AN ANALYSIS OF THE MISCONCEPTIONS ABOUT THE MATHEMATICAL ORDER OF OPERATIONS OF GRADES 4, 5, AND 6

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ABSTRACT: *This study* **reports** *on the analysis of the misconceptions about the mathematical order of operations of elementary pupils at Del Monte School. It utilized a descriptive-comparative method of research to gather the data. The study respondents were grades 4, 5, and 6 of Del Monte School, Manolo Fortich. The researcher utilized a validated 30-item test to assess the misconceptions of the mathematical order of operations among students with varying grade levels. Results revealed the following misconceptions of the pupils on Mathematical Order of Operations: mistakes in subtracting and adding integers, especially with negative integers, working from left to right but doing addition/subtraction before multiplication/division, ignoring parenthesis with power, doing addition before power, misunderstanding the power notation, interpreting division as fractions, doing multiplication first even division is on the left, squaring a negative integer, and using parenthesis as an addition. Descriptive statistical measures such as mean, standard deviation, and ANOVA aided the data analyses and interpretations. Results revealed that the scores are relatively spread out, with most scores falling above or below the mean. Based on the statistical analysis results, there is no significant difference in the test scores of grades 4, 5, and 6 students in the test about mathematical order of operation.*

Key Words: Mathematical Order of Operations, Misconceptions

1. INTRODUCTION

Basic math skills serve as a foundation for success in many areas of life, including academics, career, and daily living. As such, pupils must develop a strong understanding of fundamental concepts such as arithmetic operations and the order of operations. Mathematical order of operations is taught in school, teaching the left to right rule and with the mnemonic device PEMDAS “Please Excuse My Dear Aunt Sally”. PEMDAS is an acronym that means parenthesis, exponents, multiplication, division, addition, and subtraction. Given two or more operations in a single expression, the order of the letters in PEMDAS tells you what to calculate first, second, third, and so on, until the calculation is complete. If there are grouping symbols in the expression, PEMDAS tells you to calculate within the grouping symbols first.

According to [1], it showed that sixth, seventh, and eighth-grade students did not pay attention to the order of operations when performing arithmetic expressions from left to right, claimed that only operations in brackets needed to be carried out first in terms of order of operations, and did not pay attention to the order of operations when writing or resolving an arithmetic expression equal to a given number, and had trouble posing a problem sentence. Also, with the use of PEMDAS, still, some pupils still get wrong when answering problems involving multiple operations. According to [2], one flaw that this mnemonic has is that it does not allow pupils to remember the “left-to-right” rule associated with multiplication/division and addition/subtraction. Although classroom instruction emphasizes the proper way to carry out operations in a number sentence, many students do not fully understand the significance of the order of operations until they have taken higher-level mathematics courses. [3] mentioned pupils arrive in class with PEMDAS memorized well. The problem is, they didn’t learn it. They do not understand why there is an order, or that multiplication and division are so interrelated that would get some absurd inconsistencies if multiplication always came first. Also, the way the instruction is received by pupils can sometimes contain a subtle but highly misleading falsehood [4].

Based on [5], mnemonics are often used as memory aids in educational settings, but there are some negative aspects to their use. While mnemonics can be effective in helping pupils retain information, they can also be limited in their application. Mnemonics typically focus on memorization of facts, rather than on deeper understanding and critical thinking skills. Additionally, some pupils may find certain mnemonic devices confusing or difficult to remember, leading to frustration and ultimately hindering their learning. Furthermore, mnemonics may not be useful for all types of information, and their effectiveness may vary depending on individual learning styles and preferences. Overall, while mnemonics can be a useful tool for memory enhancement, they should be used judiciously and in conjunction with other teaching methods to support deeper learning.

It showed that pupils commit errors when faced with the use of multiple operations. Knowing the learner’s weaknesses can help determine which concepts need to be strengthened and what misconceptions are supposed to be corrected. Because of these reasons, the researcher decided to conduct this study to examine why pupils find it hard to answer problems when the mathematical order of operations process is necessary and analyze pupils’ misconceptions of the mathematical order of operations.

2. METHODOLOGY

2.1 Research Design

It utilized a descriptive-comparative method of research to gather data. Descriptive statistical measures such as frequency, percentage, mean, and standard deviation aided the data analyses and interpretations.

2.2 The Instruments

The researcher utilized a validated 30-item test to assess the misconceptions of the mathematical order of operations among students with varying grade levels.

2.3 The Participants

The study respondents were the grades 4,5, and 6 pupils of

Del Monte School, Manolo Fortich.

2.4 Data-Gathering Procedure

The pupils from Grades 4, 5, and 6 were given a test about the mathematical order of operations. The researcher utilized a validated 30-item test to assess the misconceptions of the mathematical order of operations among students with varying grade levels. Descriptive statistical measures such as mean, standard deviation, and ANOVA aided the data analyses and interpretations. An ANOVA analysis was conducted to compare the test scores on the mathematical order of operations across three grade levels, namely grade 4, grade 5, and grade 6.

