

## **Analisis Kesalahan Siswa Berdasarkan Teori Kesalahan Kastolan dalam Menyelesaikan Soal Relasi dan Fungsi Kelas VIII SMP IT Bangkinang**

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### **Abstrak**

Berdasarkan teori kesalahan Kastolan, kesalahan yang dilakukan dalam menyelesaikan soal matematika terdiri dari tiga kesalahan yaitu konseptual, prosedural, dan teknis. Penelitian ini bertujuan untuk menganalisis dan menjelaskan kesalahan yang dilakukan siswa saat menjawab pertanyaan matematika tentang relasi dan fungsi. Penelitian merupakan penelitian deskriptif kualitatif. Subjek dalam penelitian ini yaitu 30 siswa kelas VIII SMP IT Bangkinang. Pengumpulan data dilakukan dengan teknik tes. Instrumen yang digunakan adalah lima soal relasi dan fungsi berbentuk uraian. Validitas soal kemudian dihitung dan kesalahan soal yang memenuhi kategori digunakan dianalisis. Hasil penelitian menunjukkan bahwa kesalahan yang paling banyak siswa lakukan ialah kesalahan prosedural. Tingkat kesalahan siswa berdasarkan jenis kesalahan adalah 12,87% untuk kesalahan konsep, 74,26% untuk kesalahan prosedur, dan 12,87% kesalahan operasi hitung. Faktor-faktor yang membuat siswa salah dalam mengerjakan soal relasi dan fungsi adalah siswa tidak memperhatikan, siswa tidak bisa membedakan relasi yang termasuk fungsi dan bukan fungsi, dan siswa terburu-buru untuk melakukan operasi aljabar, bahwa siswa tidak menyelesaikan soal sampai hasil akhir.

**Kata Kunci:** analisis kesalahan, relasi dan fungsi, teori kesalahan kastolan.

### ***Analysis of Student Errors in Solving Relation and Function Problems Based on Kastolan Error Theory Class VIII SMP IT Bangkinang***

#### ***Abstract***

*Based on Kastolan's error theory, the mistakes made in solving math problems consist of three errors, namely conceptual, procedural, and technical. This study aims to analyze and explain the mistakes made by students when answering mathematical questions about relations and functions. This research is qualitative descriptive research. The subjects in this study were 30 class VIII students at SMP IT Bangkinang. Data collection is done by testing techniques. The instruments used were five questions of relations and functions in the form of descriptions. The validity of the questions was then calculated and the errors in the questions that met the categories used were analyzed. The results of the study showed that the most errors students made were procedural errors. The error rate of students based on the type of error is 12, 87% for conceptual errors, 74.26% for procedural errors, and 12.87% for arithmetic operations errors. Factors that make students make mistakes in working on relations and functions are that students do not pay attention, students cannot distinguish relations that are functions and not functions, and students are in a hurry to carry out algebraic operations, that students do not complete the problem until the final result.*

**Keywords:** error analysis; kastolan error theory; relation and function

## **INTRODUCTION**

Mathematics is considered a powerful tool for solving human problems. All problems that exist in life can be transformed into a mathematical model to be able to find solutions that can be applied based on the provisions that exist in mathematics lessons (Risnawati, 2015). Mathematics is a compulsory subject for students at every level of education, from Elementary School (SD) to High School (SMA). Relations and functions are mathematics material taught in schools. Based on the KI and KD mathematics syllabus in the 2013 curriculum, the KD that can be achieved by Grade VIII students is to describe and state relations and functions by using various representations (As'ari, Tohir, Valentino, Imron, & Taufiq, 2017). In learning relations and functions, a good understanding of concepts is needed so that mistakes do not occur in solving problems. However, students still do not master the material relations and functions properly.

Research result Rosidah, Nadya, Hasanah, & Sulistiawati (2019) states that students still have difficulty understanding and distinguishing relations and functions. Research conducted Wahid & Marlina (2022) at the Nihayatul Amal Purwasari Foundation students still find it difficult to work on the questions. The location of student errors in solving problems is procedural errors and conceptual errors. The cause of the error is that students do not pay attention to problem solving, students do not pay attention to problem solving steps, misunderstanding concepts, students do not understand the meaning of the question, and students do not understand the material related to the problem. Then based on the research conducted Yanti, Melati, & Zanty (2019) at SMPN 1 Margaasih that students still find it difficult to work on questions about relations and functions. Next, research Kamariah & Marlissa (2016) shows that students are wrong in determining functions and not functions and determining the value that fulfills a function. And based on research Arfany, Lestari, Fitrianiingsih, & Mustangin (2021) states that students make more mistakes in understanding concepts, students tend to mention relationships in less detail, and students make mistakes when applying relations in everyday life.

