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Analysis of Junior High School Student's Error in Solving Mathematical Connection Problems on Quadrilateral Topics

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Abstract

Mathematical connection is one of the abilities that need to be possessed by students because it can help students in obtaining meaningful knowledge. However, there are still some junior high school students who have difficulty in solving problems related to mathematical connections on quadrilateral topics, thus allowing errors to occur. The purpose of this study was to obtain a description of the errors of junior high school students in solving mathematical connection problems on quadrilateral topics. This type of research is qualitative research with a case study design. This research was conducted by giving mathematical connection test questions to class VIII junior high school students consisting of three essay questions on quadrilateral topics and the topic of broad expansion in science lessons, as well as conducting interviews with nine selected students. The results showed that there were four types of errors made by students based on Newman's Error Analysis, namely misunderstanding the problem, transformation errors, process skills errors, and writing answer errors. This is caused by the wrong strategy, illogical, carelessness, miscalculation, and misunderstanding of the concept of the quadrilateral.

Keywords: errors, mathematical connection, Newman's Error Analysis, quadrilateral

INTRODUCTION

mathematics. One of the things that can cause students' difficulties in learning mathematics is the difference in the abilities of each student which allows errors to occur in solving a problem (Kamila & Adirakasiwi, 2021). In addition, this can be due to the wrong thinking strategies used, inaccurate algorithm processes, and lack of understanding of the concepts (Nurhasanah, Turmudi, & Jupri, 2021). Errors in solving math problems can be used to detect math learning difficulties so that they can find alternative solutions in solving math problems (Farida, 2015). It is important for teachers to know the location of student errors so that they can identify and anticipate learning difficulties experienced by students.

Based on research conducted by Makhubele, Nkhoma, and Luneta, professional teachers need to analyze student errors in the learning process so that they can examine student errors in various ways (Sudihartinih, 2018). There are several ways that can be used to analyze student errors, one of which is Newman's Error Analysis (NEA) (Halim & Rasidah, 2019). NEA is a system developed by M. Anne Newman that is used to analyze student errors in solving problems in the form of story questions (Ardianzah & Wijayanti, 2020). In addition, NEA can be used to find out the underlying causes of difficulties in students, help teachers to determine the location of student errors, and determine effective learning

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strategies to overcome them (Karnasih, 2015). Newman classifies five types of errors, namely reading errors, problem understanding errors, transformation errors, processing skills errors, and writing answers errors (Clements, 1980).

In this study, mathematical connection questions were used on the quadrilateral topics in the form of word problem. Mathematical connection ability is one of the abilities that must be possessed and developed so that students can connect mathematical concepts, with other fields of science, and apply mathematical concepts in real life (Lestari & Yudhanegara, 2018). This ability requires students to think at a higher level so that meaningful knowledge will be obtained in learning mathematics. According to Piaget, learning is a process of processing information to build knowledge (Karwono & Mularsih, 2017). So that is not just remembering but can integrate knowledge, analyze, make hypotheses, evaluate, and experiment to create new knowledge (Endrayanto, 2021). Therefore, without the ability of mathematical connections, students will find it difficult to understand mathematical concepts and procedures (Ramdhani, Widiyastuti, & Subekti, 2016).

Geometry is important to learn because it can develop logical thinking skills, elaborate spatial instincts, and impart knowledge for the next material. One of the geometry materials studied at the junior high school level is quadrilaterals. The topic of quadrilaterals is important for students to learn because this will have an impact on students' understanding of the next topic, namely solid figure. However, there are still students who make mistakes in solving quadrilaterals (Malinda & Zanthy, 2019). The research from Ardianzah and Wijayanti (2020) stated that. In addition, the author conducted a preliminary study by providing a mathematical connection question on the topic of a quadrilateral which stated that there were still students who made errors.

Based on this description, the authors need to examine the errors of junior high school students in solving mathematical connection problems on the topic of quadrilaterals. This study aims to describe the types of student errors in solving mathematical connection problems on quadrilateral topics based on NEA.

RESEARCH METHOD

This research uses a qualitative approach with a case study research design. The existence of errors made by students in solving mathematical connection problems on quadrilateral topics, this design was chosen to observe and obtain an explanation of the phenomenon and analyze to obtain conclusions. The participants in this study were 28 junior high school students in class VIII consisting of 13 male students and 15 female students in a junior high school in Bandung, West Java. This research was conducted online using research instruments consisting of researchers, test questions, interviews, and documentation.

The steps in this research are (1) conducting tests in the form of description questions consisting of three questions based on mathematical connection indicators, (2) classifying student errors according to NEA, (3) conducting interviews with nine selected students because the student’s answer need to be reconfirmed and from the twelve people selected they are willing to be interviewed, and (4) documentation student work. Data obtained from tests and

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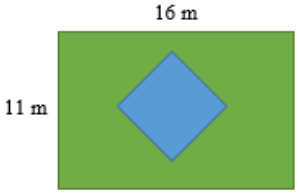
interviews were grouped based on Newman's Error Analysis using ATLAS.ti software. This software could help researchers to organize, code, and analyze research data in a systematic, efficient, and structured way, such as audio, video, or written data (Afriansyah, 2016). To distinguish correct, incorrect, or no answers, the author makes a code. The following is the code used to mark the results of student answers.

