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Research Article

Impact of Intervention on Students' Mastery Level and Analysis of Misconceptions in Operations on Integers

Nurul Ain J. Harun, Kyrille Grace A. Cuevas, Lorence James D. S. Sagdi, Ailinda A. Sapilin, Nurmina Y. Nasilon, Misra Kadil, Jayson V. Alviar*, Leo Jay V. Solon

Senior High School Department, Tairan National High School, MBHTE-Basilan, BARMM, 7301, Philippines

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**Corresponding author:*
E-mail:
jvalviar@up.edu.ph

ABSTRACT

One of the fundamental mathematics concepts expected of a high school student to master is integers. However, many students exhibit misconceptions in operating integers which affect their performance as they advanced to the higher level of mathematics. The purpose of this study is to determine the impact of the intervention on students' mastery level and analyze the misconceptions in operations on integers. In this study, a quasi-experimental one-group pretest-post-test design was employed. A total of fifty-six (56) grade 7 students were conveniently chosen of which twenty-six (26) were males and thirty (30) were females. Among these, twenty-nine (29) students belonged to Grade 7A, and twenty-seven (27) students belonged to Grade 7B. The data collected were analyzed using JAMOVI, an open statistical software. The Mean Percentage Score (MPS) was calculated to determine the mastery level exhibited by the students. Results revealed significant increase in the mastery level of grade 7 students after the intervention. In addition, there were no significant differences in the mastery level of the students in terms of the gender and section. Although the mastery level of the students improved, there were recurring misconceptions observed after the intervention. The researchers suggest further study evaluating the benefits of intervention in addressing the students' misconceptions in the four fundamental operations on integers.

Keywords*: Intervention, Mastery level, Misconceptions, Operations on integers*

Introduction

Mathematics plays a vital role in the lives of individuals. It is an essential life skill one must acquire and master to surpass 21st century challenges. However, numerous studies found that students across the globe exhibit low mastery of basic mathematics skills which affect their performance as they progress to higher levels of learning. One of the basic mathematics concepts that is fundamental in different branches of mathematics is integers.

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Integers are generally known as signed numbers with a positive (+) or negative (-) on it including zero (Setyawati & Indiati, 2018). Although it is considered as basic concepts in mathematics, it remains to be one of the least mastered competencies which majority of the students are struggling with especially when operating integers (Palisoc et al., 2019). The common findings of the related studies revealed that most of the students demonstrated misconception in operations on integers due to student's lack of conceptual understanding and skills (Rubin et al., 2014). However, Kyavoa (2017) argued that teaching strategies also influences student's performance in mathematics.

Misconception in mathematics happens when students misunderstand the concepts and incorrectly applied them when solving mathematical problems (Purwaningrum & Bintoro, 2019). Several studies have identified the common misconceptions of the students' involving integers. Operations on integers are regarded as an imperative skill that a student must master before proceeding to a higher mathematical concept (Palisoc et al., 2019). The common misconceptions among students in the fundamental operations on integers were identified by Khalid and Embong (2019) which includes confusion and carelessness on the signs of the numbers, incorrect answers due to conceptual and procedural misunderstanding of rules of operations on integers, and demonstrating rule mix-up. Oftentimes, students are confused what rules to apply when solving integers (Khalid & Embong, 2019). In addition, Makonye and Fakude (2016) claimed that students who have poor English language proficiency often experienced difficulties in understanding the concepts of integers. Also, the study of Fadillah and Susiaty (2019) and Rubin et al. (2014) showed that students have low mastery in the subtraction of integers. Researchers argued that students have poor conceptual understanding on how the results became positive, negative, or zero (Rubin et al., 2014). Furthermore, Fuadiah et al. (2019) and Makonye and Fakude (2016) highlighted that the conceptual understanding of the students on the concepts of integers particularly the negative number is not fully developed causing students to misunderstand the rules of operations on integers.

