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"Investigating Students Error When Solving Whole Number Problem": Case in Procedural Error and Concept Error

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Abstract. The study aims to explore student errors in integer counting operations. The exploration of student error is focused on concept errors and procedurals implemented class VII Secondary School in East Indonesia. A total of 100 students who participated in the study and they were 13–15 Years old. Each student worked on a matter that had been tested for validity and validity, for 40 minutes. The test given consists of 10 matters with summation, subtraction and mixture counting operating material. Analysis of research data is done by exploring the work results of students then grouping based on the type of student error. The test results data is then identified and classified into the shape and type of error. Based on the results of the study, it suggests that in performing integer counting operations, students are highly likely to commit procedural errors and concept errors. The form of procedural errors that students make is: (1) Less thorough in rewriting the matter, (2) Less Efficacy in calculating summation and subtraction results, (3) Forgot to write down negative signs on summation and subtraction results, (4) Mistake of sequence in performing summation and subtraction operations, and (5) Not Writing answers in full. Whereas the form of concept errors that students make is: (1) Errors in summing negative numbers, (2) Errors in subtraction of similar integers (a–b for a<b or (–a)–(–b)), and (3) Errors in performing the emblem operation "–" with negative numbers.

Keywords*: Count Operations, Round Numbers, Concept Error, Procedural Error.*

1. INTRODUCTION

Numbers are a basic concept in mathematical learning or called *"Number is pervades all areas of mathematics".* So that the concept of numbers is taught in every level of education. One of the number concepts taught at the junior high school level is the integer arithmetic operation. At this ladder, performing integer count operations, understanding the properties of number count operations, and their amplification in problem solving is a standard of competence that students must master.

Various studies have shown that the expulsion of number concepts will provide confidence for students. [1] revealed that students who mastered the concept of numbers, would have confidence in studying mathematics. The operation of integer counting is a basic ability for students to understand mathematical concepts such as algebra, arithmetic, calculus, etc [2]. If students have not yet understood the concept and procedural operation of counting integers, then it will have difficulty in learning the next material. [3] that students' understanding of integer operating concepts and procedures can be measured and evaluated through the awarding of tests. Students are required to complete a number of matters by writing out directly the answers and the settlement measures. Through the work results then teachers can analyze the possibility of student error in particular concept error and student procedure classification. Information related concept and

procedural errors will be used by teachers for the improvement follow-up or reflection of learning processes [4]

Specifically the study aims to analysis of student errors in integer counting operations. The analysis of student errors is focused on identifying the types of errors and their shapes. Error identification is based on concept and procedural errors [5] then researchers classified into 3 Types of errors namely concept errors, procedural errors, and concept and procedural combination errors (Procep).

The types of errors in solving integer count operations in this study are as follows: (1) Concept Errors that are the errors that students make when they do not understand the nature, concept, definition or principle of mathematics in solving integer counting operations, (2) Procedural errors that are the errors made by students due to intelligibility in sizing integer operations in the form of forgetting to write down negative signs, incorrect in summation and subtraction, simplifies the form of operation, mistaken in the order of operation, and not writing down answers in full, and (3) Mistakes Procedural concepts that is the combination of errors that students make between concept and procedural errors performed simultaneously in a single step of completion.

In the sense that in addition to students making concept errors, students are also simultaneously non-conscientious in solving integer arithmetic operation. However, there is still little investigation about student errors especially in solving integer problems. This becomes important for researchers to assess students' errors in solving integer problems

2. METHOD

The study is a qualitative descriptive study with for the purpose of thoroughly understanding and identifying student errors [6], [7], Then grouping into the shape and type of errors performing integer count operations. The study was conducted in junior high school in eastern Indonesia with one focused on accredited school B. The sample consists of 100 VII grade students aged between 13–15 Years. It consists of 60 female students and 40 male students. All students have studied the integer counting operation material by teachers according to the established competency standards. Tests are awarded to students in the odd semester of the academic year 2019/2020. It consists of 10 integer count operations with details of 3 about summation operations, 3 about reduction operations, and 4 mixed matters. The matter which has been tested for validity and validity, worked for 40 Minutes (1 Hour of Lesson) without providing apperception.

We analyze the results of student answer and classify them based on the types of mistakes they did. We also calculated the frequency or likelihood of errors seen in student work. Next, we discuss with experts about the causes of these mistakes. Until we get 2 types of problems, namely: (1) concept errors, (2) errors (procedural), and (3) error procedures. These three types of errors are material findings that will be explained in the next section.

