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Analysis of Students' Mastery Levels in Using Integer Operations in Elementary School Mathematics Learning

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Abstract

This study aims to evaluate the mathematical problem solving skills of elementary school students. This research uses a mixed method design that integrates qualitative and quantitative approaches, the research data source consists of 16 elementary school students who were selected as samples to obtain representative data. In this study, the number of participants involved was 16 learners who became quantitative respondents. Quantitative data is obtained through questionnaires or other measurement instruments that collect numerical information to be analyzed statistically. Meanwhile, for qualitative data, researchers conducted in-depth interviews with several qualitative informants consisting of 5 learners. The instruments used in this study consisted of questionnaires to collect quantitative data and interview guidelines to obtain qualitative data. Quantitative data analysis, researchers used SPSS as a statistical analysis tool. Then qualitative data, researchers applied thematic analysis. The results showed that 56% of students had not reached the Minimum Completion Criteria, indicating that they still had difficulty in solving problems effectively, especially in terms of identifying relevant information and applying the right formula. Based on the results of interviews, one of the main obstacles faced by students in solving math problems is the lack of understanding of the problems given. In addition, many learners have difficulty in documenting the facts contained in the problem appropriately.

INTRODUCTION

Mathematics as one of the basic disciplines in education has proven to be effective in both content and practical applications (Jumrah et al., 2023). The discipline is often referred to as the "queen and servant of the sciences" because of its pivotal role in teaching and its fundamental influence in the development of various other fields of science. The importance of mathematics is evident as the subject is taught at every level of education. Mathematics is concerned with the study of logic, form, structure, size, and interrelated concepts. According to Kristianto et al., (2020); Setyadi & Qohar, (2017); Zairisma et al., (2020) mathematics is the basis for many fields of science and is very important in developing critical thinking skills and problem solving skills.

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In mathematics education, students are expected not only to be able to solve problems, but also to think critically and logically, and to be able to solve the challenges they face in everyday life (Apiati & Hermanto, 2020; Kartika & Rakhmawati, 2022; Siswanto & Ratiningsih, 2020). This expectation often makes students feel anxious and depressed, because many of them consider math as a difficult subject to understand. In addition, math is often perceived as something mysterious, where many learners believe that only certain people can understand it, especially when faced with story problems that are more contextual and explicit (Ikhsan et al., 2017; Putra et al., 2017). When compared to problems that only involve numerical calculations, story problems are often considered more difficult. Solving story problems requires understanding the thinking steps that students must understand, as well as requiring ways to recognize observable results (Novferma, 2016; Nuryana et al., 2019).

Mathematics learning in schools has six basic principles, namely equity principles, curriculum principles, teaching principles, learning principles, assessment principles, and technology principles (Kania & Fitriyani, 2022). According to Fry, (2015) mathematics involves not only conveying information clearly, concisely, and accurately, but also verbal communication about mathematical concepts, which often requires the use of longer sentences. The more words used, the more likely the information can be conveyed precisely. In this context, mathematics serves as the main tool for solving real problems that arise in everyday life and are eventually solved by mathematical methods. The problems of everyday life are often explained in a simple way.

Integer operations are one of the basic topics in mathematics, as they form the basis for understanding and learning other mathematical concepts, especially those related to reasoning to explain story problems. Whole number operations include subtraction, addition, division, and multiplication. Whole number operations include several mathematical functions, such as division, multiplication, subtraction, and addition (Razak & Rumainur, 2022). These operations can be performed on positive, negative, or zero numbers. Multiplication and division can produce whole numbers or fractions, while addition and subtraction of whole numbers will produce whole numbers only.

Integer operations also have several important properties that are the basis for various mathematical calculations, such as commutative, associative, and distributive properties, the distributive property of multiplication on addition, the distributive property of multiplication on subtraction, and having an identity element. Meanwhile, division of integers is the inverse operation of multiplication (Aswan et al., 2024; Mahmuda et al., 2021; Murtiyasa & Wulandari, 2020; Mutaqin, 2017; Saparwadi, 2022). These properties are not only applicable in mathematics, but also affect many other fields, such as physics and computer science. A deep understanding of integer operations is essential, as it can help develop learners' logical and analytical thinking skills in solving more complex problems. With a solid understanding of these basic principles, learners will be better prepared for more advanced and varied mathematical tasks.