Table 1. Student Answers Code

Code	Description	Code Group
F1	Reading errors mean that students make mistakes because they have not been able to interpret the meaning, symbols, or terms that exist in solving a problem.	*Newman's Error Analysis*
F2	Misunderstanding the problem mean that students make mistakes because they do not understand the commands in the questions.	*Newman's Error Analysis*
F3	Transformation errors mean that students have not been able to determine what steps to take or create a mathematical model from the information obtained to solve a problem.	*Newman's Error Analysis*
F4	Process skills errors mean that students make mistakes in performing arithmetic operations.	*Newman's Error Analysis*
F5	Writing answers errors mean that students have not able to explain the answer correctly.	*Newman's Error Analysis*
NA	Did not answer the question on the question mean that students have not been able to understand and solve a problem.	-
TR	The correct answer means that the student is able to understand and solve a problem.	-

After giving the code to each students' answer, then a descriptive analysis is carried out to find out the errors and their causes in solving mathematical connection questions on quadrilateral topics. The questions in this study were arranged based on indicators (1) Students were able to make connections between mathematical topics, namely using the concepts of rectangles and rhombuses in solving problems, (2) students were able to relate and apply mathematical concepts to other disciplines, namely applying the concept of a rectangle and the concept of area expansion in solving problems, and (3) students were able to apply the principle of tiling to everyday problems, namely applying the concept of a rectangle with a square. The following questions are arranged based on these indicators in sequence (questions in Indonesian).

Take a look at the illustration below!



1. A rectangular plot of land with a length of 16 m and a width of 11 m will be made a rhombus-shaped pool with a diagonal of 8 m. If the remaining land area is to be planted with grass, what is the area of the land?

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2. An aluminum piece with a length of $40\ cm$ and a width of $30\ cm$ wide is heated from 40^0C to 140^0C. If the coefficient of expansion is $0.000005/^0C$, what is the area of the aluminum plate after heating?
3. The floor of a house is rectangular with a size of $30\ m\ \times\ 15\ m$. The floor will be covered with ceramic tiles measuring $30\ cm\ \times\ 30\ cm$. If the price of one ceramic tile is Rp7.800,00 then what is the total cost of tiling the floor of the house?

RESULTS AND DISCUSSION

Based on the results of tests and interviews, there are still some students who still make errors in solving mathematical connection questions on the topic of quadrilaterals. The following are the results of grouping student answers based on NEA using ATLAS.ti software.

There are 84 codes are consisting of 43 TR codes which mean the answer is correct, three NA codes which mean not answering, eight F2 codes which mean problem understanding errors, nine F3 codes which mean transformation errors, 15 F4 codes which mean process skill errors, and six F5 codes which mean writing answers errors. When student has been given a one code, for example F3 which is a transformation error, it means that student also make error in process skills and writing answers. Thus, there's no student is given two or more codes at once. In this section, some answers of students who made errors based on NEA will be presented.

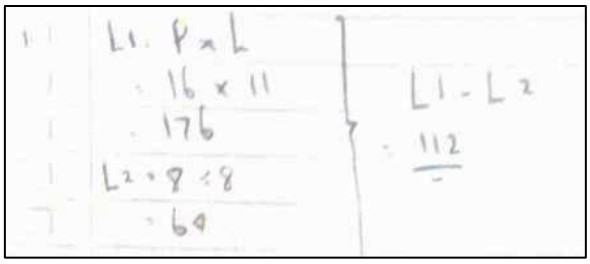

Figure 1 RAA's answer

Figure 1 shows that the student made an error in solving question number one because he was incorrect when calculating the surface area of a rhombic pool. Based on the NEA, the student's answer includes a transformation error which means that the student uses the wrong method or formulation in solving the problem. This error is caused because students use the concept without knowing how to do it.

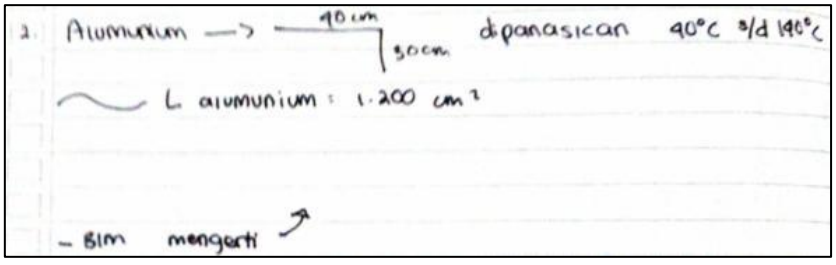

Figure 2 SZP's answer

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Figure 2 shows that students made an error in solving question number two. Based on the NEA, students misunderstood the concept which meant that students lacked understanding of rectangular shapes and the concept of area expansion. Students are only able to calculate the initial area of a rectangular aluminum chip and written "don't understand" (in Indonesian) on the answer sheet after calculating the initial area of the aluminum chip. Even after conducting interviews, students could not explain how to solve the problem.