The student answer results are then presented in the form of percentage the number of answers is right and wrong. Then, the student's wrong answer is classified into concept error, procedural and procedural concept error. Classification of student errors is done by analyzing the student's work results in the form of completion measures and student final answers.

3. RESULTS AND DISCUSSION

The Research results of 100 students consisting of 10 matters of integer counting operations are presented in the form of percentage of the number of correct, false, and unanswered answers. The research is focused on identifying and classifying the type of student error. Research results showed that 73.6% of students correct answers and 26.4% of students' wrong and unanswered answers (**FIGURE 1**). If reviewed from errors every matter, then the student's error percentage ranges from 4% - 38%. The number of students who made the most mistakes was on the matter of number 10 which is 48 students consisting of 38 students answered wrongly and 10 students did not answer. This suggests that items of matter involving mixed surgery by covering negative signs and the emblem of reduction operations, have heavy cognitive loads for students [4]

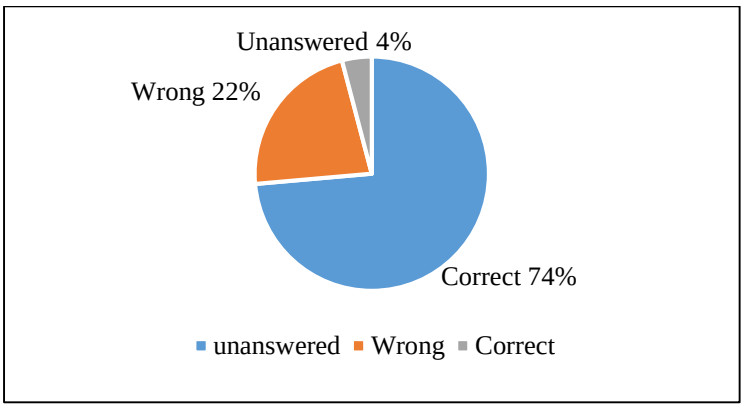

FIGURE 1. Percentage of student answer

Based on analysis of student work results, out of 22.3% of student answer errors are then classified into 3 types of errors namely concepts, procedurals, and procedural concepts. The percentage magnitude of all three types of errors is presented in **TABLE 1.**

TABLE 1. Percentage of Student Error Types

No	Questions	Kinds of Error		
		Concept	Procedure	Procep
1	$17 + 8 + 19 =$	4	0	0
2	$(-7) + (-12) + (-9) =$	4	5	4
3	$(-6) + (11) + (-15) =$	6	4	5
4	$19 - 8 - 17 =$	6	0	3
5	$13 - (-8) + 17 =$	8	10	4
6	$6 - (-11) - (15) =$	7	15	5
7	$5 + (-14) - (8) =$	8	11	6
8	$(-11) - (-9) + 18 =$	9	18	6
9	$(-18) + 7 - (-16) =$	8	24	5
10	$(-7) - (-12) - (-9) =$	9	23	6
	Amount	69	110	44
	Percent	31%	49%	20%

TABLE 1. Indicating that as many as 49% or 110 student answers constitute concept errors, as much as 31% or 69 student answers constitute procedural errors, and 20% or 44 student answers constitute procedural concept errors. Hal gives the idea that procedural-related student errors are still high, comparable to both other types of errors. Performing an operation by involving negative marks particularly in mixed operations provides a high degree of difficulty. Especially for the matter of numbers 8, 9 and 10 based on exceeding 33%-38% of its error rate. In the sense that if worked by 100 students 33–38 students chanced to make mistakes for each of them.

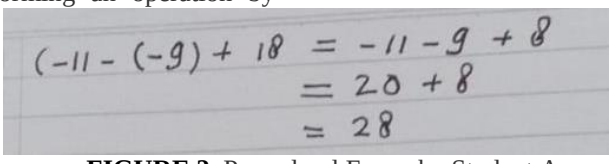

FIGURE 2. Procedural Errors by Student A

The Procedural Error that students make, we can observe from the answer results in **FIGURE 2**. From the picture shows how student A committed procedural errors when it was not thorough to rewrite the numbers contained on the 8th issue. The number on the matter should be (–(-15)) but only in writing (-15). Then student A again made procedural mistakes by forgetting in writing down negative signs. The number on the answer should be (-20) but only in writing 20. So that the answers are written out do not match the results of the settlement. It showed the student's dissolution in completing the operation of integer counting.

