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# Assessing Students' Mastery and Misconceptions in the Fundamental Operations on Integers

**[1]Nurul Ain J. Harun, [1]Kyrille Grace A. Cuevas, [1]Olivia I. Asakil, [2]Jayson V. Alviar, & [3]Leo Jay V. Solon**

## Abstract

One of the common misconceptions affecting mathematics performance of high school students involves operating integers. Evidently, students who were exposed to modular learning demonstrate poor mastery of the pre-requisite skills. This study aimed to assess the mastery level and misconceptions of the Grade 7 students involving operations on integers. A descriptive research design was used with a total of sixty-two (62) conveniently chosen Grade 7 students were twenty-nine (29) were males and thirty-three (33) were females. The Mean Percentage Scores (MPS) per operation on integers were calculated to describe the mastery level and the assessment results were analyzed to identify possible misconceptions of the students in operating integers. Similarly, data were analyzed using the Welch t-Test to determine if there is a difference in the level of mastery between the male and female students. Findings show that the overall MPS result is 50.56%, indicating that the students demonstrated Average Near Mastery (AVR) of the concepts involving operations on integers. In addition, there was no significant difference between the mastery level of male and female grade 7 students. Although the students demonstrated Average Near Mastery (AVR) in the given assessment, the item analysis showed various misconceptions and errors exhibited by the students regardless of sex and section. Students' misconceptions include subtracting integers and dealing with negative numbers. Hence, an intervention is needed to address the misconceptions in subtracting integers and a reinforcement is proposed to enhance the students' mastery in other operations on integers.

**Keywords:** *Operations on Integers, Mastery Level, Mean Percentage Score, Misconceptions*

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**About the authors:**
[1]Senior High School Student at Tairan National High School – Basilan Division – BARMM-MBHTE
[2]Corresponding author. Secondary School Teacher 1 at Tairan National High School – Basilan Division – BARMM-MBHTE. Corresponding email: jvalviar@up.edu.ph
[3]Secondary School Teacher 1 at Tairan National High School – Basilan Division – BARMM-MBHTE

## 1. Introduction

As mathematics is an integral part of human's daily life, the Philippines Department of Education (DepEd) K-12 curriculum aims to help students master the core skills which includes the critical thinking and problem solving (DepEd, 2016), which are essential competencies in the 21st century. To achieve proficiency, students must be actively involved in the learning process and should be given opportunities by the teachers to acquire and enhance their mathematical skills. However, the two years exposure of students to modular distance learning due to pandemic caused troubling impact on their mathematical abilities.

Mathematics is one of the difficult subjects to learn even before the pandemic started (Lalian, 2019). It is not a surprise that many incoming high school students who moved from modular distance learning to face-to-face classes post-pandemic school year have poor basic mathematics skills. In fact, Basilio et al. (2022) pointed that students must be assessed accurately to address the learning losses in mathematics and "identify students at risk of developing low math skills" (Mejias et al., 2019, p. 2). Misconception about mathematical concepts is one of the factors affecting mastery of competencies. This means that low mastery and misconceptions in mathematics are intertwined issues. "Misconception is a type of error in understanding each mathematical concept and solving mathematical problems" (Purwaningrum & Bintoro, 2019, p. 174). If this problem remains unsolved, it will affect students' achievement in mathematics.

One of the basic mathematics competencies that many high school students struggled and had misconceptions involve operating signed numbers or integers. Khalid and Embong (2019) accentuated that student facing difficulties in solving integers has been known throughout the world. Students often encountered errors and misconceptions in understanding the concepts and operations on integers because students learn basic operations involving integers procedurally without understanding and analyzing the concepts (Dube & Robinson, 2018). Moreover, students were confused in operating integers, and they tend to mix-up the rules especially when the signs of integers involve both the positive (+) and the negative (-) signs. In addition, students struggled to perform operations on integers especially when dealing with negative numbers. As a result, students struggled to solve problems involving operations on integers (Alsina & Nelson, 2006). This misconception can affect students' skills in solving mathematical problems (Booth & Koedinger, 2008).

Based on the Most Essential Learning Competencies (MELC) for Mathematics provided by the DepEd, the concepts of fundamental operations on integers are introduced to students as early as grade 6 in the Quarter 2 and the same concepts are re-introduced in grade 7 Quarter 1 for one week. This is where the problem could stem from poor basic mathematical skills and misconceptions about the rule of operations on integers because grade 7 students enrolled during the school year 2022-2023 were migrant learners from two-year modular learning due to the COVID-19 pandemic. The concepts of integers and the four basic operations on integers are expected competencies students must be able to demonstrate as they move to high school. However, Basilio et al. (2022) reported that grade 7 students who were exposed to modular distance learning have not fully acquired the mathematics pre-requisite skills which made them not ready for high school mathematics. In addition, the study found no significant difference in the elementary math skills of grade 7 students when analyzed by gender (Basilio et al. 2022). On the other hand, Pandey (2017) reported that male students performed better than female students.

