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Submission date: 30-Sep-2023 10:22AM (UTC+0700)

Submission ID: 2181106417

File name: 2_SI.pdf (288.74K)

Word count: 4169

Character count: 22736

Conference Paper

Understanding Elementary School Students' Errors in Completing Number Operations

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Abstract.


Integer operations are fundamental in math; students need to know how to do them before learning other things. However, students often have difficulty learning the material of integer operations. This study aims to describe the types of errors students have made in solving integer operation problems and suggests efforts that can be made to overcome these problems. This research was carried out on students at SD Negeri Pacing I Sukosewu. The study involved 19 students. The research instrument used were documents and diagnostic tests in the form of descriptive questions. The data analysis used was in the form of descriptive statistical analysis. The results showed that student errors in solving integer operation problems were reading errors at 26.32%, comprehension errors at 41.05%, transformation errors at 57.89%, process skill errors at 57.89% and conclusion drawing errors at 42.11%. One of the learning alternatives that can be used to minimize at SD Negeri Pacing I Sukosewu is guided discovery learning that involves the students' real world.


Keywords: diagnostic test, integer operation, elementary school

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Published 21 December 2022

Publishing services provided by Knowledge E

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 Selection and Peer-review under the responsibility of the ICESRE Conference Committee.

1. Introduction

Integer material is one of the basic mathematical materials that is still considered challenging by some students when viewed from the way students solve problems of integer calculation operations based on their cognitive style (1-3). The one of the materials with difficulty and abstractness is the concept of negative integers (4). This is in accordance with the research conducted by (5) that student calculations that generally occur in the process of working on integer operations, students memorize more than understand the concepts of addition, subtraction, multiplication, and division; if students forget about memorization, there will be errors in calculations. On the other hand, integer operation material must be mastered by students because integer operations are essential material in mathematics learning so that students can master other materials (6). However, students often have difficulty learning integer operations material (7,8).

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Thus, the integer material can be said to be one of the materials still considered difficult by students, although this is important to master to develop an understanding of other materials in mathematics.

Related to this, explaining that in order not to make a prolonged mistake, special attention is needed to the mistakes students face in solving integer operations problems. A review of students' difficulties in resolving integers can be done through diagnostic tests (9,10). This is in line with the research conducted by (11,12) that diagnostic learning difficulties need to be carried out by the teacher if the teacher wants his students to be able to achieve the minimum completion criteria (KKM) efficiently through a targeted remedy learning program. Thus, it is essential to conduct a diagnostic test on students to find the difficulties faced by students in order to determine the right remedy learning program.

States diagnostics is an attempt to know exactly, decide, and agree (13). Specifically, (14,15) describe diagnostic tests as a problem that is used to diagnose students' weaknesses and strengths in a particular lesson. In line with this, (16) stated that diagnostic tests are aimed at knowing the strengths and weaknesses of students and providing input to teachers and students to make decisions related to improving the teaching process and learning process. Thus, the diagnostic test is a problem given to students to find out exactly related to students' weaknesses and strengths in certain lessons in order to improve the learning process and student learning process.

Several researchers have carried out error diagnosis research (17-20). however, not all of the studies were explained in detail regarding the specifications of the instruments used. Therefore, this study was carried out concerning the type of error put forward by Newman. The Newman procedure is widely used and applied in various countries and is used to determine different types of student errors in solving mathematical problems (21). This is in line with the explanation (22) that Newman's procedure is a method that analyzes errors in problem sentences. Newman classifies the mistakes made by students into 1) reading errors are errors that occur because students are unable to read keywords or symbols on the questions, so students cannot step further on the proper problem-solving pattern. 2) Comprehension errors occur when students can read all the words on the question but do not master the meaning of these words thoroughly, so students are unable to step further on the right problem-solving pattern. 3) Transformations errors occur when students understand what the problem wants but cannot identify the operations or operating patterns needed to solve the problem. 4) Processing skill errors occur when students have identified the right operation or operating pattern but do not know the procedures needed to complete the operation

accurately. 5) Encoding errors occur when students have found a solution or problem but are wrong in writing the final answer (23).

Based on the background of the problem and theoretical studies that have been put forward, this study aims to describe the types of mistakes made by students in solving integer operation problems. This research is essential to be carried out as a first step to improving the learning process and student learning process based on empirical data. The diagnosis results can also provide information to students to demonstrate the ability to analyze integer operations and motivate them to improve weak aspects. In the end, research is expected to be a reference to improve the quality of education, especially in learning mathematics in cognitive aspects.

2. Method

This survey research aims to explore information related to students' mistakes in solving problems. This research was conducted at SD N Pacing I Sukosewu, East Java, Indonesia. The subjects in this study were categorized into three, namely students in the high, medium, and low categories. The categorization is based on the average formative value during class V. Based on the categorization, five students were obtained with high ability categories, ten with medium ability categories, four with moderate ability categories, and four with medium ability categories and low ability.