On the other hand, literature revealed limited studies evaluating gender difference in mastery skills in operations on integers. Ajai and Imoko (2015) claimed that there was no significant difference in the mathematics achievement of both male and female students. However, Kyavoa (2017) found that male students performed better than the female students. In contrast, Rabab'h et al. (2015) and Ali Mohamed Khair et al. (2012) argued that female students have higher achievement in mathematics compared to the male students.

To address this conceptual and procedural errors typically demonstrated by the high school students, mathematics educators conduct learning intervention. Most of the studies have proved that the intervention had a positive impact on the students' achievements in mathematics (Haji Ismail et al., 2023). The purpose of conducting an intervention is to help enhance and develop the skills of the students in mathematics (Rodriguez, 2019). Bofferding (2012) argue that students need to be guided at an early stage in the process of transitioning from understanding the concepts of whole numbers to integers particularly negative numbers. Similarly, Aqazade et al. (2017) stated that improving the conceptual understanding by introducing the basic concepts to the students at the lower year level can help develop their skills to lessen their difficulties as they proceed to higher level. Thus, intervention program intended for struggling students transitioning from elementary to secondary level is beneficial to support their learning needs.

According to Palisoc Jr. et al. (2019), there was a significant difference on the student's performance in operations on integers before and after the intervention. Similarly, Lee and Hong (2022) found that students improved their understanding and reduced misconceptions in operating integers after being exposed to intervention. The researchers stated that using manipulatives can help students enhance their mastery of integer operations (Lee & Hong, 2022). Through intervention, the students have improved their skills and understanding and have corrected their misconceptions particularly in addition and

subtraction of integers (Rubin et al., 2014; Bolyard & Moyer-Packenham, 2012; Bernido, 2023). In a quasi-experimental pretest-posttest study of Sato and Tanaka (2023), results showed that students exhibited better mastery of integer operations after the intervention. However, the researchers found that even after the intervention students still have recurring misconceptions. On the other hand, Layug et al. (2021) claimed that intervention is also effective in enhancing the student's skills through one-on-one tutorial. Moreover, peer tutoring as a process of intervention can also increase the proficiency level of both tutor and tutees in operations on integers. Hence, teachers need to improve their pedagogical strategies in teaching and introducing the concepts of integers to the students in order to develop the strategic knowledge of the students especially in dealing with addition and subtraction of integers (Lin Sen et al., 2017; Bofferding & Richardson, 2013).

In the preliminary investigation conducted by the researchers of the current study, the common misconceptions of grade 7 students were identified. The researchers used the initial findings as the springboard in designing learning intervention and reinforcement to address these misconceptions and increase student's mastery in operating integers. Similar to the findings of many researchers conducted in the fundamental operations on integers, it was found that students have low mastery and encountered difficulties in subtraction of integers. Moreover, the researchers found no significant difference in the mastery level of male and female students.

From these initial findings, the researchers identified the common misconceptions and designed targeted learning interventions and reinforcement. Jitendra and Griffin (2013) pointed out that a misconception-focused approach can lead to the reductions in misconceptions and improved student's performance compared to traditional approach. The researchers conducted learning interventions to the grade 7B students who demonstrated low mastery of the learning competencies involving subtractions of integers for 8 sessions of 60 minutes. On the other hand, grade 7B underwent 30-minute reinforcement activities for one week covering addition, multiplication, and division of integers. Similarly, grade 7A students who demonstrated average near mastery of the concepts of integers underwent the same reinforcement activities. After the intervention and reinforcement, the grade 7 students took the post-test to determine their learning progress.

In present study, the researchers aim to determine the impact of the intervention on the mastery levels of Grade 7 students in operations on integers. Also, this study compares the students' mastery level in terms of gender and identify the misconceptions demonstrated before and after the intervention.

Specifically, it aims to answer the following questions:

1. What is the mastery level in operations on integers of the Grade 7 students after the intervention and reinforcement?
2. Is there a significant difference in the pretest and post-test scores of the Grade 7 students in operations on integers?
3. Is there a significant difference between the mastery levels in operations on integers of male and female Grade 7 students after the intervention and reinforcement?
4. Is there a significant difference between the mastery levels of the Grade 7A and Grade 7B students after the intervention and reinforcement?
5. What are the common misconceptions students exhibit in the post-test in operations on integers?

