

MISCONCEPTIONS and Errors in the Fundamental Operations on Integers of Grade 7 STUDENTS

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ABSTRACT

This study employed a qualitative design, particularly the thematic analysis approach on misconceptions and errors in the fundamental operations on integers of grade 7 students. Out of 60 grade 7 students from private schools in Davao City who took the assessment test only 22 were purposively selected based on the inclusion criteria set for selection of participants. An open-ended semi-structured interview guide was used in the one-on-one interview to gather the misconceptions and common errors in the fundamental operations on integers. A phenomenological approach by Moustakas (1994) was used in the qualitative data analysis. The following were the five emerging themes identified as misconceptions of grade 7 students regarding fundamental operations on integers: confusion with signs and operations, comprehension and word problem interpretation, inconsistencies, and forgetfulness, struggles with specific concepts, and general discomfort and uncertainty. Meanwhile, the five themes that emerged regarding errors on fundamental operations on integers of grade 7 students were conceptual error, computational error, careless error, interpretation error, and unpreparedness. Likewise, five themes emerged from the insights shared by the participants which include effective teaching methods, encouragement of active learning, addressing student needs and concerns, enhancing study skills and strategies, and promoting a supportive learning environment.

KEYWORDS: *Mathematics Education, misconception, error, fundamental operations, integers, grade 7 students, qualitative analysis, Philippines*

INTRODUCTION

Students globally face significant challenges with integer operations, often due to procedural learning that lacks a deep understanding of the concepts

(Alviar et al., 2023; Khalid & Embong, 2019). Misconceptions about integers, a foundational concept in arithmetic and algebra, persist despite their crucial role in mathematics and its applications (Kartono et al., 2022; Nur, 2022). These difficulties are particularly evident in representing negative integers and applying correct problem-solving procedures (Nur et al., 2022; Faudiah & Suryadi, 2019).

Errors and misconceptions, though similar in the incorrect results they produce, differ in nature: errors stem from misinterpretation or carelessness, while misconceptions arise from incorrect understanding (Anggara & Wandari, 2021). Misconceptions can lead to persistent learning issues, impacting students' grasp of related concepts and overall mathematical proficiency (Kusmaryono et al., 2020; Sujarwo et al., 2020; Neidorf, 2020; Mohyuddin & Khalil, 2016).

Globally, studies have documented the prevalence of misconceptions. For instance, Khalid and Embong (2019) found that external factors like rushed teaching contributed to students' difficulties in Malaysia. In Indonesia, students struggled with defining and organizing concepts, leading to misconceptions (Setyawati & Indiati, 2018). In the Philippines, common causes included difficulties in retrieving mathematical facts and insufficient prerequisite skills, particularly exacerbated by distance learning (Basilio et al., 2022; Preclaro, 2019; Legarde, 2022; Mangulbanan, 2016).

Given these widespread issues, this study focuses on grade 7 students in private schools in Davao City to identify patterns of errors and misconceptions in fundamental operations on integers. The findings aim to aid teachers, educational sectors, and policymakers in developing targeted programs to enhance mathematical instruction and correct this problem. The results will be shared in research forums and published in peer-reviewed journals to inform and improve educational practices.

Theoretical Lens

This study was anchored to Piaget's Constructivist Theory and Schoenfeld and Kilpatrick's Theory of Mathematical Proficiency. Piaget's theory explains that students actively construct knowledge through experiences, using schemas to interpret new information, and that misconceptions arise when new information conflicts with existing beliefs. Schoenfeld and Kilpatrick's theory identifies five interconnected components of mathematical proficiency—conceptual understanding, procedural fluency, strategic

competency, adaptive reasoning, and productive disposition—each essential for effective learning. Misunderstandings in any of these areas can lead to persistent errors and hinder overall mathematical development.

METHODS

In this study, I used a qualitative research design using Moustakas (1994) approach. According to Moustakas (1994), the primary objective of this approach is to describe the nature of the phenomenon under study which is a conscious knowledge associated with saying what is perceived, sensed, and known from the person's experience. Likewise, phenomenology uses the reduction to entirely set aside empirical questions and shift from factual affirmation or negation to description. This approach is well-suited in the aim of the study, capturing participants perspective and experience, and analyzing their misconceptions and errors acquired throughout their learning process.

Research Site and Participants

The study was conducted in private schools in Davao City, Philippines. In selecting participants, a purposive sampling was done since it is commonly used in qualitative research. Participants were selected based on the result of the assessment test conducted by the researcher. The assessment on integer test has 5-item word problem on the fundamental operations of integer and was given to the identified students of Grade 7 per selected school. The seven students who got the bottom least score were selected for a one-on-one in-depth interview with me as the facilitator of the interview. As identified, seven out of nineteen students from school A, eight out of twenty-seven from School B and seven out of fourteen from school C. In which thirty-six percent from the total are part of this study. Primarily, the target number of participants of the study was 21 grade 7 students but since there was a tie in score, and for the fairness of the research, 22 out 60 students were included in the interview. According to Creswell and Poth (2018), there is no specific number of participants in the interview besides the number of participants depends on the qualitative research approach being used.

Data Analysis

This study utilized the assessment test and interview data in analyzing student's misconceptions and errors. As this research sought rich data, an in-depth interview (IDI) was used to help gain better insights regarding the misconceptions and errors exhibited by the learners.

According to Moustakas (1994), analysis of the qualitative data gathered in phenomenological study starts with bracketing the researcher's subjectivity such as setting aside one's predisposition and prejudgments towards the phenomenon. In conducting the qualitative data analysis of this study, I used in this study the following steps.

I prepared the gathered qualitative data for analysis such as transcription of all the participants narratives from the recorded interviews with each participant. Based on the result of the test and interview, I listed all relevant expressions and discarded unnecessary data to avoid the same information from student answers. Then, the next step was to cluster horizons into themes to create core themes. The themes derived from the participants were extracted from the interview, the test results, and literature to verify accuracy and representation across the data sources. The last step in this phase was to craft individual textural description of participants to explain the meaning in a narrative format to facilitate the understanding of participants experiences.

