

## **The Analysis of Students' Error in Solving Mathematics Problem**

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**Abstract:** Education is a learning process for students to be able to understand and make humans more critical in thinking. The purpose of this study was to determine the analysis of students' difficulties in solving questions on the subject of algebra. This research was conducted at Guilin Middle School, Guangxi, China in student's grade 8, a total of 40 students from 3 different rooms. The research subjects were taken as many as 9 students, each room was taken by 3 students in the low category, 3 students in the medium category and 3 other students in the high category based on the results of students' tests on 3 different question numbers. The approach used in this research was descriptive research with a qualitative approach. The results of the analysis carried out by several students in solving questions on the subject of fractions, found students' errors which included conceptual errors and procedural errors. Conceptual errors made by students include errors remembering definitions and rules, simplifying errors, errors in operating the factor and errors in understanding the addition and subtraction operations of numbers. While procedural errors made by students include unsystematic settlement errors, errors unable to manipulate the settlement process, errors in simplifying the factoring, errors in solving absolute values, errors substituting values and errors not continuing the settlement process. Therefore, this research has implications for teachers to ensure that students could know and could understand the definitions and rules needed in the material being taught, so that learning activities will run well according to the desired goals.

**Keywords:** student error, difficulty, mathematics, education

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### **1. Introduction**

Education is a learning process for students to be able to understand and to make humans more critical in thinking[1]. Education is a process carried out by human children to prepare the younger generations[2].

Education in general is any effort that is planned to influence other people, individuals, groups, or communities so that they do what is expected by the actors of education[3], [4].

Education can be a provision for someone to make innovations and to make improvements in aspects of their life that lead to self-improvement[5], [6]. The role of education is so important, the problem of education has always been a concern for the government in every country[7]. The government of a country always makes various efforts to improve the quality of education, including making improvements and improvements to the school curriculum, improving educational facilities and infrastructure, issuing policies to develop national education in accordance with the demands of science and technology[8], [9]. Currently, the quality of education really needs to be improved, especially mathematics. In an effort to develop this potential, it is necessary to improve the quality of education in various fields, one of which is mathematics.

Mathematics is one of the basic sciences for human life[10]. Mathematics is one of the compulsory subjects that can be found in schools from elementary school, junior high school, senior high school until tertiary school[2], [10]. Mathematics plays a very important role in bringing students' thoughts to an interdisciplinary logic of thinking which has now become a powerful approach to developing scientific and technology[11], [12]. Mathematics is the study of a mindset, an art, a language, and a tool. It is said to be a mindset, an art, and the language of relationships because in mathematics there are relationships between concepts and the truth are often sought to make generalizations[13], [14].

The purpose of learning mathematics in school is to prepare students to be able to face changing conditions in the life of the world, prepare students to be able to use mathematics and mathematical thinking patterns in everyday life and in studying various sciences, so mathematics is so important to be studied in every educational stage. In addition, the basic objectives of learning mathematics for students are: 1) Understanding knowledge (factual, conceptual, and procedural); 2) Explaining and performing the operations of calculating integers and fractions by utilizing various operation properties; 3) Understanding definitions, explaining the relationship between concepts, and applying concepts accurately, efficiently and precisely in problem solving; 4) Using a reason on patterns and properties, performing mathematical manipulations in making generalizations, compiling evidence, or explaining mathematical ideas and statements[15]–[18].

Based on the above objectives of learning mathematics, students are required to have a mathematical ability[19]. Mathematical skills are used by students to understand knowledge and solve the problems they face. In this case, it is the teacher who plays a role in providing motivation to students so that they can learn mathematics properly to improve students' abilities. Because it is the duty of an educator (teacher)[20]. Teacher is a professional education with the main task of educating, teaching, directing, assessing, training, and evaluating students[21]. However, the fact that students consider mathematics to be a scary subject for some students, even students rarely consider it a fun subject. Mathematics subjects are almost always identified with a fierce teacher, difficult material to understand, many complex calculations, and the use of symbols that are considered to confuse students[22]. Until present, many people still think that mathematics is a difficult subject, to learn it requires a certain will, ability, and intelligence. The teachers generally view that all students who get low learning achievement are called students with learning difficulties[23], [24].

Learning difficulties can be translated from the phenomenon where students experience difficulties when the person concerned does not succeed in achieving a certain qualification level of learning outcomes based on the criteria for success as stated in the instructional objectives or level of development[25]–[27]. Students who have learning difficulties, especially in understanding math problems usually students often make mistakes in solving problems is given, this is because the students' understanding of the definition, the rules along with the

mathematical concept underdone, on the another mismatch method and system of teaching given by the teacher resulted in students being increasingly unable to understand mathematics at a higher level[28]–[30].