Methods

Research Design

This study employed a quasi-experimental one group pretest-post-test design to determine the impact of the intervention on the mastery level of the grade 7 students and analyze the misconceptions in operations on integers exhibited before and after the learning intervention. In the present study, a comparative analysis of the pretest and post-test results of the two sections of grade 7 students was carried out. The grade 7A and 7B students were pretested at the beginning of the school year. The researchers designed appropriate learning interventions addressing the identified misconceptions in the four fundamental

operations on integers. Since the grade 7 students exhibited misconceptions in operating integers, the researchers conducted learning interventions in both sections. After the intervention, the grade 7 students took the post-test. This design is appropriate in determining the significant difference between the pretest and post-test results of the students exposed in the learning intervention (Oxford University Press, 2023; Price et al., 2017). Given that there was no control group in the experimental set-up, the researchers recognized that the result of the current study is limited only to the respondents being studied as emphasized by Choueiry (2019).

Respondents of the Study and Sampling Technique

Out of sixty-two (62) grade 7 students who were conveniently selected as respondents for this study, only fifty-six (56) students consistently attended the intervention and reinforcement program and took the post-test. Of the fifty-six respondents, twenty-six (26) were males and thirty (30) were females and there were twenty-nine (29) grade 7A students and twenty-seven (27) grade 7B students. These grade 7 students were enrolled at Tairan National High School in the school year 2022-2023. Convenience sampling technique was employed in selecting the respondents since the students in the two sections were already established prior to the opening of the school year (Cresswell & Cresswell, 2018).

Research Instrument

The researchers developed a 20-item Assessment on Integers (AI) which covers the learning competencies involving the fundamental operations on integers. This researcher-made instrument underwent validation and demonstrated acceptable reliability with a Cronbach alpha coefficient of 0.72.

Data Gathering Procedure

Before the conduct of the study, the researchers consulted the Mathematics 7 teacher and sought permission from the school head and the Grade 7 adviser. Upon the approval, the list of Grade 7A and Grade 7B were determined and pertinent documents were secured for the implementation of the study.

The pretest was administered to the sixty-two (62) grade 7 students using the Assessment on Integers (AI) at the opening of the school year and the results of the pretest were recorded and analyzed to measure the level of the mastery of the grade 7 students and identify their misconceptions. After the pretest, the grade 7B students were exposed to one-hour intervention every afternoon for the subtraction of integers for eight (8) sessions since it was found to be the least mastered operation based on the pretest results. Moreover, a 30-minute reinforcement session was carried out to grade 7B students every afternoon for one week covering addition, multiplication, and division of integers. Likewise, a reinforcement was carried out to the grade 7A covering four fundamental operations on integers. Right after the three weeks of intervention and reinforcement, the remaining fifty-six (56) students were given the same assessment for post-test to determine if there is a significant difference in the mastery level of the Grade 7 students before and after the intervention.

The pretest and post-test results were recorded and analyzed using the appropriate statistical treatment.

Data Analysis

The researchers calculated the Mean Percentage Score (MPS) per operation in the Assessment on Integers (AI) and the MPS results of the Grade 7 students were interpreted using the descriptive ratings as set in the DepEd Order No. 160 series of 2012.

The data gathered were analyzed and tested using JAMOVI, an open software for statistical analysis. A preliminary assumption test was carried out to determine the appropriate statistical treatment to be used for research problems 2 to 4.

The Shapiro-Wilk test results for the pretest and post-test of the Grade 7 students showed significant deviations from normality, (Grade 7A: $p = 0.0141$; Grade 7B: $p = 0.0654$). Hence, a non-parametric test was used, particularly, the Wilcoxon-Signed Rank Test to compare and

analyze if the difference in their mastery level is significant.