Adding on, the next step was engaging in imaginative variations. I incorporated the textural description explaining how the experience occurred. This process helped me to understand the participant's experience.

Further, I was uncovering the essence of the experience and that was when I synthesized the texture and structure into an expression. The purpose of this step was to reach the essence of the experience regarding the phenomenon being studied.

Trustworthiness

Lincoln and Guba (1985) described trustworthiness as related to a consideration of why the findings of a particular qualitative study are worth paying attention to. Further, this study used their model which provides for criteria to demonstrate reliability - credibility, confirmability, transferability, and dependability.

RESULTS

Profile of the Participants

Table 1.1

Profile of the Participants

Participant No.	Code	Sex	School
1	P1	Male	School A
2	P2	Male	School A
3	P3	Female	School A
4	P4	Female	School A
5	P5	Female	School A
6	P6	Female	School A
7	P7	Female	School A
8	P8	Female	School B
9	P9	Female	School B
10	P10	Male	School B
11	P11	Female	School B
12	P12	Female	School B
13	P13	Female	School B
14	P14	Male	School B
15	P15	Male	School B
16	P16	Male	School C
17	P17	Female	School C
18	P18	Female	School C
19	P19	Female	School C
20	P20	Female	School C
21	P21	Female	School C
22	P22	Female	School C

Table 1.1 reveals the profile of the participants for the one-on-one interview that I conducted face-to-face. There were 22 research participants in this study. The participants were chosen based on the inclusion and exclusion criteria of the study.

Misconceptions of Students on the Fundamental Operations on Integer

Table 1.2*Students' Misconceptions in the Fundamental Operations on Integers*

Themes	Core Ideas
Confusion with Signs and Operations	struggle on distinguishing and applying operations with positive and negative numbers
	find it challenging to handle expressions with multiple signs, such as interpreting and combining different signs correctly
	often confuse the subtraction operator with the negative sign
	unsure when to use addition or subtraction when faced with complex operations involving different signs
	find it difficult to understand and apply the rules for dividing and multiplying integers with unlike signs
	struggle to manage operations with mixed sign, leading to confusion
Comprehension and Word Problem Interpretation	struggle with translating word problems into mathematical operations
	find it challenging to understand and break down the sentence structure of word problems involving integers
	difficulty determining the appropriate operation (addition, subtraction, multiplication, division) to use in word problems
	trouble applying the correct rules for integers within the context of word problems
Inconsistencies and Forgetfulness	forgetting the rules and procedures related to integer operations over time
	approaching problems differently each time, leading to inconsistent results
	lack of consistent practice leading to misunderstanding and forgetfulness when solving problems with integers
	find operations involving integers particularly challenging

Struggles with Specific Concepts	struggle with how to use number line effectively for integers
	struggle with rules involving different combinations of signs in performing mathematical operations
	understanding parentheses and the order of operations can be challenging, especially in complex expressions
General Discomfort and Uncertainty	relying on trial and error, which may lead to incorrect solutions and frustration
	misunderstanding the specific procedures and rules needed to solve integer problems correctly
	Many students' express uncertainty and lack confidence when solving problems with integers

Essential themes on issues about the misconceptions of Grade 7 students in the fundamental operation on integers were coded and labelled from the transcribed one-on-one interview. As shown in Table 1.2, the following themes emerged:

Confusion with Signs and Operations. This first theme emerged from misconception of students based on the sharing of participants. The participants showed uncertainty in performing operations when both positive and negative numbers are involved. They struggle with understanding when to use addition and subtraction and find multiplying and dividing numbers with unlike signs challenging. Also, confusion arises in distinguishing between the subtraction operator and the negative sign.

Sometimes sign rules are very confusing. (P17)

I am confused when to use addition and subtraction...(P3)

I'm sometimes confused with the subtraction symbol and the negative sign. (P8)

I find it difficult to divide and multiply unlike sign numbers. (P4)

I get confused in solving if there are negative and positive... (P1)

Comprehension and Word Problem Interpretation. This second theme emerged from misconception of students based on the sharing of participants. Participants could operate mathematical expressions, however translating word problems into mathematical operation would be difficult for them. Additional struggles were also expressed by participants was the misunderstanding of non-mathematical words contributed to their difficulty in determining appropriate operation to use. Likewise, their struggle was because they had trouble in interpreting it.

I'm confused about solving it because I don't really understand the word problem. (P5)

I don't have a hard time with numbers alone, but if there are words, I get confused. (P6)

Because of the word "drops by " I'm not sure If will subtract or add. (P1)

When they said OWED, I didn't understand what they meant by that. (P14)

Should this be divided?... Because I misunderstood the word from the ground. (P4)

Inconsistencies and Forgetfulness. This third theme emerged from misconception of students based on the sharing of participants. They shared lack of consistent practice can lead to misunderstandings and forgetfulness when solving problems with integers. Others forgot the rules and procedures related to integers operation because it has been taught over time, difficulty in the performing division because wasn't focus on this during his previous grades. Also, solving was inconsistent due to forgotten lessons.

The results are evident with participants' utterances.

Sometimes, I forget the lesson. I can't figure out how to solve it again, like how many quarters have passed, and there are also many new lessons. (P6)

When I was in grade five, I didn't focus on studying division. (P19)

I forgot [the lesson], I don't really know what I'm doing. Try how to do it and if I'm wrong, I will try to do it again in a different way. (P10)

Struggles with Specific Concepts. This fourth theme emerged from misconception of students based on the sharing of participants. The core ideas of students captured by this theme were struggle with concept of number line, use of mathematical symbol such as parentheses, rules of sign, division on integers presented in fraction form and other operation where unlike sign exist in the expression.

I'm having a hard time [solving] with negative and positive. (P5)

My common struggle when it comes to integers is the fraction form. (P15)

I don't understand anything about the rules. (P4)

Lack of mastery of concept. (P10)

... confused with the parentheses, sometimes I don't know where to start and which operation should I use. ... I get confused on how to answer them (P14)

I am confused on the number line Like, horizontal and vertical number line. (P16)

General Discomfort and Uncertainty. This fifth theme emerged from misconception of students based on the sharing of participants. The participant report significant uncertainty when solving problems on integers, often not knowing what procedure to do, where to start or which operation to use which result to making up answers, and not sure in their solution.