Most studies that uncover students' misconceptions involving operations on integers made use of descriptive design. Sadler (2012) developed a 20-item assessment "to assess the students' knowledge of various aspects of integer operations" (p. 24). This assessment is composed of equational problems using all four operations in mathematics to identify which operation students exhibit poor mastery and misconceptions (Sadler, 2012). At present, there is a limited study that evaluates misconceptions of students in mathematics involving integers in post pandemic. Similarly, gender divide in terms of mastery and misconceptions involving fundamental operations on integers remains to be unexplored.

The purpose of this study is to determine the mastery level and the misconceptions of the grade 7 students in mathematics, particularly in solving integers with the involvement of the four (4) mathematical operations: addition, subtraction, multiplication, and division of integers. Also, this study compares the mastery level of the male and female students in the fundamental operations on integers and design intervention to enhance the students' mathematical skills. In addition, the study aims to test the significant difference in the mastery level of the grade 7 students on operations of integers when analyzed by sex.

## 2. Literature review

### *2.1. Integers and Fundamental Operations on Integers*

Integers are set of numbers that can either be positive or negative numbers or zero (0) (Setyawati & Indiati, 2018). Integers are also described as a signed number with a positive (+) and negative (-) sign on a number. The concepts of integers are fundamental mathematics competencies students must master. Rosyidah et al. (2021) stated that "integer is an essential part of the number concept" (p. 1). Similarly, Nurnberger-Haag et al. (2022) pointed out that "integer operations are crucial aspects of numerical competence necessary for all subsequent mathematics" (p. 1). In addition, Lamb and Thanheiser (2006) stated that "the subject of integers is a very important part of the middle school mathematics curriculum as it symbolizes a move from concrete to abstract thinking" (p. 176). In other words, learning concepts about operations involving integer is a serious topic that must be focused on to prepare students for higher mathematics.

The fundamental operations performed on integers include addition, subtraction, multiplication, and division. Rules of integer operations differ when dealing with integers with like signs and unlike signs.

For addition of integers, there are two cases to consider (1) adding integers with like signs and (2) adding integers with unlike signs. To add integers with like signs, add the absolute values of the two integers and put the common sign of the numbers. To get the sum of the two integers with unlike signs, get the difference of their absolute values then copy the sign of the larger number.

To subtract integers, change the sign of the number being subtracted and perform the addition. In other words, if a and b are integers then a – b = a + (-b).

For multiplication of integers, there are two cases to consider. When multiplying integers with like signs, the product of the two integers is always positive, that is $negative\ (-) \times negative\ (-) = positive\ (+)$ and $positive\ (+) \times positive\ (+) = positive\ (+)$. On the other hand, when multiplying integers with unlike signs the product of the two integers will always be negative. In other words, $negative\ (-) \times positive(+) = negative\ (-)$ or $positive(+) \times negative\ (-) = negative\ (-)$.

The rules for division of integers are similar to the rules when performing multiplication of integers. When two integers of like signs are divided, the quotient will

always be positive. However, when two integers of unlike signs were divided, the results will always be negative.

### *2.2. Students' Misconceptions in the Fundamental Operations on Integers*

Several studies about students' misconceptions in mathematics revealed that learners often encountered errors and misconceptions when dealing with integers (Jamaludin & Maat, 2020).

Sadler (2012) found that students who have misconceptions in dealing with integers usually arrived at an answer either having the (1) wrong sign, (2) wrong value, or (3) wrong sign and value. Students were confused what sign should be placed on the number after solving it because they have not understood well the rules on operating integers. Also, students have the tendency to solve problems involving integers and arrived at a wrong value because they are confused what to do with the signed numbers. In some cases, students arrived at an answer with a wrong sign and value because they do not know what rules to observe when performing operations on integers.