The problem that needs attention related to mathematics is the number of mistakes that students make in solving math problems. Common mistakes that students often make in solving math problems include errors in understanding the definitions and rules, errors in carrying out operations or manipulating, errors in calculating, errors in the accuracy of the substitution of a given value and using the completion procedure. Therefore, to solve math problems in essence, you must pay attention to some of these important things. This means learning mathematics must be gradual, sequential and systematic[27]. If it is associated with the mistakes that are often made by students with the bloom taxonomic theory with several stages such as remembering, understanding and analysis, it is still insufficient to determine the steps to work on the questions given and the difficulty in understanding the meaning of the questions given[25], [31]–[33].

Based on the explanation above, the researcher wants to analyze the students' mistakes in solving mathematics problems on the subject of algebra at the grade 8 Guilin middle school-Guangxi-China.

## 2. Research Method

This research was conducted at the Junior High School of Guilin Junior High School in the periode of 2020/2021 in grade 8, a total of 40 students from 3 different classes' rooms. The research subjects were taken as many as 9 students, each room was taken by 3 students in the low category, 3 students in the medium category and 3 other students in the high category based on the results of students' tests on 3 different question numbers. The approach used by researchers in this research was descriptive research with a qualitative approach[34], [35]. A qualitative approach is a research approach that produces descriptive data in the form of written or spoken words from people and observable behavior intends to understand the phenomenon of what is understood by research subjects[36], for example behavior, perceptions, actions in a special natural context. And by making use of various scientific methods. Where the researchers analyzed the students' difficulties in solving math problems on the subject of algebra. The process in this study consisted of several stages, namely: the initial stage of compiling a research instrument in the form of test questions, answer keys and assessment scores for the problem solving steps. Next, at the implementation stage, the researcher gave a test to students, determining six students based on the lower, medium and high categories. In this final stage, the researcher analyzed students' answers to the tests that have been done, made conclusions and provided suggestions. Then the assessment score given based on the steps to solve the problem can be seen in table 1 below.

**Table 1** : Assessment criteria

<i>Interval</i>	<i>Value category</i>
86 - 100	Very high
71 - 85	medium
56 - 70	Enough
41 - 55	Low
< 40	Very low

In table 1 above, the assessment scores for each of these intervals will be used by the researcher in scoring each stage of solving questions on the subject of algebra and the test referred to in this study contains questions in the form of description, which means that students need to describe and simplify it so that it is easy. To get the final solution, so a score will be given on each step of the solution.

Therefore, this test question aims to determine the accuracy and errors that students will make when simplifying the questions at each stage.

### 3. Result and Discussion

In the initial step, students learnt individually about the subject of fractions to complete practice questions on the subject of algebra of students who did not understand it, did not remember the definitions that have been learned, some forget the simplification steps so that it is difficult to get to the next completion steps. Furthermore, the researcher gave questions to students to work on individually, namely:

1. 解方程 (Solve equation) : $\frac{2}{x-1} - \frac{4}{x^2-1} = 0$ ;
2. 计算 (Calculate) : a. $\frac{a^2-2a+1}{a^3-a} \div \frac{a-1}{a^2-1} = 0$ ,  b. $(-2)^3 + (2004 - \pi)^0 - \left  -\frac{1}{2} \right $ ;
3. 先化简, 再求值 (Simplify, then evaluate) : $\frac{b}{a^3-b^2} \div \left( 1 - \frac{a-1}{a^2-1} \right)$ , 其中 (of them) $a = -1, b = 3$

Figure 1: Equations of test

The following are the results of the student work shown in figure 1 to figure 6. for pictures 1 to 3 means question 1, pictures 4 to 6 means question 2 and pictures 7 to 9 means question no.3. The three different questions were answered by 9 different students with low, medium and high score categories. So each question that was solved by two students for each room had different categories. In question no 1 is coded AQ, question no 2 is coded BQ and finally is coded CQ. Next, for more details, it can be seen in table 2 below;

#### 1. Students' class A answers to questions number 1 to number 3

The bellow is a calculations and process and the result of 3 students a representation of Class A;

Figure 2: the result of student in middle category

Figure3: the result of student in

Figure 4: the result of student in

high category

low category

Figure 2 showed the process calculation of student AQ01. Students' calculation procedure was correct, but  $x = 1$  satisfies  $(x + 1)(x - 1) = 0$ . However, the student's result is  $(x + 1)(x - 1) = 2$ . Therefore, the student's checking calculation was wrong and the final conclusion was also wrong.