A preliminary test was also conducted to check the normality of the post-test results of male and female Grade 7 students per operation. The data revealed that there were significant departures from normality in all operations (for Addition, Multiplication, and Division, $p < .001$; and for Subtraction, $p = 0.004$). Hence, a non-parametric test was employed, specifically, a Mann- Whitney U Test to determine the significant difference in the mastery level of the Grade 7 students in terms of gender. Likewise, the Shapiro- Wilk Test results for the post-test of Grade 7A and Grade 7B are not normally distributed ($W = 0.937$; $p = 0.006$), and a non-parametric test was used, specifically, the Mann-Whitney U Test to compare the mastery level of the Grade 7 students by sections.

Moreover, the researchers carried out an item analysis to identify the common misconceptions exhibited by the students in the pretest and post-test assessment on integers.

Result and Discussion

Comparison of the Grade 7A and Grade 7B MPS in the Pretest and Post-test Results

The researchers calculated the Mean Percentage Score (MPS) of the Grade 7A and Grade 7B and compared the MPS results of the pretest and post-test to determine their mastery level after the intervention and reinforcement. The implemented intervention and reinforcement aimed to address the misconceptions of the Grade 7 students identified in their pretest results. Table 1 presents the mastery level and the mean gained per operation.

Table 1. Grade 7A and Grade 7B MPS per Operation

OPERATIONS	Grade 7A			Grade 7B			OVERALL		
	Pre-test	Post-test	Mean Gain	Pre-test	Post-test	Mean Gain	Pre-test	Post-test	Mean Gain
Addition	60.59 (AVR)	65.52 (AVR)	4.93	40.00 (AVR)	63.70 (AVR)	23.70	55.16 (AVR)	64.61 (AVR)	9.45
Subtraction	45.29 (AVR)	57.93 (AVR)	12.64	25.88 (L)	56.30 (AVR)	30.42	39.03 (AVR)	57.11 (AVR)	18.08
Multiplication	55.88 (AVR)	66.21 (MTM)	10.33	44.12 (AVR)	61.48 (AVR)	17.36	54.84 (AVR)	63.84 (AVR)	9.00
Division	51.18 (AVR)	65.52 (AVR)	14.34	45.88 (AVR)	62.22 (AVR)	16.34	53.23 (AVR)	57.74 (AVR)	4.51
OVERALL	**53.24 (AVR)**	**63.79 (AVR)**	**10.55**	**38.97 (AVR)**	**60.93 (AVR)**	**21.96**	**50.56 (AVR)**	**56.37 (AVR)**	**5.81**

As shown in Table 1, the mastery level of both Grade 7A and Grade 7B across the four fundamental operations on integers improved.

For addition, the Grade 7A MPS from pretest to post-test increased by 4.93% whereas the Grade 7B gained 23.7%. Both sections demonstrated Average Near Mastery (AVR) in the addition of integers.

For subtraction of integers, both sections showed improvement after the intervention was conducted. In subtraction of integers, the Grade 7A MPS from pretest to post-test increased by 12.64%, showing that the class demonstrated Average Near Mastery (AVR). On the other hand, the Grade 7B MPS on subtraction of integers is relatively higher during the post-test as compared to the pretest with a mean gained of 30.42%. It is noteworthy to point out that before and after the intervention, the Grade 7B demonstrated from Low Mastery to Average Near Mastery. This implies that students have improved their conceptual and procedural understanding and have identified and corrected their misconceptions in subtraction of integers after the intervention.

In terms of multiplication of integers, the Grade 7A demonstrated Average Near Mastery (AVR) to Moving Towards Mastery (MTM) after

the reinforcement with a mean gain score of 10.33%. Similarly, the Grade 7B MPS both in pretest and post-test demonstrated Average Near Mastery (AVR) with a mean gain score of 17.36%. Overall, the Grade 7 students performed Average Near Mastery (AVR) in multiplying integers indicating that the Grade 7 students have mastered the concepts however they still encountered some misconceptions in multiplying signed numbers.