Fuadiah et al. (2016) determined the misconceptions of the 96 Grade 7 students Palembang, Indonesia and found out that most students encountered difficulties in understanding the "concept of integer particularly which is related with negative numbers" (p. 35). Most of the students struggled and tend to get confused with the negative numbers and misapplied the rules in operations involving integers. Makonye and Fakude (2016) pointed out that "negative numbers are difficult to teach" (p. 2). Students get confused of the signed numbers especially when the equation contained either a positive (+) or negative (-) number, hence, they often encountered misconception of "rule mix-up" where they just remember the rules of each operation of integers and apply it erroneously (Khalid & Embong, 2019). Similarly, Permata et al. (2019) found that students struggled in subtracting integers. The most common misconception of the students in subtracting integers is when the minuend is a negative integer. Also, Rubin et al. (2014) pointed out that students often have difficulties in understanding the rules of subraction of integers with opposite signs. Badarudin and Khalid (2008) claimed that the concepts of subtraction of integers involving negative numbers is difficult for the students to assimilate. On the other hand, Sadler (2012) and Ali Rahman et al. (2017) found that students have misconceptions in multiplying integers by 0.

Students also exhibited errors in calculation because of "poor proficiency in English language" (Makonye & Fakude, 2016, p. 9). This misconception is usually observed in subtraction of integers. The use of the switch word "from" in problems involving subtraction of integers confuses students in translating a verbal phrase to mathematical phrase. For example, when students were asked to "subtract 10 from 30", the common error in translating this phrase to mathematical phrase is 10 – 30, which lead to an incorrect answer.

Khalid and Embong (2019) stated that "good knowledge of operations in integers is important for manipulation of numbers and letters in algebra" (p. 11). Permata et al. (2019) revealed that the "students understanding of algebra is still low" (p.1). Moreover, Alsina and Nelson (2006) claimed that students are still struggling whenever they try to solve simple mathematical problems involving integers. To overcome this, students must deepen their knowledge in operating integers before proceeding to higher math concepts. Using models such as number lines could help students in learning integers easily. Number line is "the basic metaphor in understanding mathematics" (Nunez & Lakoff, 2013, p. 29-30). The role of using this model is significant in "the period of transition from concrete operations to abstract operations and encounter the concept of integer for the first time" (Cetin, 2019, p. 365). According to Fadillah and Susiaty (2019), correcting student's misconceptions that is fundamental to the new concepts to be learned is a must before introducing new concepts to students. Therefore, identifying students' misconceptions and how to overcome these must be done continuously to enhance students' competencies in mathematics (Jamaludin & Maat, 2020).

### *2.3. Students' Mastery level in Mathematics*

Mathematics achievement of students is very low (DepEd, 2019). Pandey (2017) revealed that the male students performed better than female students in Mathematics when analyzed by sex. Undeniably, this problem worsens due to pandemic (Delos Santos et al. 2022). At present, most of the grade 7 students were exposed to modular distance learning. Basilio et al. (2022) reported that grade 7 students are not ready for high school mathematics because they have not mastered the pre-requisite skills regardless of gender. These learning issues affect the student's level of academic achievement in mathematics, particularly in learning the concepts of integers. As a result of poor performances of the students in mathematics, an intervention is needed to overcome learning loss. Khun-Inkeeree et al.

(2016) emphasized that the achievement of the students can be improved if they give importance to mathematics and "this will automatically boost their self-confidence" to be participative in learning mathematics (p. 97).

Students' misconceptions and errors in integers can affect the level of their mastery and performance in mathematics. Studies that evaluate the mastery level of students and gender difference in the fundamental operations on integers is very limited. Moreover, there is also limited study on how to overcome the misconceptions of the students (Jamaludin & Maat, 2020). Basilio et al. (2022) pointed out that students from elementary moving into the secondary level "should be assessed to monitor who need intervention" (p. 81). Hence, the mathematics teacher can design teaching strategies that will students improve their performance in mathematics and overcome the misconception. Moreover, teachers have to choose the appropriate strategies to increase the students' achievements in Mathematics (Sadler, 2012) and to focus on least mastered competencies of the students specifically in solving integers using four operations.

## 3. Methodology

### *3.1 Research Design*

This study made use of a descriptive research design to determine and describe the students' mastery level and misconceptions involving operations on integers since it can generate both "qualitative and quantitative data" (Koh & Owen, 2000). Most studies that identify misconceptions of the students in mathematics made use of a descriptive design (Sadler, 2012).

### *3.2 Respondents of the study and sampling techniques*

The respondents of this study were sixty-two (62) Grade 7 students enrolled during the school year 2022-2023 of which twenty-nine (29) are males and thirty-three (33) are females. These respondents were conveniently chosen from the two sections of Grade 7 of which thirty-four (34) were from Grade 7A and twenty-eight (28) were Grade 7B.