The data collection techniques used in the study are documentation and diagnostic tests. Documentation is used to group students in the initial ability category. Tes diagnostics are used to collect data about the answers and the steps of work that students take in solving the questions. The diagnostic test instrument is in the form of a description question to make it easier to analyze student errors from the results of student work in solving number operation problems. The following are the indicators of the questions used in this study in full in Table 1.

In this study, the instrument's validity was proven through the validity of the content by asking for input from two mathematician lecturers. The validation results showed that the diagnostic test instrument on the number of operation materials was declared valid by the expert. Furthermore, the results of the reliability estimation show that the diagnostic test instrument has a reliability coefficient of 0.88 which is in the very high category.

The data analysis used is in the form of descriptive statistical analysis. The analysis is in the form of a description of the results of a diagnostic test that is examined by looking after the problem by the student (answering correctly, correctly but incompletely,

TABLE 1: Integer Count Operation Test Question Indicator.

Competency standards	Basic competencies	Indicator	Question Number	Cognitive level	Difficulty level
Perform integer count operations in troubleshooting	Perform an integer mix count operation	Solving problems related to addition and subtraction	1	C3	Easy
		Solving problems related to addition and multiplication	2	C3	Keep
		Solving problems related to addition and division	3	C3	Keep
		Solving problems related to subtraction and division	4	C3	Keep
		Solving problems related to addition, subtraction, multiplication, and division	5	C3	Difficult

incorrectly completed, or not doing it). Students' answers in taking diagnostic tests in the form of descriptions are checked based on the student's error score determined using diagnostic test scoring guidelines. Furthermore, the student's incorrect answers were analyzed using a coding scheme developed from the Newman error type (24). The coding scheme in question is presented in Table 1.

TABLE 2: Competency standards and description of activities.

Competency standards	Description of the action
Read	Students misinterpret the meaning of each word, term or symbol in the question
Understanding	Students cannot understand what is known and are asked the questions completely
Transformation	Students can't create mathematical models/formulas. Students do not know the procedures/steps that will be used to solve the problem correctly.
Process skills	Students cannot continue with the procedure/completion steps Students make mistakes in doing computing
Drawing conclusions	Students cannot find the final result according to the procedure/step used or cannot write the final answer as intended by the question.

Coding of the type of error is also carried out using the *reliability inter-rater*. Two raters or observers on the same sample did test the analysis of student answer sheets in solving number operation problems, namely observations. From the results of the analysis of the coefficient value of Cohen's Kappa, it shows that the average agreement

between raters is 0.92, which means that the value of the agreement between raters is very high. Furthermore, based on the analysis of the diagnostic test result data, conclusions were drawn in the form of descriptions related to the types of errors made by the research subjects in solving integer operation problems.

3. Result and Discussion

3.1. Results

This research was carried out at SD Negeri Pacing I Sukosewu, a State Elementary School located at *Jalan Poros Pacing* Village, Sukosewu District, Bojonegoro Regency, East Java. This research was carried out with the help of the participation of all students of class V.

In this study, the results of the answers to the diagnostic tests of students were described and analyzed the type of error based on Newman's criteria. The answers of 19 students were corrected based on the number of students answering true, correct but incomplete, wrong completion, not doing, and not finishing, as shown in Table 2. Each student was given a diagnostic test consisting of 5 questions about the number operation, so 95 student work results were obtained.

TABLE 3: Diagnostic test answer results in solving integer operation questions.

Student completion	Number of answer items to-				
	1	2	3	4	5
True solve (BN)	8	7	7	6	5
True but less complete (BTK)	5	5	5	4	3
Wrong completion (BC)	3	5	5	5	8
Not working (TM)	1	1	1	2	2
Not done (TS)	2	1	1	2	1
Total	19	19	19	19	19

In addition to describing the answer results from student diagnostic tests, it also describes student error scores based on the error score guidelines that have been made. The scoring guidelines are made according to the error criteria from Newman, with a score of 0 if it is correct to complete, a score of 1 if it is wrong to complete, and a score of 2 if it does not complete in each criterion. The average of the most dominant error scores was in conclusion error of 0.7, followed by the average error of process skills and transformation error of 0.6. Furthermore, the average misconception and reading of the land were 0.3.

TABLE 4: Diagnostic test answer results in solving integer operation material questions.

Types of errors	Sum	Percentage
Error reading (KM)	25	26,32
Misconceptions (KP)	39	41,05
Transformation error (KT)	55	57,89
Process skills error (KTP)	55	57,89
Error drawing conclusions (KMP)	40	42,11

Table 4. describes the percentage of student error types, where most dominant students make mistakes on process skill error types and transformation errors.