Figure 3 showed the results for student AQ02. It is to simplify the numerator and denominator of the first fraction, and then multiply by the reciprocal of the second fraction, and the students' grades showed that all the simplification and calculation procedures were correct. Here are the results for the student in question 2. The second part was also correct, because the student still remembered the exponent operation of a negative number, the student still knew that any value or variable to the power of 0 was always equal to 1, and the student still remembered the definition of absolute value. Therefore, students' AQ01 scores were all correct.

Figure 4 showed the results for student AQ03. Although the student used the correct equation of square deviation when simplifying, they could not remember the numbers and the general rules of fractions, so they could not proceed to the next process and finally could not replace the determined A and B.

## 2. Students' class B answers to questions number 1 to number 3

The below is a calculations and process and the result of 3 students a representation of Class B;

Figure 5 shows a student's handwritten work for a math problem. The problem is: "1. 解方程:  $\frac{2}{x-1} - \frac{4}{x^2-1} = 0$ ". The student's solution involves finding a common denominator, simplifying, and solving for x, concluding that x=1 is the solution. There are red checkmarks and a large red '100' written over the work.

Figure 5: the result of student in high category

Figure 6 shows a student's handwritten work for a math problem. The problem is: "2. 计算: (1)  $\frac{a^2-2a+1}{a^2-a} \div \frac{a^2+a}{a(a+1)}$ ". The student's solution involves simplifying the fractions and performing the division. There are red checkmarks and a large red '100' written over the work.

Figure 6: the result of student in low category

Figure 7 shows a student's handwritten work for a math problem. The problem is: "2. 先化简, 再求值:  $\frac{b}{a^2-b^2} \div (1 - \frac{a}{a-b})$ , 其中  $a = -1, b = 3$ ". The student's solution involves simplifying the expression and then substituting the values of a and b. There are red checkmarks and a large red '100' written over the work.

Figure 7: the result of student in middle category

Figure 5 showed the results for student BQ01. Multiply these two fractions by  $(x + 1)(x - 1)$ , and the first fraction simplifies to  $2(x + 1)$ , and the second fraction simplifies to  $-4$ . So she got  $2(x-1)-4 = 0$ . Here we get  $x = 1$ , which satisfies  $(x + 1)(x-1) = 0$ , so the final conclusion of student's was correct, so the student's score was classified as the best.

Figure 6 showed the result of the student's BQ02 calculation. The students first simplified the second fraction and then took the inverse of it and multiplied it by the first fraction, which was correct in completing the first fraction. But there was a mistake in the next stage. Student did not talk about A2-1 to simplify it, so they got the final result. Although the final answer was correct, it was not good enough for student to complete all the process of simplification. In the second part, there was an error, student still knew that any value or variable to the power of 0 was always equal to 1, and student still remember the definition of absolute value. Although the

student still remembered the rules for assigning negative numbers, the student made an error in the calculation or forgot to write the negative sign, resulting in an incorrect answer.

Figure 7 showed the results for student BQ03. Student have correctly completed the simplification process of the first part. In the second part, students made a substitution error by writing the value of the letter A in the denominator as 1 when they substituted the value of the variable. So the end result was wrong.

### 3. Students' class C answers to questions number 1 to number 3

The bellow is a calculations and process and the result of 3 students a representation of Class C;

2.先化简,再求值:  $\frac{b}{a^2-b^2} \div (1 - \frac{a}{a-b})$ , 其中  $a=-1, b=3$ .  
 解:原式 =  $\frac{b}{(a-b)(a+b)} \div (\frac{a}{a} - \frac{a}{a-b})$   
 $= \frac{b}{(a-b)(a+b)} \div \frac{a-b}{a-b}$   
 $= \frac{b}{(a-b)(a+b)} \cdot \frac{a-b}{a-b}$   
 $= \frac{b}{a+b}$   
 当  $a=-1, b=3$  时,  
 则原式 =  $\frac{3}{-1+3} = \frac{3}{2}$

Figure 8: the result of student in low category

班级: 初1906 姓名: 曹敏  
 2.计算: (1)  $\frac{a^2-2a+1}{a^3-a} \div \frac{a-1}{a^2+a}$   
 解:原式 =  $\frac{(a-1)(a-1)}{a^2-a} \cdot \frac{a+1}{a^2+a}$   
 $= \frac{a^3-2a+1}{a^2-a} \cdot \frac{a+1}{a^2+a}$   
 $= a^3-2$   
 (2)  $(-2)^3 + (2004-\pi)^0 - |\frac{1}{2}|$   
 解:原式 =  $-8 + 1 - \frac{1}{2}$   
 $= -9$