My struggle is I don't know how to solve. I just made up my answer because I am confused on what procedure I will use. (P11)

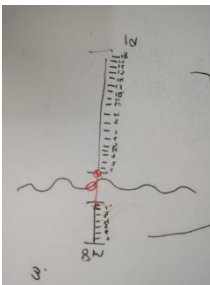
When I solved it, I'm not sure what to do. (P7)

I don't know where to start and which operation I should use... (P14)

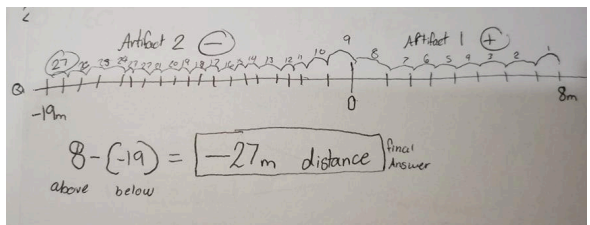
Errors of Students on the Fundamental Operations on Integer

Essential themes on issues about the errors of grade 7 students in the fundamental operation on integers were coded based on their answer during the assessment test. As shown in Table 2, the researcher came up with the following themes: conceptual error; computational error; careless error; interpretation error; and unpreparedness.

Conceptual Error. This first theme emerged from errors of students based on their answer from the assessment test. Based on the observations, the participants struggled on the concept of number line, negative sign which result in error.



Picture 1



Picture 2

Picture 1 shown the number line drawing of P7. Evidently, there were no negative sign values. Also, the picture depicted incorrect visualization of number line because there were three instances of zero presented in the picture. Although P16 drawing as shown in picture 2 presented a good utilization of number line

however he incorrectly applied the direction in number line after performing operation which caused in error.

Table 2

Student's Errors in Fundamental Operations on Integers

Theme	Core ideas
Conceptual Error	trouble in correctly apply the direction in the number line after performing operation challenge in understanding the number line and difference of negative, zero and positive can't assimilate concept like fail to differentiate between whole numbers and integers, treating all numbers as positive and ignoring negative sign do not fully grasp the concept of negative number and their significance
Computational Error	frequently confuse in operating unlike sign numbers leading to mistake in calculation incorrectly perform the operation and integer rule-mix up, where rules were remembered but incorrectly applied
Careless Error	overlook or ignore negative sign due to rushing or not paying enough attention to details not develop habit of consistent noting of negative sign, leading to random error forget to put the signs and variables fail to label or use of notation, resulting to error
Interpretation Error	Misinterpret words, results in error Word such as "from" are often misunderstood, leading to incorrect interpretation
Unpreparedness	insufficient practice and preparation causing them to guessing or incomplete answer poor time management leading to rushed answer

Evidently from the solution shown from picture 3 to 7, P15, P20, P10, P8, P11 demonstrated misconception as they fail to assimilate the difference of whole numbers and integers and operate the expression as they would the same

to whole numbers.

$$\begin{array}{r} -5^{\circ}\text{C} \\ -8^{\circ}\text{C} \\ \hline 3^{\circ}\text{C} \end{array}$$

Picture 3

$$\begin{array}{r} -5^{\circ}\text{C} \\ 8^{\circ}\text{C} \\ \hline 3^{\circ}\text{C} \\ +8^{\circ}\text{C} \\ \hline 11^{\circ}\text{C} \end{array}$$

Picture 4

$$\begin{array}{r} -5^{\circ}\text{C} \\ -16^{\circ}\text{C} \\ \hline 11^{\circ}\text{C} \end{array}$$

Picture 5

$$\begin{array}{r} 8^{\circ}\text{C} \\ +5^{\circ}\text{C} \\ \hline -13^{\circ}\text{C} \end{array}$$

Picture 6

$$\begin{array}{r} -5 + 8 = 18 \\ 18 + 9 = 27 \end{array}$$

Picture 7

Computational Error. This second theme emerged from errors of students based on their answer from the assessment test. Participants exhibit calculation error in expression where there were subtraction or series of subtraction on integers especially when negative exist,

Careless Error. This third theme emerged from errors of students based on their answer from the assessment test. Based on the result, participants errors were caused by inconsistent noting of signs as shown in picture 11, 12, 13, 15 and 16 from the answers of P1, P3, P6, P22, P5 while P11 incorrectly copied the given as shown in picture 14. The evidence was shown below.

$$\begin{array}{r} 8\text{m} \\ -19\text{m} \\ \hline 11\text{m} \end{array}$$

Picture 11

$$\begin{array}{r} 100 \\ -20 \\ \hline -120 \end{array}$$

Picture 12

$$8 \times 2 = 16$$

$$\textcircled{-16}$$

Picture 13

$$\begin{array}{r} 4 \times \frac{15}{2} \\ \hline 30 \\ -3 \\ \hline \textcircled{27} \end{array}$$

Picture 14

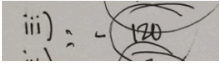
$$\begin{array}{r} 8 \\ +19 \\ \hline \textcircled{-27\text{m}} \end{array}$$

Picture 15

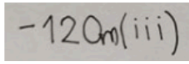
$$-8 \times 2 = 16 + 5 = \textcircled{-21^{\circ}\text{C}}$$

Picture 16

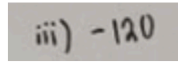
Interpretation Error. This fourth theme emerged from errors of students based on their answer from the assessment test. Participants commonly misinterpret the word “from”. While misinterpret the given problem leading to error. Based on Participants answers are shown below.