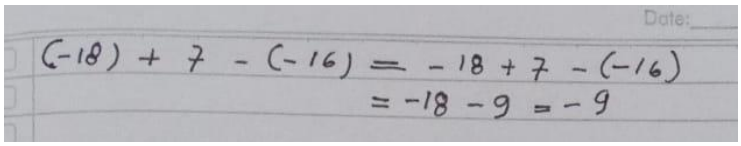

FIGURE 3. Concept Errors by Student B

FIGURE 3. the answer of student B shows the Concept error on the matter 9. The concept errors that students make when performing the emblem operation "–" with negative numbers. On the answer sheet, student B wrote down the supposed 9 answer 23 as a result. Then B students again made a concept error by writing down (-9) as a result of the reduction (-18) and 9. This suggests that students of negative number rules are deducted by positive numbers. An analysis of the integer count operation showed that the concept error percentage was 31% of the overall error. This suggests that many students have not essentially mastered the concept of integer operation. One of the concept errors that students make is seen in the answer to matter 9.

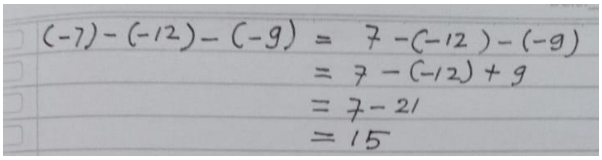

FIGURE 4. Procep Errors by Student C

Procep Errors is a combination error between the concept and procedural of students in working on integer counting operations. The percentage of students who commit procedural concept errors is 20%. One of the procedural concept errors that students make is seen in the answer to matter 10. **FIGURE 4** shows the errors The procedural concepts that students C. The form of student error is non-conscientious in rewriting the matter and mistakenly writing down the results of reductions 7 and 21. Whereas the form of concept errors that students perform the emblem operation "–" with negative numbers and Errors in reduction of similar integers (a–b for a<b). This suggests that it is necessary to have an increase in understanding of the students' concepts and procedures, as an attempt to minimize the occurrence of misconceptions.

Based on the pollution of the research results, it provides the conclusion that in performing integer counting operations, students are highly likely to commit procedural errors and concept errors. [8] mentions "Children's magnitude knowledge, or representations of negative numbers, are less well understood. [4] adds up, low student understanding and knowledge of integer operating procedures and rules can cause students to make mistakes in solving a matter [9]

Basically students have chances to commit procedural errors and concept errors. [9] revealed that reduction operations involving negative integers provide a difficulty for students in resolving mathematical problems. The form of procedural errors that students make is: (1) Less thorough in rewriting the matter, (2) Less Efficacy in calculating summation and subtraction results, (3) Forgot to write down negative signs on summation and subtraction results, (4) Mistake of sequence in performing summation and subtraction operations, and (5) Not Writing answers in full. Whereas the concept error form there are 3 namely: (1) Errors in summing negative numbers, (2) Errors in subtraction of similar integers (a–b for a<b or (–a)–(–b)), and (3) Errors in performing the emblem operation "–" with negative numbers. [9] states that students who lack understanding integer count operations often ignore the "—" coat of arms on negative numbers so that students write them down as positive numbers then operate them.

The magnitude of the student's error presentation in performing integer surgery involving negative signs, gives an idea that students have not yet run through the procedure and concept of numbers [2]. Then fore it needs special emphasis in teaching the difference in function between the insignia of numbers and the insignia of number operations [10].

4. CONCLUSIONS

Based on the results of the study, information is obtained that in performing integer counting operations, students are highly likely to commit procedural errors and concept errors. The form of procedural errors that students make is: (1) Less thorough in rewriting the matter, (2) Less Efficacy in calculating summation and subtraction results, (3) Forgot to write down negative signs on summation and subtraction results, (4) Mistake of sequence in performing summation and subtraction operations, and (5) Not Writing answers in full. Whereas there are 3 forms of concept errors that students make namely: (1) Errors in summing negative numbers, (2) Errors in subtraction of similar integers (a–b for a<b or (–a)–(-b)), and (3) Errors in performing the emblem operation "–" with negative numbers.

The three types of errors generated can be used as a reference for obtaining the type of learning that is able to minimize student errors. Furthermore, as a follow-up study, we tried to explore students' thought processes that caused them to make mistakes. We suspect this is related to interference in the cognitive structure of students, the existence of a disconnection between concepts, the existence of misconceptions, and the existence of students' unconsciousness of their finishing habits.

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