Based on some of the results of previous research, the effort to be able to explore students' mathematical abilities optimally is that teachers must be able to understand the conditions of their students. One way to understand students is to know their weaknesses or failures in solving problems. Error is a form of deviation from a truth (Sulistio, Muhsetyo, & Qohar, 2019). Error is a deviation in completing work caused by non-compliance with established procedures (Aulia & Kartini, 2021). According to Wijaya (2013) error is a form of deviation from what is correct, deviates from a certain procedure, or is expected.

One way to analyze student errors when solving problems related to relations and functions is to use the Castolan error theory. Castolan-based error analysis is a method that can be used to analyze errors made by students when solving math problems (Yulanda, 2018). According to Luthfia & Zanthi (2019), errors in solving math problems consist of three errors, namely conceptual, procedural, and technical. Khanifah (2013) stated that mathematical errors were divided into three errors: conceptual errors, procedural errors, and technical errors. Concept errors are student errors in interpreting characteristics, facts, principles, and concepts. Procedural errors, namely errors in writing symbols, systematic rule steps to solve problems. Technical errors such as errors in writing variables and errors in understanding the questions.

Based on the problems that have been described, it is necessary to have a deeper analysis of the mistakes made by students in solving relations and function questions with the aim of being able to find out how much the percentage of student errors is in solving relations and function questions with castor stages and to minimize students' mistakes so they don't the same mistake.

## **METHOD**

This type of research is descriptive qualitative research which details the types of errors students make in solving relations and function problems. This research was conducted at SMP IT Bangkinang in the even semester of the 2021/2022 academic year. In this study, 30 class VIIIIE students were used as research subjects.

Data collection in this study was carried out using test techniques. The test was carried out on research subjects which were compiled based on indicators of relational and function material in the amount of 5 description questions which would then be analyzed by students' answers based on the caste error theory. The main instrument in this research is the researcher himself. Qualitative researchers as human instruments, function to determine research focus, select providers as data sources, collect data, evaluate data quality, analyze data, interpret data, and draw conclusions from the results (Sugiyono, 2016).

The steps of the data analysis procedure, namely the initial stages of the researcher making research instruments in the form of test questions. Test questions are validated by the validator before use. At this stage, the researcher categorizes student answers into two types, namely correct answers and wrong answers, and analyzes the test results data. The student's wrong answers were analyzed and categorized into the caste error theory.

The percentage of errors in solving the average student problem was adopted from research conducted by Kurniawan & Fitriani (2020) in Table 1.

Table 1. Error Rate

No.	intervals	Category
1.	$0\% \leq P \leq 20\%$	Very low
2.	$20\% < P \leq 40\%$	Low
3.	$40\% < P \leq 60\%$	Enough
4.	$60\% < P \leq 80\%$	Tall
5	$80\% < P \leq 100\%$	Very high

**RESULTS AND DISCUSSION**

This research was conducted in the even semester of class VIII E SMP IT Bangkinang. This study began with a written test in the form of a description with five questions for all class VIII E students of SMP IT Bangkinang and a total of 30 students. After testing, the researcher used a data analysis program to analyze the validity, reliability, level of difficulty and discriminating power of the items. Test questions are said to be valid if the questions can be measured properly according to size. In this test, the results are obtained at a significant level 5% and r table is 0.361. After ascertaining the validity, reliability, level of difficulty, and discriminating power of the items, the recapitulation of the results of the instrument analysis of student questions can be seen in Table 2.

Table 2. Results of Recapitulation of Instrumental Analysis of Relationships and Functions

No.	Validity test	Reliability	Difficulty Level	Discriminating Power	Information
1.	Valid		Easy	Bad	Not used
2.	Valid		Currently	Good	Used
3.	Valid	0.848	Easy	Enough	Used
4.	Valid		Easy	Good	Used
5	Valid		Easy	Good	Used

Based on the results of the analysis of the validity of the items totaling 5 questions, it was found that all questions were valid with a reliability of 0.848, the category was very high, item 1 was not used and questions 2, 3, 4 and 5 could be used. After testing the validity, reliability, difficulty level, and discriminating power of the questions, they were tested on class VIII E even semester, where students have received the material.