### *3.3 Research Instrument*

Assessment on Integers (AI) is a 20-item researcher-made assessment which aims to determine students' mastery level and misconceptions in operating integers. AI is a multiple-choice assessment with four (4) options where students are required to provide and show

their solution for each item. The AI was carefully validated by the research adviser and the mathematics 7 teacher before it was pilot tested to twenty-two (22) Grade 7 students. The data collected from the pilot test were analyzed to ensure the reliability of the instrument. The AI was found to be acceptably reliable with a Cronbach alpha value of 0.72.

### *3.4 Data Gathering Procedures*

Before the implementation of the study, the researchers seek approval from the office of the school principal and consulted with the Grade 7 adviser and math teacher. Once the researchers secured all the pertinent documents needed for the implementation of the study, the list of the Grade 7 students both A and B were determined. These students were already exposed to mathematics instructions involving operations on integers in Grade 7.

During the first quarter of the school year, students attended three-day in-person classes and two-day modular learning. The concepts of operations on integers were introduced to learners in face-to-face classes and independent exercises were given in the two remaining days in the given week. In this study, grade 7 students were assessed after being introduced to the concepts of integers and the fundamental operations on integers.

During the implementation, the researchers presented first the keywords used for different operations on integers. Afterwards, the researchers, with the guidance of the mathematics 7 teacher, administered the AI to 62 Grade 7 students of Sections A and B to identify their mastery level and misconceptions on operations of integers.

### *3.5 Statistical Treatment*

The researchers computed the MPS per operation of the AI by section and sex using the formula $MPS = \frac{Computed\ Mean}{Total\ number\ of\ items}\ x\ 100$ and was interpreted using the descriptive equivalent of mastery level as stipulated in DepEd Order No. 160 series of 2012. The result of the AI was analyzed and interpreted using R statistical package. On the other hand, the researchers checked the normality and homogeneity of the data set using R statistical package. The Shapiro-Wilk test results for male and female showed no significant departure from normality were found: W(29) = 0.95879 , p = 0.3069 and W(33) = 0.93782, p = 0.05872, respectively. Moreover, the Levene's test results revealed that the homogeneity of variance assumption was not met. Hence, a Welch t-test was employed to determine the significant difference in the mastery level of the students when analyzed by sex.

To diagnose the misconceptions of the grade 7 students on operations on integers, an item analysis was carried out to identify which item in the assessment students failed to answer correctly and examine their solution in the problem. Misconceptions per operation on integers were identified and analyzed carefully. This served as the basis for designing class intervention and reinforcement for the grade 7 mathematics.

### *3.6 Ethical Consideration*

The researchers strictly observed the following ethical guidelines in conducting this study: (1) a communication letter was presented to the concerned authorities; (2) the identity of the respondents and all the data gathered were kept confidential; (3) health protocols and social-distancing measures set by the Ministry of Basic, Higher, and Technical Education (MBHTE) were strictly followed; and (4) the dignity and wellbeing of students was protected at all times.

## 4. Findings and Discussion

### *4.1 Mastery Level of the Grade 7 students on Assessment on Integers (AI)*

To determine the mastery level of the Grade 7 students involving operations of integers, the Mean Percentage Score (MPS) per operation was calculated. Table 1 shows the mastery level per operation by section.

**Table 1**

*Mastery Level per Operation on Integers*

| Operations | Grade 7A MPS% | Grade 7B MPS% | OVERALL MPS% |
|---|---|---|---|
| Addition | 60.59 (AVR) | 40.00 (AVR) | 55.16 (AVR) |
| Subtraction | 45.29 (AVR) | 25.88 (L) | 39.03 (AVR) |
| Multiplication | 55.88 (AVR) | 44.12 (AVR) | 54.84 (AVR) |
| Division | 51.18 (AVR) | 45.88 (AVR) | 53.23 (AVR) |
| **OVERALL** | **53.24 (AVR)** | **38.97 (AVR)** | **50.56 (AVR)** |

*Legend:* 96-100%-Mastered (M); 86-95% -Closely Approximating Mastery (CAM); 66-85% -Moving Towards Mastery (MTM); 35-65% -Average Near Mastery (AVR); 15-34% -Low Mastery (L); 5-14% -Very Low Mastery (VL); 0-4% -Absolutely No Mastery (ANM).

As shown in Table 1, the MPS of Grade 7B was relatively low (25.88%), particularly on the operation that involves subtraction of integers. This indicates that the students

demonstrated low mastery of the concepts involving subtraction of integers. It also follows that students have possible misconceptions about the rules involving subtraction of integers. This finding corroborates with the studies of Badarudin and Khalid (2008), Rubin et al. (2014), and Permata et al. (2019) that the students often encountered misconceptions on subtraction of integers.