Picture 17



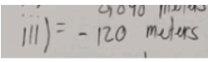
Picture 18



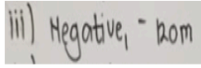
Picture 19



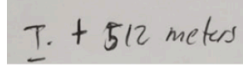
Picture 20



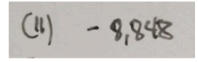
Picture 21



Picture 22

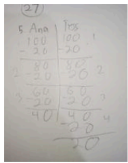


Picture 23

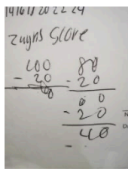


Picture 24

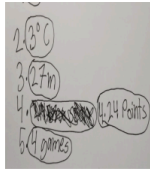
Unpreparedness. This fifth theme emerged from errors of students based on their answer from the assessment test. Participants' issues on errors were due to insufficient preparation, lack of time, leading to rushed answer. As shown on pictures 25, 26, and 28 due to insufficient time. P2's has made no solution while P6 attempted to solved, as shown in pictures 27 and 29, however rushed answers still result in error. Insufficient preparation caused them to incomplete answer or guessing of answer.



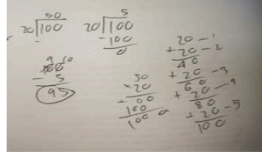
Picture 25



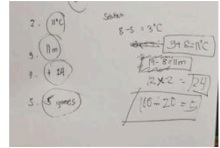
Picture 26



Picture 27



Picture 28



Picture 29

Based on the pictures above, solutions were incomplete as shown on pictures 25, 26, and 28 due to insufficient time. P2's has made no solution while P6 attempted to solved, as shown in pictures 27 and 29, however rushed answers still result in error. Insufficient preparation caused them to incomplete answer or guessing of answer.

Insights and Suggestion for Academe and Society

Table 3

Students' Insights Share to the Academe and to the Society in General

Themes	Core ideas
Effective Teaching Methods	Teachers should explain lessons thoroughly and clearly, taking the time to ensure students understand the material

	<p>Writing problems on the board and demonstrating problem-solving processes can help students grasp concepts more effectively</p> <p>Teachers should go at a pace that suits the students and be patient when answering questions or providing explanations</p> <p>Providing numerous examples, including easy ones, helps students practice and understand concepts better</p> <p>Tailoring teaching styles to the needs and learning preferences of students can improve comprehension</p>
Encouragement of Active Learning	<p>Students should consistently practice problems to master concepts and improve understanding</p> <p>Teaching others can help solidify one's own understanding of the material</p> <p>Regularly reviewing material and concepts can aid retention and comprehension</p> <p>Encouraging students to refer to textbooks and other learning materials for additional practice and understanding</p> <p>Encouraging student questions and providing opportunities for interactive learning helps solidify understanding</p>
Addressing Student Needs and Concerns	<p>Recognizing that students learn at different paces and adjusting teaching methods accordingly</p> <p>Creating a safe and welcoming environment for students to ask questions and seek clarification</p> <p>Minimizing distractions in the learning environment and promoting focus during lessons</p> <p>Being mindful of students' emotional needs and supporting them through challenges</p> <p>Adapting lessons and teaching methods to accommodate the diverse needs of students</p>
Enhancing Study Skills and Strategies	<p>Encouraging students to study regularly, take notes, and review lessons to retain knowledge</p>

	Focusing on teaching students effective problem-solving skills and encouraging analytical thinking
	Introducing keywords and mnemonics to simplify complex concepts and aid memorization
	Allowing students to explore concepts independently while providing guidance when needed
	Encouraging students to prioritize understanding over rote memorization
Promoting a Supportive Learning Environment	Supporting students in building confidence in their abilities and encouraging them to strive for improvement
	Instilling a sense of patience and perseverance in students to work through challenges
	Promoting group work and peer-to-peer support as ways to enhance understanding and share knowledge
	Providing positive feedback and reinforcement to motivate students and build their confidence

Essential themes on insights and suggestion of Grade 7 participants for academe and society in performing operations on integers as shown in table 3.

Effective Teaching Methods. This first theme emerged from the insights and suggestion of grade 7 participants for academe and society. The participants expressed that when teachers explained the lesson too fast, it hindered their understanding of the material because some procedures were not emphasized properly. Additionally, participants suggested that teachers should also provide more examples for practice including easy once.

I hope the lesson is explained properly because some [teachers] teach fast and we don't understand it well. (P22)

For teachers, they should not be too fast in teaching because there are times when they are too fast procedures are no longer emphasized. (P12)

Help them [students] know how to solve and give more example to practice, like easy example... (P10)

I think its best if the teachers demonstrate how to do it because not everyone can listen to the teacher when they talk... (P9)

Encouragement of Active Learning. This second theme emerged from the insights and suggestions of grade 7 participants for academe and society. Participants expressed when with consistent practice helped them improved their understanding. Allowing them to solve so that the teacher could identify areas where they struggled. They express the suggestion that referring to textbooks for additional practice could guide their process when performing operations on integers.

Help them how to solve it and give more examples to practice like easy example. Tell them to refer in book and follow the process step by step. – (P10)

My suggestion is to ask more questions to the teacher... (P19)

Motivate students and encouraged to try solving problems so that they can also see where they struggle in solving. (P6)

Addressing Student Needs and Concerns. This third theme emerged from the insights and suggestions of grade 7 participants for academe and society. The participants expressed that they often feel too shy to raise their hands for fear of embarrassment or judgement from their teacher and their classmates. The participants conveyed they need teachers to listen, patiently addressed their repeated questions and frequently asked them if they understood the lesson.

We feel shy to raise hands because we might be embarrassed.... need to listen attentively... (P22)

When I ask repeated questions to the teacher, patience is important. (P21)

...to ask questions individually to check if they understand because some students... don't ask questions because they're afraid of being judged by their teacher and classmates. (P19)

Enhancing Study Skills and Strategies. This fourth theme emerged from the insights and suggestions of grade 7 participants for academe and society. Enhancing study skills and strategies involved both diligent review and practice. Exercise and study habits were important in helping them retrieve concepts. Taking ownership of their learning provided with additional practice and guidance from the teacher. Additionally, aside from taking notes, the use of keywords was also important in assisting their fast retrieval of information.