Next, the researcher analyzed the students' answers using castoran error analysis. The results of data analysis carried out with 4 items used on 30 students can be seen in Table 3.

Table 3. Percentage of Errors

No Question	Error Type		
	Conceptual	Procedure	Count Operation
2.	20.69%	79.31%	0%
3.	14.29%	85.71%	0%
4.	0%	83.87%	16.13%
5.	18.52%	51.85%	29.63%

Question 2 for the achieved GPA is to determine which relations are functions and which are not functions. The problem given is that it is known that the relation from set  $A = (1,2,3,4)$  to set  $B = (a,b,c,d)$  is expressed in the set of ordered pairs as follows: a.  $\{(1, a), (2, b), (3, c), (4, d)\}$ , b.  $\{(1, b), (2, a), (3, c), (2, d)\}$ , c.  $\{(1, a), (2, b), (3, c), (1, d)\}$  Of the three relations, which one is a function and which is not a function? Explain your reasons! In question 2, 6 students made conceptual errors with a percentage of 20.69%, 23 students made procedural errors with a percentage of 79.31%. These errors can be seen in Figure 1 and Figure 2.

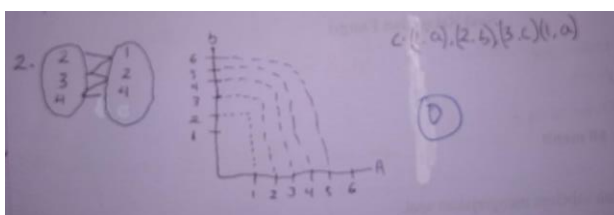


Figure 1. Concept Error and Procedural Error In Question 2

Figure 1 students make conceptual errors and procedural errors. Students have not been able to distinguish between relations that are functions and not functions. Students also do not give reasons for these relations including functions and not functions. This is because students do not understand the contents of the questions or the concept of relations and functions.

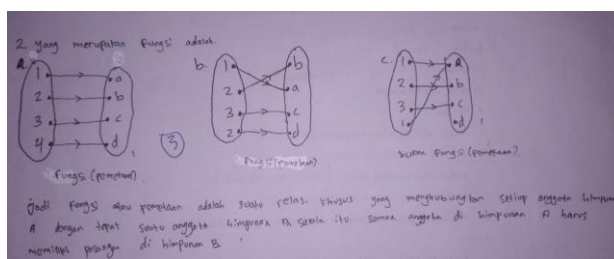


Figure 2. Concept Error In Question 2

Figure 2 students make conceptual errors. Students do not pair the right sets with their partners in making arrow diagrams so that they are wrong in determining functions and not functions. The b part should not be a function.

Question 3 for the achieved GPA is to give an example of the function of a set in Cartesian diagrams and arrow diagrams. The questions given are the following set of sequential pairs regarding the preferred sport, namely,  $\{(Afifah, Berenang), (Beni, Basket), (Chava, Melukis), (Didi, Badminton), (Elena, Menggambar)\}$ . Based on these sets, make functions in the form of arrow diagrams and Cartesian diagrams! In question 3, 2 students made conceptual errors with a percentage of 14.29%, 12 students made procedural errors with a percentage of 85.71%. These errors can be seen in Figure 3 and Figure 4.

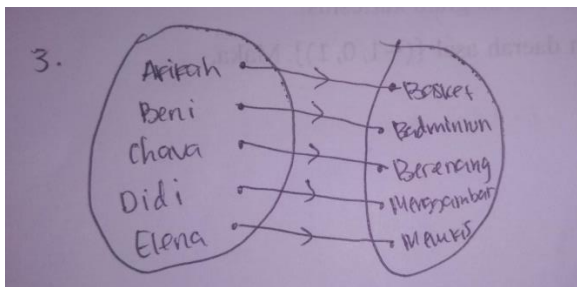


Figure 3. Concept Error and Procedural Error In Question 3

Figure 3 students make conceptual errors and procedural errors. The students paired the sets incorrectly and the students only made arrow diagrams so that students made procedural errors by not making Cartesian diagrams.