On the other hand, for operations of integers involving addition, multiplication, and division, students in both sections demonstrated Average Near Mastery (AVR). It is noteworthy to mention that among the operations, the addition of integers has the highest MPS. Based on the assessment given, students find it easy to add integers with like signs. Comparing the MPS of the two sections, the overall MPS of Grade 7A is relatively higher than the Grade 7B by 14.27%. This shows that the Grade 7A students got more correct answers in the Assessment on Integers (AI) compared to the Grade 7B students. Overall, the MPS of the grade 7 students in the given Assessment on Integers (AI) is 50.56% indicating that the students exhibited Average Near Mastery (AVR).

The MPS will be the basis for conducting intervention and reinforcement to help students enhance their skills involving operations on integers. Based on these findings, the focus of the intervention for Grade 7B shall be on the subtraction of integers. In addition, a reinforcement is needed for addition, multiplication, and division of integers because even though the MPS for these operations is relatively higher than the subtraction of integers, students still exhibited misconceptions in these operations of integers. Similarly, Grade 7A should be exposed to reinforcement to improve their competence in solving problems involving integers.

### *4.2 Mastery level of the Grade 7 Students when analyzed by Sex*

A Welch t-test was used to determine if there is a significance difference in the mastery level of the Grade 7 students on the operations of integers when analyzed by sex. Table 2 shows the mastery level of male and female students on the given AI.

As shown in Table 2, the p-values in all four (4) operations were not significant. This indicates that there is no significant difference in the mastery level on operations of integers when analyzed by sex. This result contradicts the findings of Pandey (2017) that male students performed better than female students in Mathematics.

**Table 2**

*Mastery level per Operation on Integers when analyzed by Sex*

| OPERATIONS | MALE | | FEMALE | | *Df* | *T* | *p* | Cohen's *d* |
|---|---|---|---|---|---|---|---|---|
| | M | SD | M | SD | | | | |
| Addition | 2.41 | 1.81 | 2.42 | 1.36 | 58.69 | -0.92 | .36 | 0.23 |
| Subtraction | 1.55 | 0.91 | 1.73 | 1.25 | 53.54 | -1.60 | .12 | 0.39 |
| Multiplication | 2.45 | 1.41 | 2.42 | 1.21 | 58.37 | -0.18 | .85 | 0.05 |
| Division | 2.55 | 1.37 | 2.31 | 1.26 | 59.74 | 0.07 | .95 | 0.02 |
| **OVERALL** | **8.95** | **2.92** | **8.88** | **3.39** | **54.21** | **-0.89** | **.38** | **0.22** |

*Legend:* Significant at $p<0.05$ (two-tailed).

### *4.3 Misconceptions of the Grade 7 students in the AI*

The researchers analyzed the AI results to determine the misconceptions made by the Grade 7 students in both sections and these were categorized accordingly into four operations: (1) addition, (2) subtraction, (3) multiplication, and (4) division. These misconceptions are common to all grade 7 students regardless of their section and sex.

#### *4.3.1 Misconceptions in Addition of Integers*

The concept of adding integers has two (2) cases: Case 1) adding integers with the same signs is just simply add the integers and apply the common sign to their sum; and Case 2) adding integers with unlike signs requires to subtract first the integers and apply the sign of the bigger integer to their difference.

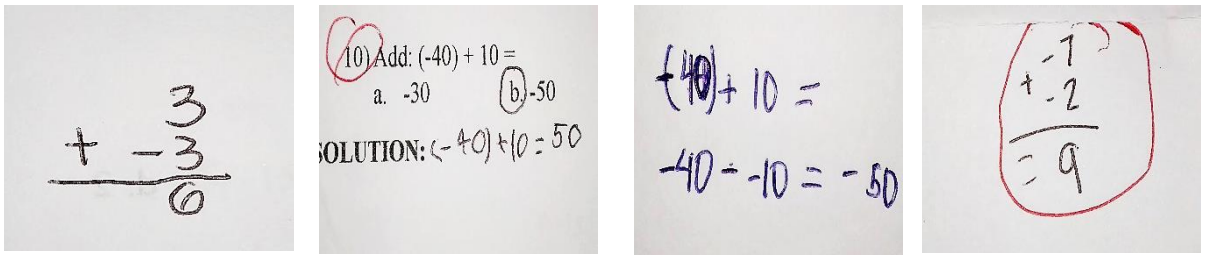
Students were struggling in adding integers with unlike signs and tend to get confused with signed numbers and the appropriate sign to use in the result. For example, in item 2, the question is 3 + (-3). However, students disregard the negative sign and wrote this in their solution as 3 + 3 = 6 instead of 3 + (-3) = 0. Likewise, in item 10 which asked students to simplify this expression, (-40) +10. The students simplify this as (-40) + 10 = 50 and (-40) + 10 = -50 instead of applying the rules in adding integers with unlike signs that should be (-40) + 10 = -30.