Study hard and review. (P1)

Teach them and then try a difficult problem to challenge them. There should be more examples to understand. (P5)

Try teaching it yourself, practice and then you will learn. Strive more and do exercises. (P7)

Study review, listen to the teacher, take notes so I don't forget how to answer and solve. The problem needs to be understood. (P6)

Try how to solve this particular problem on a paper so that we will have guide or notes.(P9)

Keywords are helpful for memorizing stuff...My suggestion to the teacher is to provide always keywords to the students to make it easier to remember. (P20)

Promoting a Supportive Learning Environment. This fifth theme emerged from the insights and suggestions of grade 7 participants for academe and society. Based on the shared insights of participants, collaborative learning environment where teachers and classmates support helped them overcome their challenges in understanding the lesson. Teacher patience, guidance, and feedback could certainly correct their mistakes and build their confidence.

Help my classmates understand the lesson and listen to the teacher attentively. (P4)

Just strive hard and encourage students to strive and just analyze their answers well. (P8)

Patience of the teachers and practice. (P19)

Check where we went wrong and then teach us the correct way.
So that we will know next time. (P18)

DISCUSSION

Based on the transcribed experiences of grade 7 participant. The emerging themes on students and errors in the fundamental operations on integers were discussed.

Misconception of Students on the Fundamental Operations on Integer

Students often encounter misconceptions regarding fundamental operation on integers. This misconception can arise from various sources and may possibly experience by any student unwantedly. There were five themes emerged namely: confusion with signs and operations, comprehension and word problem interpretation, inconsistencies and forgetfulness, struggles with specific concepts and general discomfort and uncertainty.

Confusion with Signs and Operations. Based on observation the presence of unlike sign integers, where both negative and positive integers coexist in the same problem, amplifies students' difficulty. This complexity is underscored by research finding of Permata et al. (2019), which emphasized that equation involving both negative and positive numbers can intensify the challenge for students. The experience of participants in the current study is like the finding from previous research of Makonye and Fakude (2016), highlighting the pervasive nature of these challenges.

Also, the findings reveal significant challenges that student encounter when it comes to understanding and applying fundamental operations involving integers. Students' express uncertainty and confusion, particularly with subtraction, and division, especially when signed numbers are involved. The shared experiences of the participants in this study are like those being pointed out in the study of Nur et al. (2022) and Ruben et al. (2014), where students face challenges specifically, difficulties in performing the fundamental operations in integers.

Moreover, the finding that participant has difficulty in understanding the purpose and differentiate between a minus symbol and a negative sign. The lack

of emphasis, on integers and the minus (-) symbol can lead to confusion among students resulting in errors in applying integer operation principles as discussed by Makonye and Fakude (2016). It is believed that when student could not classify the distinction, which in this study, between the operator and symbol could attribute to error, this misunderstanding will build up which later develop classificational misconception as described in Dayanti et al. (2019). As such, it is important to note the distinction and purpose between minus symbol and negative sign.

Comprehension and Word Problem Interpretation. Participants evidently express some challenges when operating integers, and it gets even harder because they struggle to understand the terms. This difficulty is potentially the reason why they conceive terms differently and apply them incorrectly. Despite having operational skills, struggles with understanding could result to struggle in interpreting problem into mathematical expression, still leads to misconceptions, and often lead to mathematical errors. The findings in the study exhibits an issue with comprehension and interpretation. This mathematical challenge aligns with Makonye and Fakude (2015) who linked them to language barriers.

This emerging theme on misconceptions corroborates to what Legarde (2022) and Mangulbaan (2016) had noted regarding the struggle experienced by students with mathematical terminology and difficulty faced in choosing the right problem-solving strategy because they struggled to interpret in the first place. Their lack of understanding of mathematical terms is the reason why they cannot process the problem resulting to misunderstanding and trouble in applying the rules within the context of the problem. Likewise, the finding is in accordance with the idea of Sun (2018) underlining the importance of clear understanding of the mathematical terms to prevent improper use of the term.

Findings of this study support the theory of Piaget's Constructivism theory, when students encounter disbalance in receiving information, they misinterpret them because their existing schemas do not match with the information, they receive causing possible misconceptions. Its either student will adjust to new information or maintain incorrect information and add to their existing information.

Inconsistencies and Forgetfulness. These are issues of the participants regarding difficulties caused by concepts that were taught overtime, and they

sometimes persist because they were left unattended. This finding suggests that students lack of consistent correct practice, students tend to forget how to apply them. The finding connectedly be because of external limitations such as limited time dedicated to learning as discussed by Khalid and Embong (2019).

Moreover, the findings support the idea of Fadillah and Susiaty (2019), plenty of practice exercises to work on that connect ideas to various real-life situations help student learn better. Adding on, challenges in mastering integer operations necessitates linking of concepts with regular practice or use of mnemonic to aids retention. Thus, correcting misconception and errors before introducing to new topic are significant as emphasized by Fadillah & Susiaty (2019).

Struggles with Specific Concepts. The study findings show that students do not have enough understanding the rules and principles of integer operations. The participants expressed struggles in different areas, including number line, sign rules, parentheses, concept of integers and operations involving integers. As pointed out in the study of Kwakye and Aggrey (2022), these difficulties may stem from a lack of understanding of the purpose behind the concept of integers which shows a theoretical misconception as described by Dayanti et al. (2019).

Also, student reported difficulty using the number line model, showing that even common visualization tools can contribute to misconceptions if not presented accurately. Adding on, students struggle with interpreting symbols, such as parentheses making things even more difficult for them to do which was confirmed in the sharing of P14. The struggles of students with specific concepts, emphasizing the order and use of parentheses is crucial in facilitating the order of execution when performing operation on integers.

Moreover, some students attribute their struggle to a lack of foundational understanding due to missed focus on certain concept in previous grades. Also, P15 expressed that he is struggling with integers when they are presented in fraction which is expected to have been taken up in the lower grades. The finding of the study aligns with Jean Piaget's Constructivism theory, when students encounter disbalance in receiving information, they misinterpret information because their existing schemas do not match with information sources. When students do not fully grasp a concept, they may struggle with ideas and may affect in receiving related concept especially in the study of

integers. This situation emphasizes the interconnected nature of concepts of integers and the importance of establishing a foundation, which is crucial for learning arithmetic and algebra as highlighted by Kartono et al. (2022) that integer is a basic concept in learning higher Math.