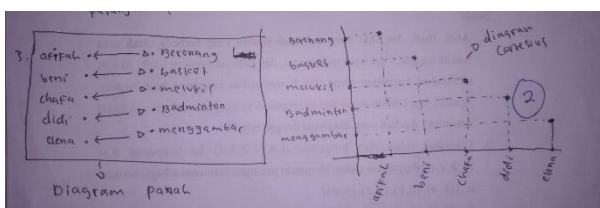


Figure 4. Concept Error In Question 3

Figure 4 students make concept errors. Students are right in pairing sets but students are wrong in making arrow diagrams. The arrow diagram should be separated between sets.

Question 4 for the achieved GPA is determining the result area based on a certain function. The problem given is a function  $f(x) = -2x^2 - 4x - 1$  with origin  $(-1,0,1)$ . Then the result area is? In question 4, 26 students made procedural errors with a percentage of 83.87% and 5 students made arithmetic operations errors with a percentage of 16.13%. These errors can be seen in Figure 5 and Figure 6.

Figure 5. Error Count Operation Procedure and Error In Question 4

Figure 5 students make procedural errors and arithmetic operations errors. The student is correct in finding the result area for  $x = 0$ . However, students are wrong in determining the result area for  $x = -1$  and  $x = 1$ . Students also do not write down the result area obtained as the result area  $(-7, -1, 1)$ .

4.  $F(x) = -2x^2 + 4x - 1 \in (1, 0, 1)$   
 $F(-1) = -2(-1)^2 + 4 \times (-1) - 1$   
 $= -2(1) + (-4) - 1$   
 $= -2 - 4 - 1$   
 $= -6 - 1$   
 $= -7$

Figure 6. Procedure Error In Question 4

Figure 6 students make procedural errors. The student correctly determines the result area for  $x = -1$ . However, students do not look for other result areas and students do not write down the result areas obtained as result areas  $(-7, -1, 1)$ .

Question 5 for the achieved GPA is solving problems related to relationships. The problem given is  $P = (2, 3, 4, 5)$  if Q is the square of P. Determine the value of Q! make a relation from set P to set Q in the arrow diagram! In question 5, 5 students made conceptual errors with a percentage of 18.52%, 14 students made procedural errors with a percentage of 51.85% and 8 students made arithmetic operations errors with a percentage of 29.63%. These errors can be seen in Figure 7, Figure 8, and Figure 9.

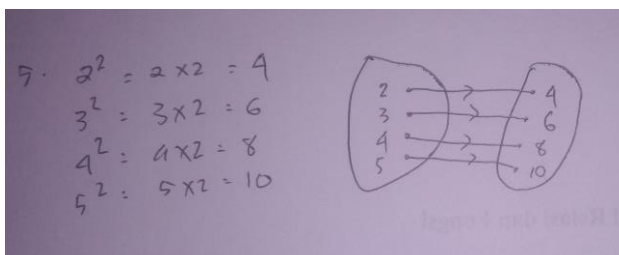


Figure 7. Concept Error In Question 5

Figure 7 students make conceptual errors. The student is wrong to find the square of the set P. The student writes down  $3^2 = 3 \times 2 = 6$ ,  $4^2 = 4 \times 2 = 8$ ,  $5^2 = 5 \times 2 = 10$  which should be  $3^2 = 3 \times 3 = 9$ ,  $4^2 = 4 \times 4 = 16$ ,  $5^2 = 5 \times 5 = 25$ .

5.  $2^2 = 2 \times 2 = 4$   
 $3^2 = 3 \times 3 = 9$   
 $4^2 = 4 \times 4 = 16$   
 $5^2 = 5 \times 5 = 25$

Figure 8. Procedure Error In Question 5

Figure 8 students make procedural errors. Students are right to find the square of the set P. However, students do not make the relationship in the arrow diagram of the set.