3. RESULTS AND DISCUSSIONS

TABLE 1. Mean and Standard Deviation of the Test Scores in Mathematical Order of Operations According to Grade Level

	Grade 4	Grade 5	Grade 6
Mean	10.875	15.333	12.625
SD	5.3569	5.049	4.5336

Table 1 shows the mean and standard deviation of the test on the mathematical order of operations of Grades 4, 5, and 6. The given data provides insights into the performance of the three different grade levels in the test about the mathematical order of operations. The mean score for Grade 4 is 10.875, indicating that on average, students in this grade level scored below the midpoint of the test. However, the standard deviation of 5.3569 indicates that the scores were widely spread out, with some students scoring much higher or lower than the average.

On the other hand, Grade 5 students had a mean score of 15.333, indicating a better performance compared to Grade 4. The standard deviation of 5.049 suggests that the scores were less widely spread than those of Grade 4.

Finally, Grade 6 students had a mean score of 12.625, slightly lower than Grade 5. However, their standard deviation of 4.5336 indicates that the scores were tightly clustered around the mean, with slight variation among the scores. Overall, the data provides valuable information on the relative performance of each grade level and the distribution of scores within each group.

TABLE 2. Summary Table of ANOVA: Single-Factor

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	86.21	2	43.105	1.728128	0.200868	3.443357
Within Groups	548.75	22	24.94318			
Total	634.96	24				

Table 2 shows the summary of the ANOVA test. The result is as follows: the SS between groups of 86.21 and within groups of 548.75 along with the degrees of freedom of 2 and F-critical value of 3.443357. Since the p-value is greater than the alpha level at 0.05, there is no significant difference in the test scores of grades 4, 5, and 6 levels in solving mathematical order of operations. This means there is no significant difference between the means of the three groups.

The results of the test on the mathematical order of operations revealed several misconceptions among the participants. 1) Mistakes in subtracting and adding integers, especially with negative integers, were committed by the learners. The pupils attempted to solve an equation involving negative integers freely interchanging the smaller number to the larger one and immediately solved the answer not minding the presence of a negative symbol. 2) Pupils work from left to right but do addition/subtraction before multiplication/ division. 3) Ignore parenthesis with power. The misconception lies in distributing the square to the nearest number ignoring the other number inside the parenthesis that was supposed to be added first. 4) Doing addition before power; the number that was supposed to be squared first was added to the other number. The power was applied after solving for the sum. 5) Misunderstands the power notation. 6) Pupils interpret division as fractions and then make mistakes in adding the fractions. Thinking that is the only way to find the answer. 7) Many pupils followed the left and right rule but failed to do multiplication or division before addition and subtraction. It is important to note that in the mathematical order of operations, start on the left, and if the operation was division before multiplication, then division should be done first. 8) Commits mistakes in squaring a negative integer. In finding the result of the square of the negative number inside the parenthesis, pupils often fail to include the negative sign while applying the power notation. 9) Use parenthesis as an addition. Learners view parenthesis as an operation for addition.

These misconceptions reveal a need for more explicit instruction and practice in these areas. Finally, many students had difficulty with basic arithmetic skills such as adding and subtracting negative numbers, multiplying and dividing correctly, and understanding the concept of fractions. Addressing these misconceptions will be crucial for improving math skills and building a strong foundation for future math concepts. The findings of this study are consistent with [6] results, which also indicate a common tendency among students to rely on left-to-right thinking, struggle with recognizing fractions as divisions, errors with multiplication or addition, and incorrect interpretation of power outside a bracket. The study also highlights how these challenges are linked to a rule-based approach to learning.

4. CONCLUSIONS AND RECOMMENDATIONS

Based on the statistical analysis results, there is no significant difference in the test scores of grades 4, 5, and 6 students in the test about mathematical order of operations with a p-value of 0.20086. It can be assumed that the three grade levels have similar performance on the test. Additionally, all three grade levels have relatively high standard deviations, indicating a wide variation of scores within each group. There are several misconceptions among the grade 4, 5, and 6 students regarding the mathematical order of operations; mistakes in subtracting and adding integers, especially with negative integers, working from left to right but doing addition/subtraction before multiplication/ division, ignoring parenthesis with power, doing addition before power, misunderstanding the power notation, interpreting division as fractions, doing multiplication first even division is on the left, squaring a negative integer, and using parenthesis as an addition.

As a recommendation, it may be beneficial to conduct further investigations into the possible reasons for the variation in scores within each grade level, as this information could inform targeted interventions to improve math proficiency. Additionally, future studies could explore the use of alternative teaching strategies and approaches to enhance math learning and retention among students.

5. REFERENCES

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