General Discomfort and Uncertainty. Participants lack confidence is a manifestation of their uncertainty of the correctness of their answers due to incomplete understanding of concept of integers. This uncertainty caused them to feel discomfort which affected their self-confidence. Incomplete, as observed because somehow participants can perform operations but could not fluently dwell across signs and operations to be specific. As shared by P14 who expressed not knowing where to start and which operations to use.

General discomfort and uncertainty in performing operations on integers can lead to misconception as they disrupt the process of cognitive construction as outline in Jean Piaget's Constructivism theory. When students lack self-confidence, they will struggle to understand the correct procedure, they will experience a conflict on their thinking. This discomfort would result to either they will adjust their understanding just to accommodate the procedures or maintain their misconception. Addressing this issue requires opportunities for students to reconcile their existing understanding to new information or with correct information. Essentially, it is important to identify which persisting misconceptions students had experienced (Neidorf, 2020).

Errors of Students on the Fundamental Operations on Integers

Despite frequent practice and being careful, students will still often encounter error when performing problems in general. This error can arise from various sources and may possibly experience unwantedly. The five themes that emerged regarding errors of students on the fundamental operations on integers are *conceptual error*, *computational error*, *careless error*, *interpretation error*, *unpreparedness*.

Conceptual Error. The findings include the difficulties of participants in correctly applying number line and directions after performing operation was also reflected in the study of Khalid & Embong (2019). Another is participants failure in assimilating distinction between applying operations on integers and operation of whole number were also the findings in the study of Faudiah & Suryadi (2019).

Mostly, participants common error was applying operations on integers. The finding of this study was supported by the results of the study of Kwakye and Aggrey (2022), where students applied the same rule as they would for whole numbers without considering sign of integers, especially for negative.

Accepting of concepts that differ from their previous beliefs or concept may not align with their accepted mathematical concepts thought consequently lead to the improper use of terms as noted by Koutsoyiannis and Montanari (2015), .This error is connected to theoretical misconception as participants perceived wrong understanding of concept as described by Dayanti et al., (2019) and they applied it unconsciously, thinking it was right.

It is suggested that educators should reinforce understanding of negative numbers and specific rules, possibly integrate interactive number line exercises for clear visualization, such as utilization of number line media as suggested by Arif & Kholifa (2018) to provide accurate figures and directions of numbers after operation.

Computational Error. The finding of the study shows participants incorrect procedure in carrying out the problem as student commonly incorrectly operate subtraction of integers. This result is identified in the study of Nelson & Powell (2018), where errors exhibit while performing operations on integers such as subtraction of integers. The challenges arise, particularly in operating negative integers and employing the incorrect procedures for problem-solving (Nur et al., 2022) which potentially result in error in the solution and result. It is noted that arithmetic skills in performing operations are not just theoretical, they are indispensable in daily activities and form the core of basic mathematics (Zhang et al., 2019) as such it is important to address it even in small amount of error.

Careless Error. As explained by Bethany (2016), It happens when participants rush through problems or not paying attention leading to dropping important signs and/or mistakenly identifying negative as minus, the same in the findings of my study. The overlooking of small or important details still resulted in mistakes such carelessness as also noted by Anggara & Wandari (2021). These were evident in the student's calculation which resulted in error. Another careless error happened was when participants forget signs and variables because of unsystematic solution, this is also evident in the findings and analysis of Koch's (2014).

To reduce careless errors, it is suggested that students should work methodologically and double checking of work. When this error left unattended, this potentially hampers their procedural fluency, which is an important factor for mathematical proficiency as emphasized in the theory of Schoenfeld and Kilpatrick.

Interpretation Error. The findings show that participants exhibit this error as they misinterpreted the problem or words. Errors were potentially be rooted from poor proficiency in the language as figure out in Makonye & Fakude (2015). Misinterpretation of question is the factor; this error is also supported in the study of Angara & Wandari (2021) where students mistakenly process incorrect information contributed to incorrect answer. When students exhibit issues with interpretation, this challenge can be linked to language barriers as interpreted by Makonye & Fakude (2015).

Educators should integrate language support within mathematics instruction, ensuring that students understand the terminology for emphasis and clarification along with strategies of breaking down problem. Likewise, in accordance with the idea of Sun (2018) underlining the importance of clear understanding of the mathematical terms to prevent improper use of the term.

Unpreparedness. The findings show that participants' unpreparedness contributes to error. Participant's failure to finish mathematical problem and leaving answers unfinished results in error as its indication of incomplete solution. This finding was also reflected in the findings of the study of Mathaba et al. (2024). Unpreparedness may stem from mismanagement of time, struggle in identifying appropriate operation or struggle during the process of calculation. As such it is important for educators to enhance arithmetic fluency as highlighted by Zhang et al. (2019) and providing ample exercises to practice and aid senses, relating concepts in different contexts will facilitates a better understanding as suggested by Fadillah & Susiaty (2019).

Insights that Students Can Share to the Academic Community

Essential themes are classified according from the insight of the participants gathered through one-one-one interview. The following are the themes: *effective teaching methods, encouragement of active learning, addressing students' needs and concerns, enhancing study skills and strategies, and promoting supportive learning environment.*

Effective Teaching Methods. Clear and effective teaching strategies play a vital role in helping students grasp mathematical concepts especially integers. Participants stress the importance of teaching at a pace that allows them to grasp procedures and concepts effectively. With the student's responses, it is evident in their shared lived experiences that teachers need to adjust their pacing in teaching the lesson. Students felt it necessary so that through illustrative problems, the teachers can present and emphasize the logical procedures in solving integers. Giving of examples or exercises were also needed by participants to harness their solving skills and retention on integers as what Fadillah & Susiaty (2019) promoted.

Limitation of lesson time could be one of the potential reasons which was also noted by Khalid and Embong (2019) which potentially contributes to students' struggle however there are alternatives that can be used in teaching such as utilization of manipulative media which is proven effective to increase numeracy skills in learning integers as proved by Listrianti et al. (2022).

Further, continuous identification of misconceptions and effective strategies can address the problem as suggested by Jamaludin and Maat (2020).