The results of interviews with informants show a decrease in students' mathematics skills, namely there are still 56% of students who have not completed. This is because students have not mastered the concept of integers and the obstacles of students solving story problems because students have not been able to understand the meaning of sentences from story problems, students still have difficulty in converting story problems to mathematical models and there are even students who cannot solve story problems because they cannot determine the steps for solving them. In the material of integer addition

operations, students have more difficulty if there are negative integer elements in the problem. Learners also have difficulty when faced with problems that are different from the example problems that have been taught before. This indicates that students tend to only understand problem solving based on the examples and formulas given, so difficulties arise when they are faced with unpopular problem patterns (Agustyaningrum & Simanungkalit, 2016; Aziz et al., 2016; Tatto, 2021).

This phenomenon reflects the limitations of students in understanding and applying the mathematical concepts that have been taught, which in turn affects their ability to solve various kinds of problems. Based on these findings, researchers are interested in analyzing the stage of proficiency of learners using integer counting operations in mathematics learning in elementary schools.

The difference between this research and previous research lies in the focus of analysis and approach. Previous research emphasizes more on the general understanding of the difficulties faced by learners in learning mathematics, especially regarding basic concepts such as integers (Boru & Hakim, 2022; Djatmika & Praherdhiono, 2024; Hasibuan et al., 2024). Meanwhile, this study is more in-depth in analyzing the problem-solving procedures used by students in the context of integer arithmetic operations, as well as identifying the specific obstacles they get, such as students' difficulties in understanding story problems and converting story problems into mathematical sentences (Farida, 2015; Laily, 2014).

This study also focuses on evaluation based on problem solving criteria, which includes the stages of understanding the problem, planning the solution, applying the appropriate method, and verifying the results, as described by (Setyaningrum et al., 2024). Therefore, although there are similarities in identifying learners' difficulties, this study provides a more detailed analysis of the procedures and strategies used by learners in overcoming these obstacles, as well as providing further understanding of the factors that influence their ability to solve more complex and varied math problems.

METHODS

This research uses an explanatory mixed method design, which is a research approach that combines two types of methodologies, namely quantitative and qualitative (Kartono et al., 2019; Masturah et al., 2021; Nur Sya'adah & Samsudin, 2022; Syafril et al., 2021). In this design, quantitative data collection is carried out first, then the results are analyzed to provide an overview of the phenomenon under study. After that, qualitative data is collected to further explain or provide in-depth context to the findings obtained from quantitative data. This method aims to refine the understanding of quantitative results by digging deeper into aspects that cannot be fully explained only through numbers or statistics (Agusti et al., 2018; Zfirah et al., 2018; Kastira & Irwan, 2023; Maharani et al., 2023; Sandra et al., 2024).

The research subjects consisted of 16 elementary school students in grade VI of Madrasah Ibtidaiyah Bahjatul Ulum Lampung, Indonesia who were selected as samples to obtain representative data. In this study, the number of participants involved was 16 learners who became quantitative respondents. Quantitative data were obtained through questionnaires or other measurement instruments that collect numerical information to be analyzed statistically. Meanwhile, for qualitative data, researchers conducted in-depth interviews with several qualitative informants consisting of 5 learners. The instruments used in this study consisted of questionnaires to collect quantitative data and interview guidelines to obtain qualitative data. For

quantitative data analysis, researchers used SPSS as a statistical analysis tool. Then qualitative data, the researcher applied thematic analysis.

RESULT AND DISCUSSION

Using quantitative data obtained through questionnaires given to 16 learners can be presented in the form of numbers and statistics. The researcher evaluated the level of satisfaction or the learners' view of a phenomenon using the Likert scale and found the following results.

