Based on the explanation, the researcher conducted a study titled analysis of junior high school students' error in solving math problems in the topic of circle.

METHOD

This type of research is expost facto. This research was conducted in one of the junior high schools in Purworejo. The populations of this study were 182 students of grade VIII students , while the samples in this study were as many as 94 randomly selected students.

This research was studied about students' errors in solving math problems in the topic of circle in grade VIII of one of junior high schools in Purworejo. The instrument used was a diagnostic test consisting of 15 multiple-choice questions and 5 items of essay about parts of circles, circumference, and area of the circle, central angles, arc length, area of the sector, and tangents.

The collected data is analyzed by examining the students' answers and classifying the forms of errors performed by students. For multiple-choice items, the problem is used to determine the errors that the students have done in each basic competency. As for the question of the type of error description students can be seen from errors in comprehension, transformation, operation, and drawing conclusion. The next step is to provide a score to the students' answers, then calculate the percentage of students who worked wrong for multiple-choice questions, by:

$$pk = \frac{e}{n} \times 100\%$$

with:
pk: percentage of student errors
e : the number of students who answer wrong
n : the number of students who take the test

and calculate the percentage of error rates on each type of error performed by students in the description, by:

$$pk = \frac{e_a}{s_{max} \times n} \times 100\%$$

with:

e_a : many students answer wrong in every aspect

s_{max}: maximum score in each aspect.

RESULTS AND DISCUSSION

The data on this research is derived from a mathematical test that is in the form of multiple-choice and description. For multiple-choice questions, there are 15 questions and 5-item descriptions. Table 1 was the result of students' answers on multiple-choice questions.
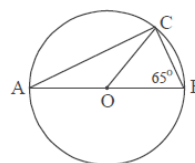
Table 1. The Number of Students who Answer Wrong in Working with Multiple Choice Questions (n = 94).

Number	Students who Answer Wrong	Percentage (%)
1.	4	4,26
2.	14	14,89
3.	6	6,38
4.	8	8,51
5.	19	20,21
6.	22	23,40
7.	9	9,57
8.	15	15,96
9.	9	9,57
10.	22	23,40
11.	14	14,89
12.	4	4,26
13.	3	3,19
14.	13	13,83
15.	17	18,09

Based on Table 1, the most errors in the matter of number 6 and number 10 are performed by 22 students with a percentage error of 23,40%.

> **Question No. 6**
> Perhatikan gambar berikut.
>
>
>
> Diketahui *AB* diameter lingkaran dan $m\angle ABC = 65°$. Hitunglah $m\angle CAB$ ....
>
> A. 25° C. 50°
> B. 130° D. 65°

This problem was used to test students' ability in basic competence (KD) 3.7 Explains the central angle, circumference angle, arc length, and area of the circle, as well the relationship and 4.7 Resolving problems relating to central angles, circumference angles, arc lengths, and the area of the circle, as well as its relationship. The correct answer is A. There are 22 students who answer incorrectly that is 7 students answered B, 10 students answered C, 2 students answered D, and 3 students did not work. The student error rate percentage is 23,40% with very low criteria.

Analysis of the wrong answer

Answer: B

$m\angle ABC = 65°$ then

$m\angle CAB = 2 \times m\angle ABC$

$\qquad = 2 \times 65°$

$\qquad = 130°$

Students' answers were wrong because students were wrong in understanding the central angle and circumference angle of the circle. So the student was wrong in performing the completion steps. These errors include errors in transformation.

Answer: C

$m\angle ABC = 65^o$ then

$m\angle AOC = 2 \times m\angle ABC$

$\qquad = 2 \times 65°$

$\qquad = 130°$

$m\angle BOC = 360° - (m\angle AOB + m\angle AOC)$
$= 360° - (180° + 130°)$
$= 50°$

because $\angle BOC$ and $\angle CAB$ facing the same arc then $m\angle BOC = m\angle CAB$. So, $m\angle CAB = 50°$.

Students' answers were wrong because students did not understand the relationship between the central angle and the circumference angle facing the same arc. This error includes an error in comprehension.

Answer: D

because $\angle ABC$ and $\angle CAB$ is a round angle then $m\angle ABC = m\angle CAB$. So, $m\angle CAB = 65°$.

Students' answers were wrong because students lack an understanding of the circumference angle of the circle. This error includes an error in comprehension.

Question No. 10
Panjang garis singgung lingkaran berjari-jari 6 cm dari titik di luar lingkaran yang berjarak 10 cm dari pusat lingkaran adalah ....
A. 8 cm   C. 7 cm
B. 7,5 cm   D. 6,5 cm

This problem was used to test students' ability in basic competence (KD) 3.8 Explains the tangent of the outer fellowship and the alliance in two circles and the way it is painting and 4.8 Resolving issues related to the tangent of outer fellowship and fellowship in two circles. The correct answer is A. There are 22 students who answer incorrectly, 6 students answered B, 7 students answered C, 1 student answered D, and 8 students did not work. The student error rate percentage is 23,40% with very low criteria.