Figure 9: the result of student in middle category

2.先化简,再求值:  $\frac{b}{a^2-b^2} \div (1 - \frac{a}{a-b})$ , 其中  $a=-1, b=3$ .  
 解:原式 =  $\frac{b}{(a+b)(a-b)} \div (\frac{a+b}{a+b} - \frac{a}{a-b})$   
 $= \frac{b}{(a+b)(a-b)} \div (\frac{a+b-a}{a-b})$   
 $= \frac{b}{(a+b)(a-b)} \cdot \frac{a-b}{a-b}$   
 $= \frac{b}{a+b}$   
 当  $a=-1, b=3$  时,  
 原式 =  $\frac{3}{-1+3} = \frac{3}{2}$

Figure 10: the result of student in high category

Figure 8 showed the results for student CQ01 in the lower category of results. Since there was an error from the first step of the universal score, the simplified score was wrong, which directly led to the error of everything that followed.

Figure 9 shows the results for student CQ02. The students only factored the first fraction of the numerator, leaving the rest unchanged. Moreover, student directly changed the division sign into a times sign without changing the second score, so student did not understand the meaning of factorization or forgot the corresponding formula. In the second part, students still remembered the exponent operation of negative numbers, and moreover, each number or variable to the power of 0 was always equal to 1, but student did not remember the definition of absolute value, so it was the wrong operation to make the final result was also wrong.

Figure 10 showed the results for student BQ03 in the top category. That is, the student's completion first simplified the second fraction, equalized the denominators, and added and subtracts the same variable. In the next stage, the second fraction must be reversed, multiplied by the first fraction, so that it simplified to the correct answer. Then replaced the values of a and b with the corresponding numbers, and the final result showed that everything was correct.

Table 2: Students' answers to questions number 1 to number 3

From the results of the student error analysis above, the researcher categorized the students' errors into two categories of errors, namely conceptual errors and procedural errors.

<i>a. Conceptual errors</i>	Mistakes remembering definitions and rules	This error was done by student BQ02 in the second question, where they could not remember the definitions and rules of exponent so that they showed wrong results and student CQ02 proved in the answer that the students had errors remembering the definitions of absolute values so that they also showed wrong results.
	Mistakes simplify	This error was made by student CQ02, where students did not remember the rules for simplifying the multiplication and division of a fraction because the student showed an error at the completion stage.
	Error operating the factor	This error was done by student CQ01 and students BQ02 in the first question that, the two students made mistakes in operating a factor so that at the completion stage and the final result was wrong.
	Error understanding addition and subtraction operations	This error was made by students BQ02 and BQ03 in the second question, that the student made a mistake in the operation of adding and subtracting real numbers to fractions so that the solution step was wrong so that the result also was wrong.
<i>b. Procedural errors</i>	Unsystematic completion error	This error was often made by students when they have experienced a point of confusion. Finally, the students did an unordered completion procedure. This was shown in the results of student AQ03 and AQ02. The two students at the end of completion wrote the final result. Even though the previous step was not systematic with the written results.
	Errors because cannot manipulate the resolution process	This error was committed by students AQ03, CQ01 and CQ03. They could not manipulate the completion process because they have difficulty how to manipulate to the next process.
	Error simplifying	This mistake was made by student CQ01 , students'

	factoring	AQ02 and BQ02 because they did not really understand how to simplify factoring. Therefore, when simplifying the factoring, it was not in accordance with the rules.
	Error resolving absolute values	This error was made by student CQ02 because they did not remember the definition so that at the completion stage it showed wrong results.
	Error substituting value	This error was made by student BQ03 because the student was too hasty in his work and was not careful so that in the end substituted the wrong grades which resulted in wrong processes and results.
	Error, because does not continue with the resolution process	This error was made by students AQ03. The student could not continue the process of solving it because he started to get confuse and had difficulty how to proceed with the next steps.

#### 4. Conclusion

Based on the findings of research conducted by several students in solving problems on fractional material, students' errors were found which included conceptual errors and procedural errors. Conceptual errors made by students include errors in remembering definitions and rules, simplification errors, errors in factoring operations and errors in understanding and subtraction operations. While the procedural errors made by students include unsystematic completion errors, errors could not manipulate the completion process, factoring simplification errors, errors in completing absolute values, errors in substituting values and errors in unable continuing the completion process.

Factors causing students' errors include: students do not understand and do not yet remember the definitions of the subjects that have been studied, students do not understand the rules in solving a problem, students have not yet mastered the nature of addition in math or subtraction of real numbers and their properties multiplication and division of fractions, then less careful in the problem solving process.

Concluded that, the researchers suggest that teachers ensure the students could know and could understand the definitions and the rules needed in the material being taught, so that learning activities will run well.

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