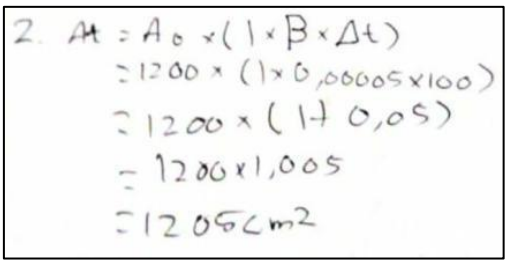

Figure 3 RIW's answer

Figure 3 shows that students made an error in solving question number two because in the steps to solving the problem the student was correct but was wrong in writing the final result of the aluminum chip area after being heated. Based on the NEA, students made an error in writing an answer, which means that they wrote the wrong answer according to the order of the questions. This error is caused because students are careless in doing calculations.

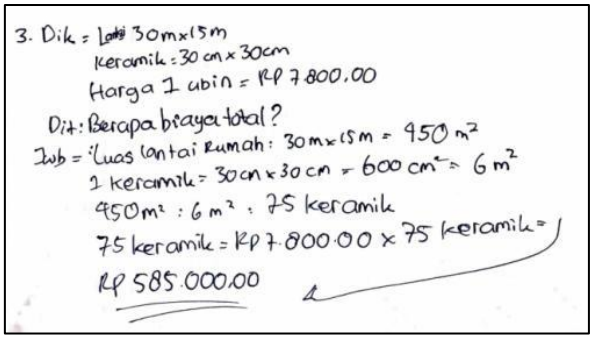

Figure 4 NNH's answer

Figure 4 shows that students made an error in solving question number three because they were wrong in calculating the area of a square ceramic tile. According to the NEA, the student's answer was a process skill error. After the interview, the student realized that he had miscalculated the area of the ceramic tile when he took the test. Then he explained again the steps of the process. However, the student's answer was still categorized as a process skill error because he made an error in converting cm^2 to m^2.

Based on the test results presented above, it was found that the errors made by students based on NEA in solving mathematical connection questions on the topic of a quadrilateral were, misunderstanding the problem, transformation errors, process skill errors, and writing answers errors. First, the cause of students misunderstood the problem, there are, students' lack of understanding of the concept of quadrilaterals and broad expansion (Physics), not understanding how to solve a problem, and not getting used to working on mathematical connection

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problems. Second, the cause of students making transformation errors is not using the right method or formula in solving a problem. Third, the cause of students making errors in processing skills is incorrect in doing calculations and changing units of length or area. And the last one, the cause of students making mistakes in writing answers, namely, incorrect in writing information that is already known on the problem, writing down the results of calculations, writing the right formula in solving problems, writing down the right area unit, and not being accustomed to working on problems by writing down what is known. asked, and the final answer or conclusion.

Based on the characteristics of ways of thinking and ways of understanding, students have the wrong way of thinking by understanding the wrong way in solving mathematical connection problems in quadrilateral topics. This means that students use thinking strategies that are wrong, illogical, or not careful with the algorithm process, miscalculate, and do not understand well the concepts that have been learned (Nurhasanah, Turmudi, & Jupri, 2021). Hence, students cannot optimize the use of knowledge related to mathematical ideas, procedures, or facts from a quadrilateral. The following are the types of errors found in students and their characteristics are presented in the form of the table below.

Table 3. Student Errors and Their Characteristics

No.	Type of Errors	Characteristics
1.	Misunderstanding the problem	Student do not understand well a concept and do not understand the commands in the problem
2.	Transformation errors	Student using a wrong formula, wrong strategies, and illogical
3.	Process skills errors	Student miscalculated and changed units incorrectly
4.	Writing answers error	Student not careful with the algorithm process

The results of research related to student errors based on the NEA are in accordance with the research of Ardianzah and Wijayanti (2020), but there are things that distinguish the research, namely the authors did not find reading errors in students and used test questions with mathematical connection indicators. Then, errors were still found in solving mathematical connection problems on the topic of quadrilaterals, especially on indicators connecting mathematics with everyday life. This is in line with the research found by Malinda and Zanthy (2019).

CONCLUSION

Based on the discussion of the study, it was concluded that there were still some students who were wrong in solving mathematical connection problems on the topic of quadrilaterals. Errors made by students based on NEA are problem understanding errors, transformation errors, processing skills errors, and writing

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answers errors. The type of error that is often found is processing skill error, where students make incorrect calculations and change the unit of length or area. This is caused by the wrong strategy, illogical, carelessness, miscalculation, and misunderstanding of the concept of the quadrilateral. In addition, many errors occur in indicators of the application of mathematics in real life.

There are several suggestions that can be used for further research and professional practitioners related to student error analysis, including (1) students need to practice HOTS questions, especially on mathematical connection skills because it can train students to have more wide and open thinking towards mathematics; (2) it is necessary to explore the concept of a quadrilateral before making mathematical connection test questions in order to find possible errors made by students; and (3) teachers should use error analysis to identify the location of student errors as a source of information in the learning process so that they can find out the causes of errors to overcome students who make error.

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