Encouragement of Active Learning. Participants highlighted the importance of empowering students through practice and application for reinforcing learning and mastering mathematical concept especially integers. This resulting theme is congruent to the results of the study conducted by Abla and Fraumeni (2019) why student engagement matters. They stated that teachers influence the students' levels of engagement which in turn influence students' academic attainment. Also, Nur (2022) emphasized the importance of establishing connection between integer concepts and real-life concept to facilitate more comprehensive understanding of mathematical operations.

Contrary to the theme, Makonye and Fakude (2016) identified language proficiency as challenge. While not directly contradicting the importance of active learning, this challenge suggest that language may hinder student ability to actively engage with mathematical concepts.

Overall, the findings emphasize the importance of establishing a nurturing learning environment through active learning with additional support and encouragement through peer teaching, allowing active and collaborative learning environment which provide positive reinforcement.

Addressing Students Needs and Concerns. I noted through the sentiments of some students, showing worries, feeling shy or embarrassed because of their apprehension of being humiliated by their teachers and classmates. As such, students are scared to ask questions to clarify things for better understanding of the lesson. This emerging theme resonates with the study of Gamage (2021) which discusses how personal values affect teaching methods and student performance.

The academe aims for good mathematical fluency however augmented by concern with cognitive challenge, educator should also acknowledge psychosocial challenges of students as noted by Nyborg et al. (2022).

Recognizing students differences and equally welcoming environment are essential to support students emotional needs. Classroom culture factors students learning styles. Creating a safe space for asking questions helps students feel more comfortable in their learning journey. When student feels emotionally supported, they are more likely to engage in learning activities. Significantly, this will boost students' proficiency in solving integers, and even other related mathematical problems. In a supportive environment, students are less afraid to ask question, which allows them to address their errors or any misperceived concepts earlier.

Enhancing Study Skills and Strategies. The participants emphasized the importance of effective study habits and support in their learning prices. A majority of them, highlighted the significance in studying diligently and understanding the material. Study habits is related to mathematical self-concept as proved by Tossavainen et al., (2022), thus with good study habits will positive affect proficiency in solving mathematical problems.

Another, Participants note the value of using of keywords or mnemonic to aid understanding. This idea was congruent to the suggestion of Balbuena & Buayan (2015) , the use of mnemonics in teaching integers were significantly important in improving students performance in operating integers, such as using the mnemonic device LAUS and LPUN.

By teachers support, devising strategies and students consistent practice, routined study habits, and good note-takings strategies students could overcome challenges and reduce their misconception and errors when performing operations on integers.

Promoting a Supportive Learning environment. Participants highlighted the importance of empowering one another. Through the insights, participants need the encouragement, patience and continuous support in building their confidence. Teacher must work out how they can help their student to understand mathematics as also noted by Anthony & Walshaw (2023), by considerations factors can be pointed out and discussed.

Mistakes are natural component of learning as pointed by Hansen et al., (2020), as participants develop understanding, they will unavoidably misconceive ideas, however through teacher frequent support and recognition, could helped their mathematical development. As such, it is significant foster a good classroom culture where mistakes are openly accepted and corrected.

Implication for Educational Practice

The implication for educational practice is multifaceted and critical for addressing the challenges and misconceptions identifies in students understanding of integer operation. First and foremost, educators should focus on strengthening the conceptual foundation of student in operation and sign integers, especially in addition and subtraction of integers. Emphasized conceptual understanding over rote memorization and providing clear guidelines and frameworks to help student classify and apply operations and integers accurately. Reinforcement of concepts through consistent practice and linking new concepts to previous knowledge can help overcome these challenges and enhance students mathematical reasoning and problem-solving skills.

Secondly, teachers should employ clear and effective teaching strategies, incorporating multiple examples and utilizing visual aids in direction of number lines after performing operations to facilitate deeper visual and conceptual understanding on integers. Demonstrating problem-solving method step by step, adapting the pace of instruction to ensure effective understanding, and providing regular and constructive feedback are essential to enhance student grasp of concept.

Lastly, promoting effective study habits by encouraging students to develop consistent and structured study habits, providing effective note-taking strategies, and encouraging regular practice and independent study can reinforce mastery of concept, particularly integers. By implementing these implications into education practice, educators can address the identified misconceptions and errors effectively, fostering a deeper conceptual understanding, enhancing

procedural fluency improving language comprehension, and promoting supportive and empowering learning environment, eventually improving student mathematical reasoning and problem-solving skills in operations involving integers.

REFERENCES

- Abla, C., & Fraumeni, B. R. (2019). *Student engagement: Evidence-based strategies to boost academic and social emotional results*. McREL International. <https://files.eric.ed.gov/fulltext/ED600576.pdf>
- Alviar, J. V., Asakil, O., Cuevas, K. G., Harun, N. A., & Solon, L. J. (2023). Assessing students' mastery and misconceptions in the fundamental operations on integers. *International Journal of Science, Technology, Engineering, and Mathematics*.
- Anggara, B., & Wandari, W. (2021). Misconceptions of senior high school students in solving high order thinking skills questions. *Journal of Physics: Conference Series, 1918*(4), Article 042089. IOP Publishing.
- Anthony, G., & Walshaw, M. (2023). Characteristics of effective teaching of mathematics: A view from the West. *Journal of Mathematics Education, 147*–164.
- Arif, M. S., & Kholifah, K. (2018). The numbers line media to improve the ability of the students in calculating integer operation. *Jurnal Konseling dan Pendidikan*.
- Balbuena, S. E., & Buayan, M. C. (2015). Mnemonics and gaming: Scaffolding learning of integers. *Asia Pacific Journal of Education, Arts, and Sciences, 2*(1), 14–18.
- Ballenas, G. J. (2023). Improving computational skills in integers, fractions, and decimals through technology-enhanced mathematics instruction (TEMI). *American Journal of Educational Research, 11*(9), 603–613.
- Basilio, K. D., Asanon, F. J., Sahidena, R. A., Abdul, A. J., Espacio, L.-G. P., & Alviar, J. V. (2022). Ready or not ready: Extent of readiness in mathematics of Grade 7 students. *International Journal of Academic Pedagogical Research, 6*(8), 81–85.
- Bethany. (2016). *3 types of math errors and how to prevent them*. Math Geek Mama. <https://mathgeekmama.com/types-of-math-errors/>
- Creswell, J. W., & Poth, C. N. (2018). *Qualitative inquiry and research design: Choosing among five approaches*.
- Dayanti, P., Sugiarno, S., & Nursangaji, A. (2019). Miskonsepsi siswa dikaji dari gaya kognitif dalam materi jajargenjang di sekolah menengah pertama. *Jurnal Pendidikan dan Pembelajaran Khatulistiwa, 8*(9).