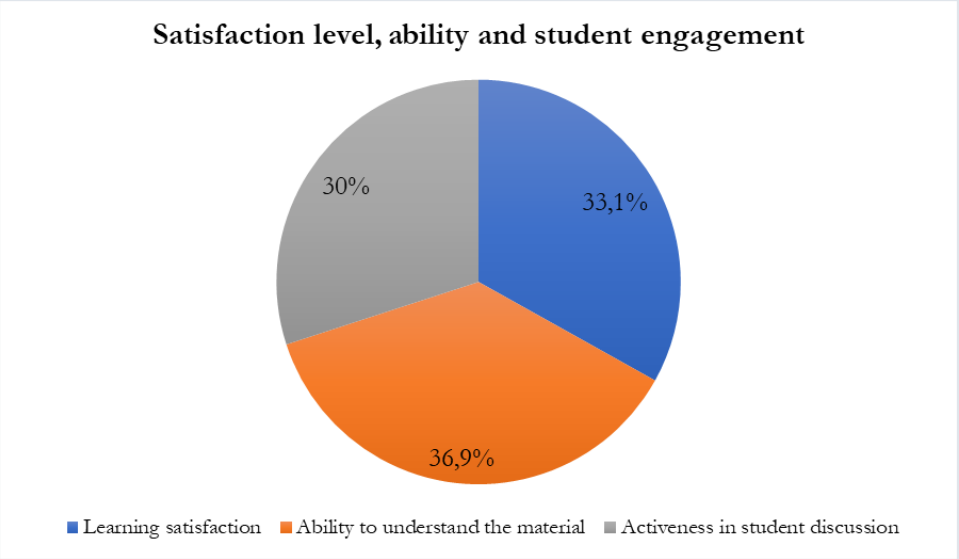


Fig 1. Level of satisfaction, ability and activeness of students towards learning integer operations

From table 1 above, it is found that the average satisfaction with learning whole number operations is 33.1%, which means that learners' satisfaction with learning whole number operations is at a fairly low level. With a mean score of 3.31 which lies around 3 (meaning "moderately agree" on a Likert scale of 1-5), this indicates that most learners felt that the learning was inadequate or not fully effective in improving their understanding. Only about a third of the learners gave a positive assessment of the learning received. Therefore, this indicates the need for improvement in the learning methods or approaches used in teaching whole number operations, to increase learners' overall satisfaction and understanding.

Then, the average ability of students to understand the material is 3.69 (on a scale of 1-5), which means that the ability of students to understand the learning material is quite good, but there is still room for improvement. A score of 3.69 or 36.9% indicates that most learners are at a fair or good level in understanding the material taught. However, this figure also indicates that there are still some learners who may face difficulties or not understand the material optimally. Therefore, further efforts are needed to improve teaching methods or provide additional support for learners who need a deeper understanding.

The average learner engagement in the discussion was 3.00 (on a scale of 1-5). This shows that the average learner engagement in the discussion was good, with most learners showing active participation. After giving questionnaires to learners, researchers then conducted interviews about the evaluation of learning implementation. As the following interview excerpt.

> *I find the lessons very interesting, especially when there are group discussions. It is easier for me to understand difficult material because my friends explain it in different ways, but sometimes I find it difficult to follow the lesson because the material is delivered too fast* (informant 1)*, I think that learning that utilizes technology, such*

as videos and learning applications, really helps me understand the material, but I would be happier if the teacher gave more time (informant 2)*, learning in class is very helpful, especially with questions and answers after the material is taught. However, I feel that there is some material that is difficult without further explanation. If given more opportunities to discuss, I as a learner feel I would understand the integer operations material better* (informant 3)*, I like it when teachers give me the opportunity to ask questions. However, I feel that sometimes the teacher's explanation is too fast so I do not have time to understand properly. If the material is presented more in the form of practicum, I think I will be more interested* (informant 4)*, the learning provided by the educator is very interesting and fun, especially when there are practical activities and experiments using real objects. However, I feel less confident when I have to answer questions directly in front of the class. I hope learning can involve group discussions more often* (informant 5)

With a focus on whole number operations, and involving 16 learners randomly selected from one class. The tool used in this research is a test sheet designed to measure learners' problem-solving skills. This assessment aims to measure learners' skills in solving math problems using whole number operations, based on predetermined problem-solving criteria. The test sheet consists of four essay questions given to learners. The test sheet contains math story problems related to whole number operations, which are arranged according to the relevant competencies. This problem-solving document required only one change to ensure its validity. Each problem was given a score of 5 if the answer was correct and in accordance with Polya's problem-solving criteria. If learners only answer part of the problem correctly, the score given is 2, and if the answer is wrong, it is given a score of 0. This assessment method is used to evaluate the extent to which learners understand and can solve the given math problem.