Analysis of the wrong answer
Answer: B, C, and D

Students answer wrong because students can not work on the question and only the origin chose the answer only. This error includes an error in comprehension.

Table 2. Percentage of Student Errors on Each Basic Competency for Multiple Choice Questions (n = 94).

Basic Competency (KD)	Percentage (%)
3.7 Explains the central angle, circumference angle, arc length, and area of the circle, as well as the relationship.	
4.7 Resolving problems relating to central angles, circumference angles, arc lengths, and the area of the circle, as well as its relationship.	33,07
3.8 Explains the tangent of the outer fellowship and the alliance in two circles and the way it is painting.	
4.8 Resolving issues related to the tangent of outer fellowship and fellowship in two circles.	27,02

(Source: Kemdikbud, 2016)

Based on Table 2, for multiple-choice questions, students in grade VIII of one of junior high schools in Purworejo have a greater percentage of errors in basic competence (KD) 3.7 Explains the central angle, circumference angle, arc length, and area of the circle, as well as the relationship and 4.7 Resolving problems relating to central angles, circumference angles, arc lengths, and the area of the circle, as well as its relationship with error percentage of 33,07%.

Here's a table to figure out the student score on the aspect of comprehension, transformation, operation and concluding the description.

Table 3. Percentage of Errors for Each Type of Error for Description.

Number	Comprehension	Transformation	Operation	Draw Conclusion
16.	11,72	32,97	35,90	71,98
17.	19	30,88	25,82	81,86
18.	19,20	9,78	9,06	59,24
19.	17,41	6,67	12,22	60,56
20.	17,35	58,45	54,79	71,23
Total	16,93	27,39	26,30	71,55

Based on Table 3, for the description, grade VIII students of one of the junior high schools in Purworejo have the most error percentage on the aspect of draw conclusion with an error percentage of 71,55%.

Question No. 17
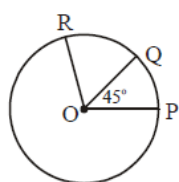
Pada gambar di samping, diketahui panjang busur PQ = 11 cm, panjang busur QR = 22 cm, dan $m\angle POQ = 45°$.

a. Berapa $m\angle QOR$?
b. Hitunglah panjang jari-jari lingkaran.
c. Tentukan luas juring OPQ dan OQR.
Penyelesaian:
Diketahui: panjang busur PQ = 11 cm, panjang busur QR = 22 cm, $m\angle POQ = 45°$
Ditanyakan:
a. $m\angle QOR$
b. panjang jari-jari lingkaran
c. luas juring OPQ dan OQR

The error of comprehension was done by 18 students, including 1 student who wrote one of the known or only asked, 17 students did not write down what was known and asked, and 1 student did not work. The percentage of an error on the aspect of comprehension is 19% with very low criteria.

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a. $m\angle QOR$
Jawab:
$$\frac{m\angle POQ}{m\angle QOR} = \frac{panjang\ busur\ PQ}{panjang\ busur\ QR}$$
$$\frac{45°}{m\angle QOR} = \frac{11}{22}$$
$$m\angle QOR = \frac{22 \times 45°}{11}$$
$$m\angle QOR = 90°$$
Jadi, $m\angle QOR$ adalah 90°.

The error of the transformation aspect was carried out by 33 students, including 6 students writing inappropriate mathematical formulas and symbols, 27 students did not write mathematical formulas or symbols, and 3 students did not work. The percentage of an error on the transformation aspect was 32,97% with low criteria.

The error of the operation aspect was carried out by 26 students, including 1 student answer with the steps but the result of the calculation was not correct, 19 students only wrote the final answer and correct, 6 students only wrote the final answer but wrong and or does not write the final answer, and there were 3 students who did not work. The percentage of an error on the operation aspect was 20,88% with very low criteria.

The error of the draw conclusion aspect was carried out by 74 students, including 74 students did not write down conclusions and 3 students did not work. The percentage of an error on the draw conclusion aspect was 81,32% with very high criteria.

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b. Panjang jari-jari lingkaran
Jawab:
Panjang busur QR $= \frac{m\angle QOR}{360°} \times 2\pi r$
$$22 = \frac{90°}{360°} \times 2 \times \frac{22}{7} \times r$$
$$22 = \frac{1}{4} \times 2 \times \frac{22}{7} \times r$$
$$r = \frac{22 \times 4 \times 7}{2 \times 22}$$
$$r = 14$$
Jadi, panjang jari-jari lingkaran tersebut 14 cm.