TABLE 5: Percentage of types of student errors on the material of number operations based on the category of initial ability.

Types of errors	Initial ability categories of students		
	Low (%)	Medium (%)	High (%)
Error reading (KM)	52,00	36,00	12,00
Misconceptions (KP)	43,59	35,90	20,51
Transformation error (KT)	40,00	38,18	21,82
Process skills error (KTP)	38,18	36,36	25,45
Error drawing conclusions (KMP)	40,00	37,50	22,50

While Table 5 describes the types of errors based on the category of student's initial abilities. In general, students with a higher initial ability have an error in doing the integer calculation operation problem, which is lower than those with a lower initial ability.

TABLE 6: A student error based on material indicators on integer operations.

Types of errors	The number of errors on butir to-				
	1	2	3	4	5
Error reading (KM)	2	3	3	8	10
Misconceptions (KP)	2	5	8	10	14
Transformation error (KT)	2	6	10	13	24
Process skills error (KTP)	2	7	11	13	24
Error drawing conclusions (KMP)	2	4	5	14	15

Table 6 shows that, in general, the most dominant types of errors in the types of error of process and transformation skills.

3.2. Discussion

The type of reading error that students make in completing the diagnostic test of integer counting operations is the type of error whose percentage is the least compared to other types of errors. This is also in accordance with the research that has been

done that reading errors are the lowest aspect performed by students when solving mathematical problems (25,26). Furthermore, (27,28) explained that students' low errors in reading math problems can be caused because the questions are made using the rules of Indonesian correctly, and the words used also use terms in students' daily lives. Nevertheless, some students still experience confusion in searching for keywords or symbols on the questions. This is because errors in interpreting sentences on the question can make it difficult for students to find keywords to solve the problem (28,29). Thus, avoiding students' mistakes in solving mathematical problems can be done by familiarizing students with finding keywords for a question. Students can be allowed to re-express the intent of the problem.

The type of misconception is the error of determining what is known and the error of determining what is asked on the question. These mistakes can be seen from the results of student work, namely, students reading the questions but without understanding what information is obtained from the questions. This is in accordance with Newman's statement (23) that students are able to read all the words on the question but do not master the meaning of these words. Another study in line with this was carried out by (1) that students' difficulty in solving the problem is the difficulty of understanding the meaning of the story problem. Therefore, the use of story questions should involve problems related to the student's world so that students can get a real picture of the problem (30,31). Thus, the use of learning involving real-world problems can be used as an alternative to facilitate students in learning integer calculation operations.

The type of error at the stage of process skills carried out by students is that students are unable to use the information in the questions to solve the questions, do not carry out the stages completely so that the answers found are incomplete, and errors in processing numbers, and errors in processing variables. This is in accordance with the opinion (32,33) that process skills errors occur when the student is able to select the operations necessary to solve the problem but is unable to carry out the procedure correctly, as is the case with using the information in the problem. In this regard, it is recommended to use guided discovery learning to improve students' process skills (34-36).

In the type of error of drawing conclusions, including the dominant type of error in questions 4 and question 5. The students have been able to reach the stage of drawing conclusions if students can write down answers correctly and completely (11,22). Thus, students are said to make mistakes in this stage if the student is incomplete in writing the answers to the questions by not providing information from the answers according to what is asked in the questions. In general, students can work on completions, but

sometimes they are not able to express the solution into mathematical sentences that are acceptable or according to what is asked of the problem. (37) suggests providing a column as a place to express the conclusions of the solutions that have been carried out. It also minimizes students' forgetfulness in writing conclusions.

14 4. Conclusion

Based on the results of research and discussion, it can be concluded that the types of errors made by students in solving the number operation problem are reading errors of 26.32%, comprehension errors of 41.05%, transformation errors of 57.89%, process skill errors of 57.89% and conclusion drawing errors of 42.11%.

The findings indicate that students still have difficulty in solving integer operation problems. One of the learning alternatives that can accommodate this is guided discovery learning that involves the real-world of students. Based on these findings, it is recommended for teachers to be able to design mathematics learning designs that can train students in solving problems, especially related to aspects of understanding, transformation, process skills, and drawing conclusions. In addition, it is also recommended that other researchers explore other aspects that cause students' difficulties in solving mathematical problems, both in terms of cognitive and non-cognitive aspects.

20 Acknowledgements

The research team would like to thank the Directorate General of Higher Education, Research, and Technology, c.q. Directorate of Research, Technology, and Community Service and LPPM IKIP PGRI Bojonegoro for providing grants for the publication of this activity. This publication is part of the output of the "Pokjar RELINA based on the World of Imagination" Program for The Recovery of Child Literacy and Numeracy during the Covid-19 Pandemic in Border Village (Pacing Village, Sukosewu District, Bojonegoro Regency).

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