Another misconception is found in item 13 which involves adding integer with the same signs, and both are negative signs. The expression is (-7) + (-2) and they solved this as 7 + 2 = 9, ignoring the negative signs present in the expression where the final answer should be (-7) + (-2) = -9. This result coincides with the findings of Fuadiah et al. (2016) that

students struggled in understanding the concepts of negative numbers in terms of operations on integers.

**Figure 1**

*Misconceptions on Addition of Integers*



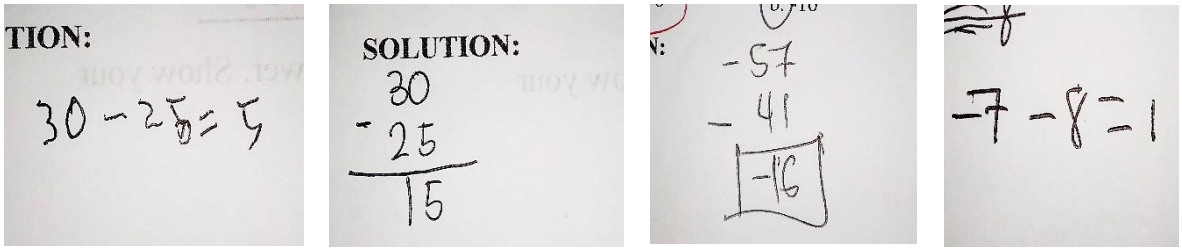

### *4.3.2 Misconceptions in Subtraction of Integers*

In subtracting integers, there are also two (2) cases which differs from the addition of integers: Case (1) for subtracting unlike sign integers, it requires to change the sign of the second integer (subtrahend) and apply the rules in adding integers with unlike signs; and Case (2) subtracting a bigger number from a smaller number will leads to a negative answer.

Students encountered most of the misconceptions in subtracting integers based on the MPS. In item 6, only eight (8) students out of sixty-two (62) got the correct answer. The question asked students to “subtract 30 from 25”, where most of the students translated this expression into 30-25. The students were confused and have no idea about the use of the switch word “from” in an expression that instead of simplifying it as 25 – 30 = -5, they ended up with 30 -25 = 5. The same error can be found item 16, “subtract -57 from 41”. This expression must be solved in this way, 41 – (-57) = 98, applying the rules in subtracting unlike sign integers. However, the students solved this as, -57 – 41 = -98 while others calculated it in this way -57 – 41 = 98. There were also students who solved in this way, -57 - 41 = 16, where they just directly subtract the integers and applying the sign of the bigger number, -57, to its difference just like in the rules of adding unlike sign integers. This misconception is known as “rule mix-up” and it corroborates the findings of Khalid and Embong (2019) wherein the students tend to remember the rules of the operations of integers but misapplied these rules in solving integers. Morever, these findings coincide with Badarudin and Khalid (2008) and Rubin et al. (2014) that students struggled to subtract integers with unlike signs.