- Fadillah, S., & Susiaty, U. D. (2019). Developing refutation text to resolve students' misconceptions in addition and subtraction of integers. *Beta: Jurnal Tadris Matematika*, 12(1), 14–25.
- Fuadiah, N. F., & Suryadi, D. (2019). Teaching and learning activities in classroom and their impact on student misunderstanding: A case study on negative integers. *International Journal of Instruction*, 12(1), 407–424.
- Gamage, K. A. A., Dehideniya, D. M. S. C. P. K., & Ekanayake, S. Y. (2021). The role of personal values in learning approaches and student achievements. *Behavioral Sciences*, 11(7), Article 102.
- Hansen, A., Drews, D., Dudgeon, J., Lawton, F., & Surtees, L. (2020). *Children's errors in mathematics*. Sage.
- Khalid, M., & Embong, Z. (2019). Sources and possible causes of errors and misconceptions in operations of integers. *International Electronic Journal of Mathematics Education*, 15(2).
- Kilpatrick, J., Swafford, J., & Findell, B. (Eds.). (2001). *Adding it up: Helping children learn mathematics*. National Academy Press.
- Koch, M. A. (2014). *The relationship between peer coaching, collaboration and collegiality, teacher effectiveness and leadership* [Doctoral dissertation, Walden University].
- Koutsoyiannis, D., & Montanari, A. (2015). Negligent killing of scientific concepts: The stationarity case. *Hydrological Sciences Journal*, 60(7–8), 1174–1183.
- Kowalski, P., & Taylor, A. K. (2017). Reducing students' misconceptions with refutational teaching: For long-term retention, comprehension matters. *Scholarship of Teaching and Learning in Psychology*, 3(2), 90.
- Kusmaryono, I., Basir, M. A., & Saputro, B. A. (2020). Ontological misconception in mathematics teaching in elementary schools. *Infinity Journal*, 9(1), 15–30.
- Kwakye, D. O., & Aggrey, J. (2022). The teaching and learning of integer operations: The case of number rule and conventional method. *Teaching and Learning*, 13(27).
- Legarde, M. A. A. (2022). Working with mathematical problems: An analysis of student's misconception and its impact on mathematical learning. *International Journal of Advanced Research*, 10(3), 25–33.
- Lincoln, Y. S., & Guba, E. A. (1985). *Naturalistic inquiry*. Sage.
- Listrianti, F., Baharun, H., & Wati, N. I. (2022). Using manipulative media in improving students' abilities in operations to calculate the addition of integers in madrasah. *ZAHRA: Research and Thought Elementary*

- School of Islam Journal*, 3(2), 114–128.
https://risbang.unuja.ac.id/media/arsip/berkas_penelitian/24.pdf
- Makonye, J. (2015). Understanding of Grade 10 learner errors and misconceptions in elementary algebra. *Journal of Educational Studies*, 2015(si-1), 288–313.
- Mangulabhan, M. (2016). *Difficulties encountered by the students in mathematical problems*. Academia.edu.
https://www.academia.edu/34837407/difficulties_encountered_by_the_students_in_Mathematical_problems
- Mathaba, P. N., Bayaga, A., Tirmovan, D., & Bossé, M. J. (2024). Error analysis in algebra learning: Exploring misconceptions and cognitive levels. *Journal on Mathematics Education*, 15(2), 575–592.
- Mohyuddin, R. G., & Khalil, U. (2016). Misconceptions of students in learning mathematics at primary level. *Bulletin of Education and Research*, 38(1), 133–162.
- Moustakas, C. (1994). *Phenomenological research methods*. Sage.
- Neidorf, T., Arora, A., Erberber, E., Tsokodayi, Y., & Mai, T. (2020). *Student misconceptions and errors in physics and mathematics: Exploring data from TIMSS and TIMSS Advanced*. Springer Nature.
- Nelson, G., & Powell, S. R. (2018). Computation error analysis: Students with mathematics difficulty compared to typically achieving students. *Assessment for Effective Intervention*, 43(3), 144–156.
- Nur, A. S., Kartono, K., Zaenuri, Z., & Rochmad, R. (2022). The learning trajectory construction of elementary school students in solving integer word problems. *Participatory Educational Research*, 9(1), 404–424.
- Nyborg, G., Mjelve, L. H., Edwards, A., & Crozier, W. R. (2022). Teachers' strategies for enhancing shy children's engagement in oral activities: Necessary, but insufficient. *International Journal of Inclusive Education*, 26(7), 643–658.
- Schoenfeld, A. H., & Kilpatrick, J. (2008). Toward a theory of proficiency in teaching mathematics. In *International handbook of mathematics teacher education: Volume 2* (pp. 321–354). Brill Sense.
- Setyawati, R. D., & Indiati, I. (2018). Analysis misconception of integers in microteaching activities. *Journal of Physics: Conference Series*, 1013(1), Article 012146. IOP Publishing.
- Sujarwo, M., Sudiyanto, S., & Kurniawan, S. (2020). Analysis on mathematics learning misconceptions of the second-grade students of elementary school in addition and subtraction integer topics.
- Sun, X. H. (2018). Bridging whole numbers and fractions: Problem variations in

Chinese mathematics textbook examples. *ZDM*.
<https://doi.org/10.1007/s11858-018-01013-9>

Tossavainen, T., Wall, P., & Sundhäll, M. (2022). Engineering students' mathematical self-concept and its dependence on their study habits and views about mathematics. *International Journal of Engineering Education*, 38(5A), 1354–1365.