Table 1. Results of math problem solving ability

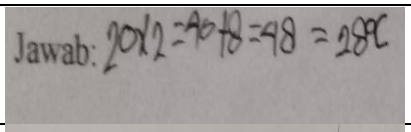
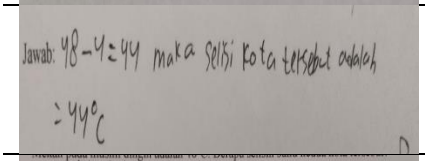
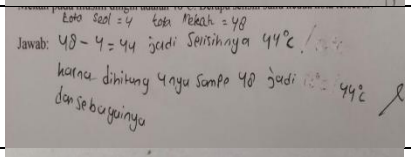
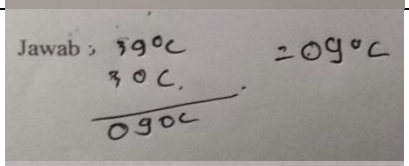
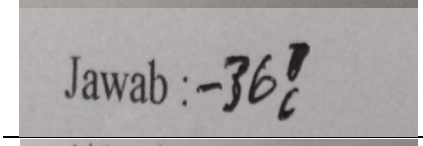
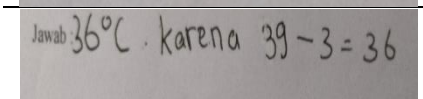
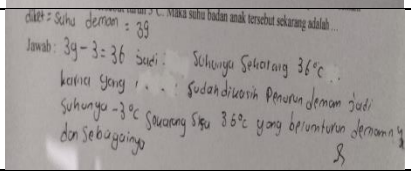
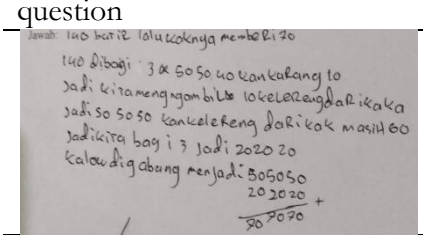
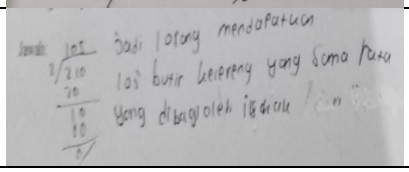
No	Student code	Score				Total
		Question 1	Question 2	Question 3	Question 4	
1	S1	0	2	5	5	12
2	S2	5	2	2	5	14
3	S3	2	2	2	5	11
4	S4	5	5	2	5	17
5	S5	2	5	2	5	14
6	S6	2	0	0	5	7
7	S7	5	5	2	5	17
8	S8	5	5	2	5	17
9	S9	0	5	2	2	9
10	S10	5	5	5	5	20
11	S11	5	5	5	5	20
12	S12	2	5	5	5	17
13	S13	2	5	0	2	9
14	S14	2	5	2	5	14
15	S15	2	0	2	5	9
16	S16	0	5	2	5	12

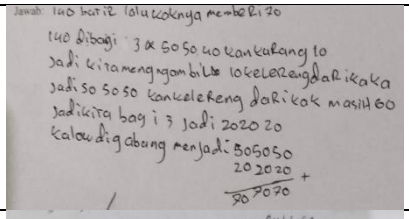
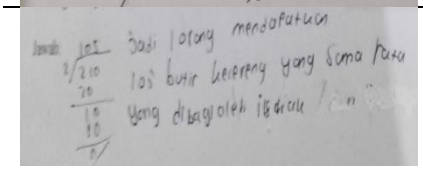
Based on table 1 above, in the early stages of problem solving, learners can effectively understand the problem, identify known facts, know the question being asked, and collect data needed for calculations. All learners are able to understand the given situation, recognize the information available, and know what needs to be found. However, in problem numbers 1 and 3, more than 75% of learners had difficulty in solving problems based on the information given. In problem number 1, 10 learners could not answer the

problem, and in problem number 3, 12 learners experienced similar difficulties.