**Figure 2**

*Misconceptions in Subtraction of Integers*




### *4.3.3 Misconceptions in Multiplication of Integers*

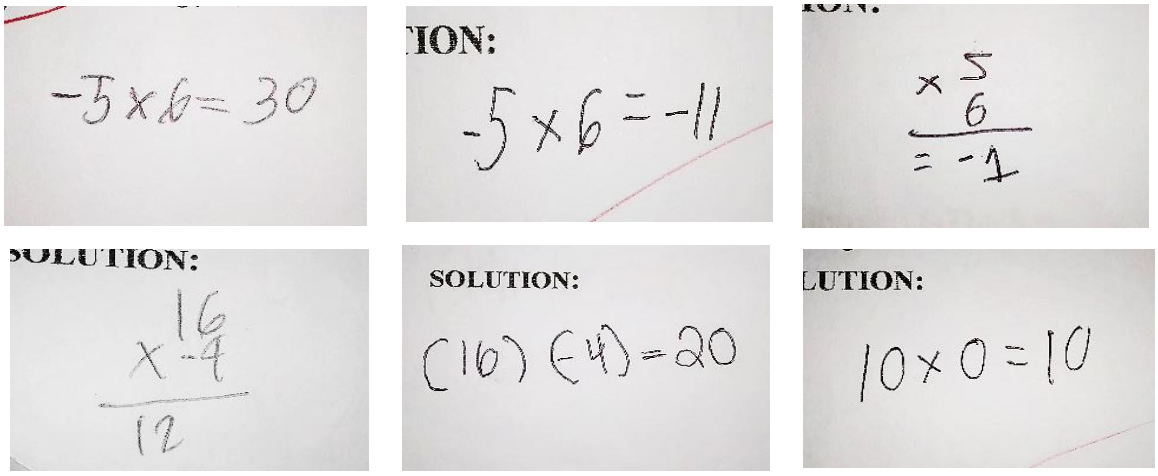
In multiplication of integers, there are three (3) cases: Case 1) the product of two integers with like signs is always positive; Case 2) the product of two integers with unlike sign is always negative; and Case 3) the product of an integer and zero is zero.

In the AI, students encountered misconceptions in multiplying unlike sign integers. For example, in item 4 the students were asked to evaluate (-5) (6). Some of the students got the correct answer which is (-5) (6) = -30. However, there were some who ignored the negative sign and wrote it as (-5) (6) = 30. Rule mix-up misconception is also present in this item where students solved it as (-5) – 6= -11, applying the rules in subtracting unlike sign integers and some also applied the rule in adding unlike sign integers, (-5) + 6 = 1. The same misconceptions were also determined in item 20, 16 x (-4). Students often disregard the negative sign that leads to a wrong answer that instead of solving it as 16 × (-4) = -64, it became 16 × (-4) = 64. They also misapplied the rules and solved it in these ways, 16 – (-4) = 20; 16 + (-4) = 12.

Another misconception can be found in item 7, which asked the students to evaluate 10 x 0 or multiplying an integer by zero. Most of them applied the rules in addition or subtraction of an integer and zero; 10 + 0 = 0 and 10 – 0 = 10, instead of using the zero-property rule of multiplication which should be equal to 0. This is the same with the findings of Rahman et al. (2017) and Sadler (2012) that the students have not mastered the property rule of multiplication in terms of multiplying a number by zero.

**Figure 3**

*Misconceptions in Multiplication of Integers*



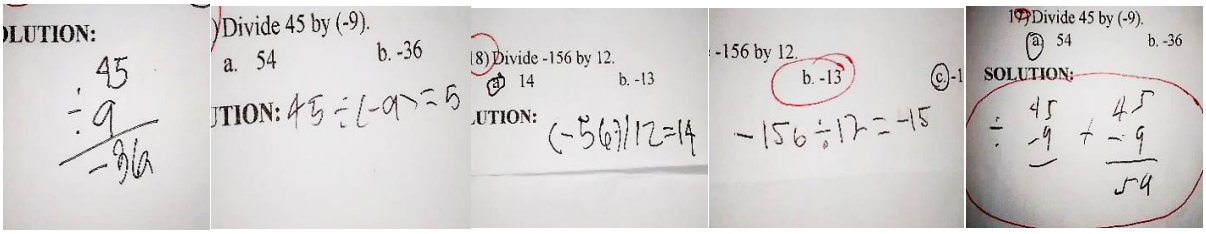

### *4.3.4 Misconceptions in Division of Integers*

The rules and cases in dividing integers are the same with the multiplication of integers, the only difference is the operations used.

Aside from the difficulties in dividing unlike sign integers and rule mix-up, another misconception was identified in this operation. Based on the AI results, students struggled in dividing numbers. In item 17, they were asked to solve 45 ÷ (-9). The students were still ignoring the negative sign and solved this as 45 ÷ (-9) = 5 instead of -5. However, there are some students who used the rules in adding unlike sign integers [ 45 + (-9) = 36] and subtracting unlike sign integers [ 45 – (-9) = 54]. In contrast, the misconception that was identified in item 18 shows that most of the students do not know how to divide numbers. The expression is, -156 ÷ 12, and the quotient must be -13 by applying the rules of dividing unlike sign integers. However, because of the poor knowledge in dividing numbers, the students arrived at the answer of either 14 or -15 to that given expression. These misconceptions found in this study are similar to the findings of Dube and Robinson (2018) that students have a poor conceptual understanding of the division of numbers and that students also struggle to perform division of integers which led to wrong sign and value (Sadler, 2012).