The Grade 7 students also showed improvement in the mastery level specifically in dividing integers after the reinforcement. The Grade 7A and Grade 7B MPS increased by 14.34% and 16.34%, respectively. In general, both sections demonstrated Average Near Mastery (AVR).

Overall, the Grade 7 students' mastery levels on the four fundamental operations on integers improved after the intervention and reinforcement whereas the overall MPS increased from 50.56% to 56.37%. This shows that conducting the intervention and reinforcement can help address the misconceptions in operations on integers and improve the mastery level of the students. These findings corroborate with Sato and Tanaka (2023) and Rodriguez (2019) that learning intervention can improve students' proficiency in operating integers. Moreover, identifying misconceptions before the opening of the school year and at an early stage of learning can help teachers plan for reinforcement and intervention program to address these misconceptions (Aqazade et al., 2017). Further, Sato and Tanaka (2023) emphasized that even when the mastery level increased due to the intervention, the students still exhibited misconceptions in operating integers.

Mastery Level of the Grade 7A and Grade 7B Students in the Pretest and Post-test Results

A Wilcoxon Signed Rank Test was carried out to compare the pretest and post-test results of Grade 7A and Grade 7B and to determine if the increase in the MPS result is significant. Table 2 shows the statistical analysis of the test.

Table 2. Comparison of the Pretest and Post-test Results by Sections using Wilcoxon Signed Rank Test

Pretest	Post-test		Statistic	p	Mean difference	SE difference
Grade 7A Pretest	Grade 7A Post-test	Wilcoxon W	49.0 [a]	0.004	-3.00	0.662
Grade 7B Pretest	Grade 7B Post-test	Wilcoxon W	50.5 [b]	0.002	-3.00	0.761
Grade 7 Pretest	Grade 7 Post-test	Wilcoxon W	195.0 [d]	< .001	-3.00	0.500

Note. $H_a\ \mu_{Measure\ 1\ -\ Measure\ 2} \neq 0$; [a] 5 pair(s) of values were tied; [b] 1 pair(s) of values were tied; [d] 6 pair(s) of values were tied

Table 2 revealed the significant differences between the pretest and post-test results of the Grade 7A ($W = 49.0, p = 0.004$) and Grade 7B ($W = 50.5, p = 0.002$). Similarly, there is highly statistically significant difference between the pretest and post-test results of the entire Grade 7; ($W = 195.0, p < .001$). This indicates that the increase in the MPS results of both sections across the four fundamental operations on integers are statistically significant. Furthermore, this implies that the reinforcement and intervention conducted proved to positively influence students' mastery level and address misconceptions in operations on integers. These findings coincide with Haji Ismail et al. (2023) that an intervention has a positive impact on the students' mastery level. Also, Rodriguez (2019) claimed that intervention can improve the conceptual skills and mastery of the students in learning.

Mastery Level of the Grade 7 Students in the Post-test when analyzed by Gender

The Mann-Whitney U Test was conducted to compare the mastery level between male and female Grade 7 students. Table 3 shows the summary statistics of the Mann-Whitney U Test of the post-test results by gender per operation.

Table 3. Mastery Level of the Grade 7 students in the Post-test Result per Operation by Gender using Mann-Whitney U Test

Operations		Statistic	P
Addition	Mann-Whitney U	379	0.860
Subtraction	Mann-Whitney U	362	0.636
Multiplication	Mann-Whitney U	370	0.737
Division	Mann-Whitney U	352	0.521
Overall	Mann-Whitney U	279	0.067

As shown in the Table 3, the p-values in the four fundamental operations and the overall p-value of both genders in operations on integers were not significant with $p = 0.067$, $(Male: Mdn = 10.0;\ Female: Mdn = 12.0;\ U = 279)$. These indicate that there is no difference in the performance of male and female grade 7 students in the given assessment after being exposed to the intervention and reinforcement program. This finding corroborates with the findings of Ajai and Imoko (2015) that there is no significant difference in the mathematics achievements of the students in terms of gender.