The error of the transformation aspect was carried out by 25 students, including 17 students who wrote inappropriate mathematical formulas and symbols, 8 students did not write mathematical formulas or symbols, and 32 students did not work. The percentage of an error on the transformation aspect was 29,57% with low criteria.

The error of the operation aspect was done by 26 students, including 11 students answered with the steps but the final answer was not correct, 5 students only write the final answer and correct, 10 students just write the final answer but wrong and or did not write the final answer, and there were 32 students who did not work. Percentage error on operation aspect was 27,42% with low criteria.

The error of the draw conclusion aspect was carried out by 51 students, including 51 students did not write down conclusions and 32 students did not work. The percentage of an error on the draw conclusion aspect was 82,26% with very high criteria.

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c. Luas juring OPQ dan OQR
   Jawab:
   Luas juring OPQ $= \frac{m \angle POQ}{360^0} \times \pi r^2$
   $$= \frac{45^0}{360^0} \times \frac{22}{7} \times 14 \times 14$$
   $$= 77 \text{ cm}^2$$
   Luas juring OQR $= \frac{m \angle QOR}{360^0} \times \pi r^2$
   $$= \frac{90^0}{360^0} \times \frac{22}{7} \times 14 \times 14$$
   $$= 154 \text{ cm}^2$$
   Jadi, luas juring OPQ dan OQR berturut-turut adalah 77 cm^2 dan 154 cm^2

The error of the transformation aspect was carried out by 20 students, including 14 students who wrote an improper mathematical formula and symbol, 6 students did not write mathematical formulas or symbols, and 43 students did not work. The percentage of an error on the transformation aspect was 28,76% with low criteria.

The error of the operation aspect was performed by 26 students, including 14

students answered with the steps but the final answer was not correct, 12 students only wrote the final answer but wrong and or did not write the final answer, and 43 students did not work. The percentage error on the operation aspect was 32,68% with low criteria.

The error of the draw conclusion aspect was carried out by 43 students, including 2 students who wrote with the wrong answer, 41 students did not write down conclusions and 43 students did not work. The percentage of an error on the draw conclusion aspect was 82,35% with very high criteria.

A circle was one of the topics on mathematical subjects that were included in the aspect of geometry. To solve the mathematical problems on this subject, it was necessary for accuracy and thoroughness as it involves geometric and numerical ideas. Noting the characteristic, the process of observing every step that the student takes to solve the problem.

In general, the errors that students did, occurred because of a lack of skill students especially skills to issue ideas used to solve math problems on the topic circle. Besides, many students have not yet understood how to solve the story. In this case, students were confused to solve the problem of using circle formulas. This was because students lack an understanding of the concept of circles. The lack of practice given to students also affects the students' errors in resolving questions.

Based on the error percentage of each aspect of the error for the description, most students' error do was an error in the drawing conclusion. This was because students did not write the conclusion of the answer. The second most error was the transformation error. This was because students were confused about using circle formulas. The third-largest error was an error in operation. This was due to a lack of student skills in the calculation. The fourth most error was an error in comprehension. This was due to a lack of understanding of the circle topic both in

writing what was known and what was asked in the question. Therefore in the learning process, teachers need to emphasize the concept of circle topic clearly and also teachers need to emphasize the thoroughness in the calculation. Besides, students also need to conduct exercises in both classes and outside classes to improve understanding of the concept of circle topic. Information about the students' errors in resolving the problem of this circle can then be used by the teacher to conduct more effective learning. With effective learning, teachers are expected to minimize the students' errors. But in fact, not all teachers have the ability to design more effective learning so that errors and misconceptions of students can be minimized. It is supported by the research results of Setyaningrum, et al. (2018) indicating that the prospective teacher is still having difficulties in diagnostic the students' errors and how to minimize the errors. This can, of course, be a consideration for the education organizer of prospective mathematics teachers, that the need for an increase in the ability of prospective teachers to diagnostic students' errors and prospective teachers' ability to minimize students' errors so that teachers can help students in mastering a mathematical concept.

CONCLUSION

Based on the results of the research and discussion, it can be concluded that the type of error performed by students of grade VIII of one of junior high schools in Purworejo in solving the problem of mathematics on the subject of circles that are errors in comprehension, transformation, operation, and concluding. The percentage of error in comprehension is 16,93% with very low criteria. The error in transformation is as much as 27,39% with low criteria. The error in operation is as much as 26,30% with low criteria. The error in the drawing conclusions is 71,55% with high criteria.

The students' errors make can be used as consideration for teachers to plan teaching and learning activities. The students' errors take to solve math problems on the subject matter are known so that the teacher can be taken anticipation so that similar errors do not happen again. Students' errors can also provide an overview of the level of students' mastery and ability, knowing the level of mastery and ability of the student, the teacher can know what students need to overcome the difficulty in learning as well as improving it.

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