The results show that some learners face challenges in problem solving, especially in certain types of difficulties. Some examples of problem-solving questions given to learners and their answers can further illustrate this.

Table 2. Results of students' answers to questions 1-4

No	Question	Answer	Assessment result
1	The winter temperature in Seoul City is 4°C, while in Makkah City it reaches 48°C. What is the temperature difference between the two cities?		Score 0
			Score 2
			Score 5
2	The child's temperature at the time of the fever was recorded as 39°C. After being given fever-reducing medicine, the child's temperature dropped by 3°C. So, the child's body temperature is now...		Score 0
			
			Score 2
			Score 5
3	A well digger can dig up to 2 meters of soil per hour. The worker has started digging since 06.00 and continues to work until 12.00. Based on his work speed, the depth reached by the well digger at 12:00 is...	Learners do not answer the question	Score 0
			Score 2
			Score 5
4		Learners do not answer the question	Score 0

Look at the picture above! Iskak has 140 marbles. Then, his brother gave him 70 marbles. Because his father forbade him from playing with marbles, Iskak decided to share all his marbles with his two friends, as shown in the picture. The marbles were distributed equally to his two friends. Thus, each of Iskak's friends will receive ... marbles.	  	Score 2 Score 5

Based on table 1, in problem number 1, three learners scored 0, seven learners scored 2, and six learners scored 5. Examples of learners' work for problem number 1 are contained in table 2 which shows the differences in learners' understanding and ability to solve the problem.

The study of learners' responses to problem number 1 showed that some learners did not include known information and things to look for. Many learners immediately wrote the final answer without explaining the steps used in solving the problem. Learners who scored 5 had included the known information, albeit using simple language, and provided an explanation of the reasoning behind their choice of solution. In contrast, learners who scored 2 showed a good understanding of the problem and followed the right procedure, although they only listed the final result without explaining the calculation process. Nevertheless, the formula used was correct. Meanwhile, learners who scored 0 showed difficulty in understanding the problem, so they were unable to reach the correct solution.

Based on table 1, in problem number 2, there were two learners who scored 0, four learners scored 2, and eleven learners scored 5. In problem number 2, which illustrates the various levels of understanding and ability of learners in solving the problem. Based on the learners' answers to question number 2, it can be seen that some learners do not include the information that has been given and which needs to be sought. Many learners immediately write the final result without explaining the steps they take. In the answers of learners who got a score of 5, they had included the known information even though they used simple language, and gave a clear explanation of the reason behind the answer given. This shows that these learners have understood the core of the problem and can solve the problem correctly.

Meanwhile, in the answers of learners with a score of 2, although they can solve the problem, they do not include the known information and what needs to be found. However, these learners were able to follow the solution steps correctly, although they only gave the final answer without further explanation. The formula used was correct. On the other hand, in the answers of learners with a score of 0, these learners had difficulty understanding the

problem, so they were unable to solve the problem correctly. Some learners were confused with the placement of the degree symbol when working on multilevel subtraction, while another learner did not understand the basic concept of subtraction, which led to incorrect answers, for example the result that should have been 36 became -36.

Based on table 1, in question number 3, two learners scored 0, ten learners scored 2, and four learners scored 5. The following are some examples of learners' answers to question number 3, which show variations in learners' understanding and ability to solve the problem. Based on the learners' answers to question number 3, most learners did not include the known or required information. Many of them immediately gave the final answer without explaining the steps of the solution. In the answers of learners with score 4, although they did not include the known information, they provided an explanation for the answer chosen. This shows that these learners understand the essence of the problem at hand and are able to solve it correctly. In contrast, learners who scored 0 showed a lack of understanding of the problem, so they could not solve the problem correctly and produced an incorrect answer.