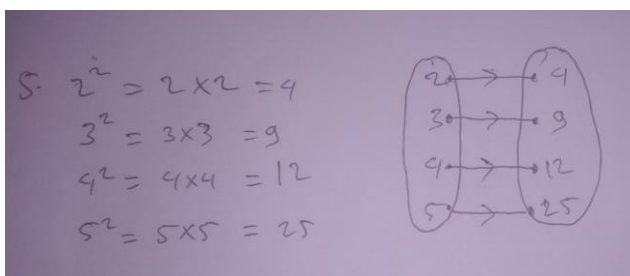


Figure 9. Count Operation Error In Question 5

Figure 9 students make arithmetic operations errors. In finding the square of 4 students wrong in the product. Students write  $4 \times 4 = 12$  should  $4 \times 4 = 16$ .

Based on the explanation of student errors, the average percentage of errors made by students can be seen in Table 4.

Table 4. Average Percentage of Student Errors

No.	Error Type	Percentage
1.	Draft	12.87%
2.	Procedure	74.26%
3.	Count Operation	12.87%

In this study, the researcher conducted an error analysis consisting of concept errors, procedural errors, and arithmetic operations errors. In the error of the student's concept wrong in determining the function. Students make mistakes when pairing relations from sets. In addition, the students were wrong in describing the squares.

The student procedural error does not explain the reason why the relation is a function. Students also do not determine the value of all areas of results. In addition, students only make relationships in arrow diagrams and do not make them in Cartesian diagrams. Errors in arithmetic operations performed by students in calculating algebraic forms.

## DISCUSSION

Conceptual errors are errors where students are unable or wrong to use the formula correctly. This conceptual error can occur if a student cannot understand the concepts related to the material that has been taught. This type of error is made by students, it can be seen from students who do not know the formula used or use the formula incorrectly to solve relation and function problems. Based on the results of the students test on question number 5, the student is wrong to find the square of the set P. The student writes down  $3^2 = 3 \times 2 = 6$ ,  $4^2 = 4 \times 2 = 8$ ,  $5^2 = 5 \times 2 = 10$  which should be  $3^2 = 3 \times 3 = 9$ ,  $4^2 = 4 \times 4 = 16$ ,  $5^2 = 5 \times 5 = 25$ . The percentage of students who make mistakes in this type is 12.87%.

Procedural errors are students' errors in compiling systematic steps to answer questions. Students cannot change story problems into mathematical form. This happens because students cannot know what is known and asked about the problem, do not read the problem correctly and do not know the steps used to solve the problem. Based on the results of the student test on question number 4, the student correctly determines the result area for  $x = -1$ . However, students do not look for other result areas and students do not write down the result areas obtained as result areas  $(-7, -1, 1)$ . The percentage of students who make mistakes in this type is 74.26%.

Arithmetic operations errors are errors in calculations made by students in solving problems. A student can be said to have made an arithmetic operations error if the student cannot perform the calculation correctly. This is usually caused by students rushing to do the questions. Based on the results of the student test on question number 5, in finding the square of 4 students wrong in the product. Students write  $4 \times 4 = 12$  should  $4 \times 4 = 16$ . The percentage of students who make mistakes in this type is 12.87%.

Based on the results of the previous research and discussion, the researcher carried out an error analysis consisting of concept errors, procedural errors, and arithmetic operations errors. In the error of the student's concept wrong in determining the function. Students make mistakes when pairing relations from sets. In addition, the students were wrong in describing the squares. The student procedural error does not explain the reason why the relation is a function. Students also do not determine the value of all areas of results. In addition, students only make relationships in arrow diagrams and do not make them in Cartesian diagrams. Errors in arithmetic operations performed by students in calculating algebraic forms.

Students have difficulty distinguishing relations and functions, students are also wrong in determining functions and not functions, and determining the value that fulfills a function, this is in line with Kamariah & Marlissa (2016) and Rosidah et al. (2019). In understanding concepts, students still make many mistakes. Students tend to mention relationship in full and students are wrong in connecting relationships in everyday life, this is in line with Arfany et al. (2021). Students cannot explain the reasons why relations are functions and not functions. Students also cannot complete the task until the final result.

## CONCLUSION

Based on the analysis, it was concluded that the average conceptual error was 12.87%, procedural error was 74.26%, and arithmetic operation error was 12.87%. The most common error is procedural error. Students cannot explain the reasons why relations are functions and not functions. Students also cannot complete the task until the final result. The wrong factors in solving relations and function problems are lack of attention students, the inability to distinguish between relations and functions, rushed algebraic operations, and the final results to problems resolved.

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