**Figure 4**

*Misconceptions on Division of Integers*




## 5. Conclusion and Recommendation

This study aimed to determine the mastery and misconceptions of the students in the fundamental operations on integers. The findings showed that grade 7B students have misconceptions in operations on integers particularly in subtraction with a Mean Percentage Score (MPS) of 25.88% indicating Low Mastery. Moreover, there is no significant difference in the mastery level of Grade 7 students when analyzed by sex. Although the overall MPS of the Grade 7 is 50.56% which translated to Average Near Mastery (AVR), the students still have misconceptions in the fundamental operations of integers. Students tend to "mix-up rules" in performing the operations on integers. Moreover, grade 7 students struggled to perform subtraction of integers, especially when dealing with negative numbers.

Based on these findings, an intervention and reinforcement are needed to address these misconceptions in operations on integers and improve students' mastery level. Intervention will be needed for grade 7B class particularly for subtraction of integers since it is the only operation that both sections got the lowest MPS. As suggested by the mathematics teacher in grade 7, the intervention will be done one (1) hour for two weeks to ensure that students have more time to practice subtracting integers with negative numbers. However, the researchers suggest that reinforcement should be carried out to grade 7B for addition, multiplication, and division of integers while for grade 7A all the fundamental operations on integers should be the focused of the reinforcement since the MPS showed that students exhibited Average Near Mastery (AVR) of the competencies.

## Proposed Intervention and Reinforcement for Operations of Integers

The researchers proposed an intervention and reinforcement based on the identified misconceptions of the Grade 7 students in the AI. This intervention and reinforcement program was designed based on the least mastered competencies found through the MPS. It aims to address the misconceptions of the students in the fundamental operations on integers that can possibly affect students' achievement in Mathematics.

**Table 3**

*Designed Intervention and Reinforcement for Integers*

| **A. INTERVENTION** | | | |
|---|---|---|---|
| **OPERATION** | **OBJECTIVES** | **TARGET STUDENTS** | **PERIOD** |
| **Subtraction** | Students should be able to:<br>a) illustrate the rules of subtracting integers with like signs.<br>b) Illustrate the rules of subtracting integers with unlike signs.<br>c) Translate verbal phrase to mathematical phrase using the switch word "from" in subtraction of integers.<br>d) Perform subtraction of integers. | Grade 7B students | 1 hour session every afternoon for 2 weeks |
| **B. REINFORCEMENT** | | | |
| **OPERATIONS** | **OBJECTIVES** | | **PERIOD** |
| **Addition** | Illustrate the concepts of adding integers specifically in adding integers with unlike signs [(+) + (-)] or [(-) + (+)].<br>Perform addition of integers. | Grade 7A and 7B students | 30 minutes session every afternoon for 1 week |
| **Multiplication** | Illustrate the concepts of multiplying integers particularly with the negative integers.<br>Illustrate the zero property of multiplication.<br>Perform multiplication of integers. | Grade 7A and 7B students | 30 minutes session every afternoon for 1 week |
| **Division** | Illustrate the concepts of dividing integers especially in dividing unlike sign integers.<br>Perform division of integers. | Grade 7A and 7B students | 30 minutes session every afternoon for 1 week |
| **Subtraction** | Illustrate subtraction of integers with unlike signs.<br>Perform subtraction of integers. | Grade 7A students | 30 minutes session every afternoon for 1 week |

The researchers together with the mathematics 7 teacher developed and designed learning interventions to address the misconceptions of the students in the fundamental operations on integers. The intervention is intended for students in the Grade 7B class who exhibited poor mastery of the competencies involving subtraction of integers. The two-week intervention aims to enhance students' mastery in subtracting integers with unlike signs and deal with negative integers. the intervention will be done one-hour per session every afternoon for two weeks. The intervention will be carried out by the teacher teaching in grade 7.

On the other hand, the researchers also proposed a reinforcement to enhance further the mastery level of the Grade 7B students in operating integers specifically for addition, multiplication, and division of integers. Similarly, the Grade 7A students will be exposed to a reinforcement for one (1) week per operation on integers. The researchers proposed that the intervention and reinforcement should be done per operation, in separate and granular sessions, to enable the students to master the skills and remove the possibilities of committing the same errors in solving integers, particularly the "rule mix-up" issue as made mentioned by Khalid and Embong (2019). Furthermore, the proposed intervention and reinforcement is submitted to the Office of the School Principal for the inclusion to the priority programs of the school to address learning losses and gaps in learning mathematics.

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