Based on table 1, in problem number 4, two learners scored 2, while fourteen other learners scored 5. Based on the analysis of learners' answers to problem number 4, it was found that some learners did not include the information that had been given or that needed to be sought. Many learners immediately wrote the final answer without explaining the steps of the solution. In the answers of learners with a score of 5, they have included known information even though they use simple language, and explain the reasons behind the answers given. In contrast, in the answers of learners with a score of 2, although these learners understood the problem and followed the solution steps, they were less focused on the core of the question. These learners relied more on the picture in the question to provide the answer. However, the formula used by these learners was correct.

The next stage in this research is to conduct interviews with students and teachers regarding the analysis and understanding of the problems that have been done.

> *Problem number 3 was different from the examples we discussed before, I was confused about why the answers were not the same* (student 1)*, I sometimes don't realize that I recorded important information, so I could be wrong in doing the problem* (student 2)*, math story problems are difficult, I have difficulty imagining what they mean, so I often have difficulty answering the questions* (student 3), *I know the formula, but sometimes I use the wrong formula because I don't really understand how to apply it* (student 4)*, there are still some learners who have difficulty in converting story problems into appropriate mathematical sentences. They are often confused about which information to use* (teacher 1)*, in my opinion, it is very important to focus more on recording the information that is already known and what needs to be found. However, I often don't focus too much on that in my daily learning* (teacher 2)

From the results of the interview, there were several findings, namely students felt that questions number 3 and 4 were different from the example problems discussed previously, some students did not realize the mistakes in recording known information, students had difficulty understanding mathematical problems presented in story form, many students still used inappropriate formulas. These findings indicate that learners still face challenges in solving problem solving problems. The results of interviews with teachers found that not all learners can convert story problems into appropriate mathematical representations and teachers rarely emphasize the

importance of recording known and sought information in learning.

Analysis of interviews with students and teachers, as well as evaluation of the answers given, shows that students' ability to solve mathematical problems is still low. This is due to a lack of understanding of the material, difficulty in distinguishing relevant information, and inaccuracies in applying formulas. In addition, many students make mistakes in the calculation procedure, which causes the final result to be incorrect. This finding is in line with research Saja'ah, (2018) which identified several factors that cause students' difficulties at the elementary school level, such as difficulties in understanding the language of the problem, limited skills in designing problem-solving strategies, lack of practice, and errors in performing arithmetic operations. Research conducted by Kurniadi & Purwaningrum, (2018); Murtiyasa & Wulandari, (2020) factors causing students' difficulties in solving problems, namely students cannot absorb information from the problem properly, and are wrong in interpreting the problem because of difficulties in recognizing important information in it.

Further research shows that many primary school learners experience difficulties at the planning stage of problem solving. In fact, some learners already face difficulties at the problem identification stage. This finding is in line with research Hutagaol & Jamilah, (2024); Jahanger et al., (2022); Utami, (2016) which shows that most learners can only fulfill the problem solving planning indicators, while others are not able to identify problems properly. Interviews with teachers also revealed that learners had difficulty in converting information from story problems into appropriate mathematical symbols. Similarly, the opinion of Kania & Fitriyani, (2022); Lamolinara et al., (2022); Magfirah et al., (2019); Masfingatin, (2014); Pratiwi et al., (2019) states that mathematics requires a more mature thinking process, high concentration and strong self-confidence to overcome the challenges.

CONCLUSION

Based on the results of the research using quantitative and qualitative data, it was found that students' satisfaction with learning integer operations was at a fairly low level. Although most students were quite satisfied with the learning, they felt that the material was still difficult to understand and needed a more effective approach. Students' ability to understand the material shows a fairly good number, but there is room for improvement. Students' activeness in discussion is also good. The results of students' problem solving evaluation showed that more than 75% of students had difficulty in solving certain problems, especially in terms of identifying relevant information and applying the right formula. Then many students have difficulty in converting story problems into the correct mathematical form, and do not always record information that is important for problem solving. This is due to a lack of understanding of basic mathematical concepts and limitations in problem-solving strategies. As a result, many participants did not record the steps systematically, resulting in inaccurate answers.

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