Mastery Level of Grade 7A and Grade 7B in the Post-test Assessment

The post-test results of Grade 7A and Grade 7B were analyzed using the Mann-Whitney U Test to compare the mastery level between the two sections. This was analyzed to determine who perform better in the given assessment after being exposed to intervention. Table 4 shows the result of the statistical analysis.

Table 4. Mastery Level of Grade 7A and Grade 7B in the Post-test Assessment

		Statistic	P
Score	Mann-Whitney U	348	0.474

As shown in the table, there is no significant difference between the Grade 7A ($Mdn = 12.0$) and Grade 7B ($Mdn = 14.0$); $U = 348, p = 0.474$. This finding indicates that there is no significant difference in the mastery level between the Grade 7A and Grade 7B students in the post-test in operations on integers whereas the implemented intervention had influenced the mastery level and addressed the misconceptions of the entire Grade 7 class in operations on integers.

Misconceptions of the Grade 7 Students in the Post-test

In the previous study, the researchers have examined the pretest results to determine the misconceptions of the students per operation on integers. The researchers discussed different misconceptions by noting the rules and concepts of the operations on integers including the cases involved in dealing with the numbers with like signs and unlike signs. This served as the bases for the intervention and reinforcement.

After being exposed to the intervention and reinforcement, the results of the post-test were also reviewed. An item analysis was conducted to identify the recuring errors exhibited by the students and were classified per operation.

Misconceptions in Addition of Integers

In the pretest results, the researchers have identified the common misconceptions of the Grade 7 students in addition of integers. Similar to the findings of Fuadiah et al. (2019) students encountered difficulties in dealing with negative numbers particularly in adding unlike signs integers.

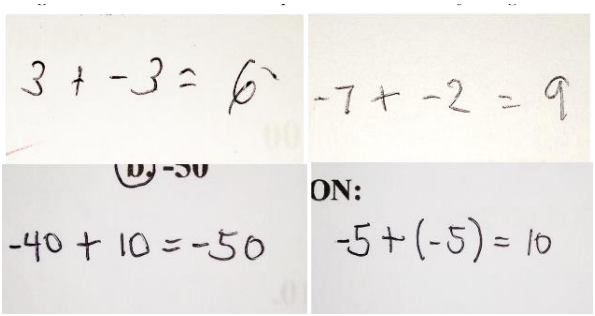

Figure 1. Common Misconceptions in Addition of Integer

The same misconception was demonstrated by some students in the post-test wherein students are still confused with the negative signs and adding unlike signs integers. Just like in items 2 and 10 as shown in Figure 1, most of the students disregard the rule of adding integers with unlike signs wherein they just directly added the expressions 3 + (-3) = 6 and (-40) +10= -50 instead of applying the sign of the bigger number then subtracting the two numbers. Other cases were noted in the items 12 and 13 where the students are expected to add two like signs integers. Instead of applying the rules in adding like signs integers of which the sum must have a negative sign, the students erroneously answered it with positive sign. This shows that students applied the rule of multiplying like signs integers. Evidently, the students were confused what rules to follow when adding integers. These misconceptions were characterized by Khalid and Embong (2019) as carelessness on the signs and rule mix-up. It is noteworthy to point out that the number of students who encountered this misconception during the post-test is lesser than compared to the pretest results. This can be attributed to exposure of the students in the intervention and reinforcement.

Misconceptions in Subtraction of Integers

The Grade 7B students performed low mastery in terms of subtracting integers based on the MPS of the pretest results. Thus, this served as the basis for the intervention to focus more on the concepts of subtraction of integers. Similar to the previous studies, such as those conducted by Fadillah and Susiaty (2019) and Rubin et al. (2014), found that most of the students are struggling with subtraction of integers among the fundamental operations on integers.

Despite the intervention, identical misconceptions were identified in the pretest and post-test based on the item analysis of the post-test results. Based on the findings, some of the students still encountered difficulties in dealing with the switch words, specifically, the word "from" in an expression when subtracting integers. For instance, in item 16, where students were asked to "subtract 41 from -57," the expected answer is -57 – 41 = -98. In addition, there were students who struggled in subtracting bigger number from smaller number as exhibited in item 11, which asked, "9 – 36 =?". Evidently, there was confusion among students leading to varied and incorrect answers. It can be noticed that students are still confused with the switch word in translating from verbal phrase to mathematical phrase. These errors exhibited by the students were also observed by Makonye and Fakude (2016). Similarly, students also displayed confusions when subtracting integers with like and unlike signs. Students exhibited rule mix-up which resulted to different solutions and answers (Khalid & Embong, 2019).

On the contrary, in item 6, which asked the students to "subtract 30 from 25," the question which has the lowest score in the pretest with only 8 out of 62 students answered correctly. However, after the intervention the number of students who answered it correctly increased to 31 out of 56 students. This suggests that intervention plays a significant role in improving the mastery level of the students.

Based on the comparison of MPS of the pretest and post-test results, it can be noticed that the mastery level improved from Low mastery to Average Near Mastery particularly, the Grade 7B students. These results corroborated with the study of Jitendra and Griffin (2013), where misconception-focused intervention improved students' ability to subtract integers. Additionally, targeted intervention specifically for subtraction is necessary to address the misconceptions identified before the conduct of the study. In general, the intervention positively impacts the student's mastery level and lessen their misconceptions in subtraction of integers.

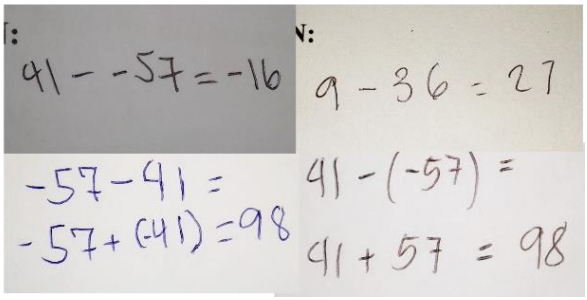

Figure 2. Common Misconceptions in Subtraction of Integer

Misconceptions in Multiplication of Integers

For multiplication of integers, the MPS of the Grade 7 students in the pretest and post-test increased from Average Near Mastery to Moving Towards Mastery. However, there were some students who exhibited misconceptions in multiplying unlike signs integers.

For instance, in items 4 and 20, which asked students to solve the expressions (-5) × (6) and (16) × (-4). Students got the correct value however they disregarded the negative sign. Students exhibited carelessness in dealing with signed numbers as described by Khalid and Embong (2019), wherein they solved these expressions as (-5) × (6) = 30 and (16) × (-4) = 64.

On the other hand, students also displayed procedural errors when multiplying integers with like signs. In item 19, students answered (-40) in the expression "(-8) × (-5)". This shows that students applied the rule in adding like signs integers and this error can be classified as rule mix-up (Khalid & Embong, 2019).

On the flip side, most of the students demonstrated mastery of multiplication of integers with zero. However, a small number of students still unable to evaluate the expression in item 7 which asked them to multiply 10 from 0.

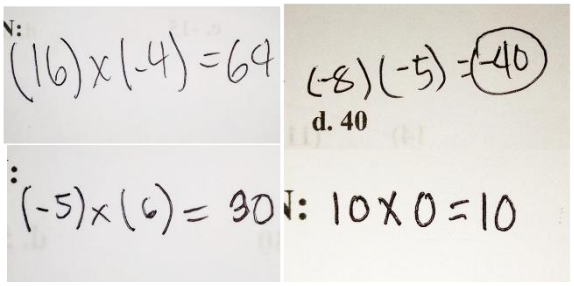

Figure 3. Common Misconceptions in Multiplication of Integer

Misconceptions in Division of Integers

In division of integers, both sections performed Average Near Mastery based on the MPS results of the pretest and post-test. However, there were some notable misconceptions exhibited by the small number of students even after the intervention.

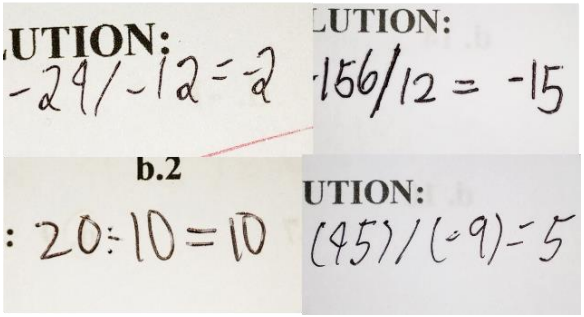

Figure 4. Common Misconceptions in Division of Integer

In item 17, the students were asked to solve the expression 45 ÷ (-9). However, due to the carelessness, students answered 45 ÷ (-9) = 5. Congruent to the findings of Khalid and Embong (2012), students divided the integer and gave the correct value but with wrong sign.

Another procedural error demonstrated by the students in pretest which recurred in the post-test is dividing unlike signs integers. Conversely, students exhibited misconceptions when dividing integers with like signs especially with negative numbers as shown in item 9, which asked students to evaluate (-24) ÷ (-12). The students performed rule mix-up by copying the negative sign to the quotient. Students forgot the rules that when dividing two negative integers, the quotient is always positive.

Additional procedural error observed after the intervention was a lack of basic knowledge in dividing numbers. As shown in Figure 4, both items 5 and 18, which asked students to evaluate the expressions "20 ÷ 10" and "-156 ÷ 12," respectively, revealed that students were unable to provide the correct values. This shows that there are some students who still struggle in dividing numbers.

In general, the Grade 7 students have increased their mastery level after being exposed to the intervention based on the mean gained in the MPS results between the pretest and

post-test. Similarly, the implemented intervention and reinforcement was able to address and lessen the misconceptions of the Grade 7 students in dealing with the four fundamental operations on integers. However, students exhibited misconceptions even after the intervention. These findings were also noted by Sato and Tanaka (2023). The students were able to identify and correct their misconceptions in operations on integers, especially in subtraction of integers, which is evidently reflected on the MPS which increased significantly from Low Mastery to Average Near Mastery particularly in Grade 7B. The results of this study highlighted the importance of targeted learning intervention and reinforcement in helping the students improve their mastery level and skills in understanding the rules and concepts of the four fundamental operations on integers. Furthermore, these findings align with the study of Palisoc et al. (2019) which similarly demonstrated a significant difference in the mastery level of the Grade 7 students before and after being exposed to an intervention.

Conclusions

Based on the findings of this study, the researchers concluded that:

1. The mastery level of the Grade 7 students improved after the intervention and reinforcement.
2. There is a highly statistically significant difference between the pretest and post-test results of the Grade 7 students, showing the positive impact of intervention in the student's mastery level in operating integers.
3. There is no significant difference in the mastery level of both male and female after being exposed to intervention.
4. Both Grade 7A and 7B students exhibited similar mastery level in operations on integers after the intervention.
5. The recurring misconceptions exhibited by Grade 7 students in operations on integers after the intervention include rule mix-up, dealing with negative numbers, and confusion and carelessness with signs.

Limitations and Future Research

The intervention proved to be effective in improving student's mastery and help address their misconceptions in the four fundamental operations on integers. However, this study has limitations which include the design and sampling technique employed. With this, the findings of the study can be generalized to the samples considered in the study. The researchers compared the pretest and post-test results of the grade 7 students to determine the impact of intervention on students' mastery level and the misconceptions exhibited by the students without the control group in the experimental set-up. Moreover, the study used a non-probability sampling method. Hence, the researchers recommend the following:

1. Conduct similar study by considering random sampling method in selecting respondents and evaluating the impact of intervention on mastery level of students in operating integers by comparing experimental and control groups.
2. Administer the Assessment on Integers (AI) to the Grade 7 students to identify their mastery level and misconceptions before the start of the regular class every school year.
3. Conduct a regular intervention to fully develop the mastery of the students in dealing with the four fundamental operations on integers.
4. Evaluate the mastery level and misconceptions among students in other grade levels within the school and across the Schools Division of Basilan, using the same assessment tool.

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