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Enhancing Computational Skills of Grade 7 Students Using Indigenous Manipulatives

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Abstract:- This study determined the effects of indigenous manipulatives on the performance of Grade 7 students on the operations of integers at Pili National High School, Bacacay, Albay for School Year 2023 – 2024. Specifically, it answered the following questions: 1. What is the performance in the pre - test of the control and experimental groups along adding integers; subtracting integers; multiplying integers; and dividing integers? 2. What is the performance in the post - test of the control and experimental groups? 3. Is there a significant difference in the performance between the control and experimental groups in the post - test? 4. What are the least mastered skills of Grade 7 students on integers? and 5. What teaching materials may be developed to enhance the computational skills of Grade 7 students on integers? The experimental method was applied in this study since the effect of the materials used on the performance of Grade 7 students on operations on integers was measured. In addition, the researcher employed the pre - post - test design, using two (2) groups, the control, and the experimental groups. These groups were tested before and after the experimentation. Test results were utilized as a basis for providing judgment on the effect of the interventions provided. The main tool used by the researcher to gather the data was a teacher - made pre - and post - test. The skills tested were adding integers, subtracting integers, multiplying integers, and dividing integers. The test is composed of forty (40) items, twelve (12) items were allocated to adding integers, twelve (12) for subtracting integers, eight (8) for multiplying integers, and eight (8) for dividing integers. Item allocation was based on the weight and number of days utilized for each topic as reflected in the table of specification. The performance of the students in each group was determined by computing the mean score in each skill and the corresponding performance level. The test of difference in the performance of the control and experimental groups in the post - test was, a t - test for independent samples was utilized.

I. INTRODUCTION

The importance of Mathematics can be seen in all aspects of life whether in everyday tasks such as shopping, managing daily expenses, calculating the amount of fertilizer to be used in plants, designing a garden, figuring out distance, time, and cost for travel, playing games, measuring and weighing ingredients for baking and cooking, and doing household chores. Without Mathematics, daily tasks would be more difficult to accomplish and everything would become disorderly. Furthermore, Mathematics is effective in building numerical and visual reasoning, analytical, and logical reasoning which are important in making decisions in life.

Trends in International Mathematics and Science Study (TIMSS) 2019, results revealed that the Philippines only scored 297 in Mathematics, significantly lower than any other country participating in the Grade 4 Mathematics assessment. Based on the International Benchmarks set by TIMSS that determine students' competence, only 19% of Filipino students were on the Low Benchmark which means that they had "some basic mathematical knowledge – they can add, subtract, multiply, and divide one – and two – digit whole numbers; can solve simple word problems; can read and complete simple bar graphs and tables; and some knowledge of simple fractions and common geometric shapes", while 81% did not even reach this level.

Republic Act No. 10533 – section 2, emphasizes that the state shall establish, maintain, and support a complete, adequate, and integrated system of education relevant to the needs of the people, the country, and society - at - large.[i] Its purpose is to create a functional basic education system that will develop productive and responsible citizens equipped with the essential competencies, skills, and values for both life-long learning and employment. This can be achieved by giving every student an opportunity to receive a quality education that is globally competitive and based on a pedagogically sound curriculum that is at par with international standards.

In addition, Republic Act No. 10533 states that a learner – centered curriculum, inclusive, developmentally appropriate, relevant, responsive, and contextualized must be implemented. The schools are allowed to localize, indigenize, and enhance the curriculum based on their respective educational and social contexts. Furthermore, it provides a curriculum that uses pedagogical approaches that are constructivist, collaborative, and spiral progression approach. This is to ensure that schools provide quality and best learning experiences among the students and that mastery of knowledge and skills after each level is achieved before moving forward to the next competencies.

Many students struggled with and had misconceptions about performing operations on integers. The teacher as a facilitator of learning must provide diverse and relevant mathematical tools for the students that would result in the improvement of their academic performance. Having access to mathematical tools expands students' ability to model and interpret mathematical phenomena. It also increases the opportunity for student involvement and interaction in the teaching and learning process.

The use of manipulatives in teaching computational skills on integers is effective when students are given physical tools. It leads to higher retention rates and a positive attitude in Mathematics learning. It creates fun and enjoyment for them to be actively and collaboratively engaged in the educative process. When they are provided with an opportunity to develop a concrete understanding of mathematical skills using manipulatives, they are much more likely to perform those skills and truly understand the concepts at the abstract level. Moreover, students become more confident in learning and responsive to the manipulatives.

In connection with the Mathematics performance of students, the performance level of Pili National High School is still low based on the results of the Albay Numeracy Assessments (ALNAT). In 2021 – 2022 ALNAT results, Grade 7 students obtained a numeracy rating of 22.86% which increased slightly by 6.25%, with a numeracy rating of 29.11% in the next school year 2022 – 2023, both are in the numeracy level of Needs Major Support (NMS). This continued in the school year 2023 – 2024 where the pretest result was 26.17% with its equivalent numeracy level of Needs Major Support (NMS). The ALNAT results show that the topic of integers was the least mastered skill in the first quarter. Moreover, the same least mastered skill is based on the school record as identified through the Periodic Tests of the Grade 7 students for the past three (3) school years.

The researcher observed that there were a high percentage of students experiencing difficulty in learning the operations of integers. As the students entered the next grade level they were not mathematically prepared for higher concepts. Thus, as a teacher, the researcher wants to address and find a solution to the difficulty of the students. He believes that when students fail to master the skills expected of them, teachers contribute to this failure. So, it is the role of the teacher to employ effective pedagogical approaches and relevant mathematical tools to provide the students with a strong foundation for learning.

That's why the study focused on determining the effects of the teaching materials on the computational skills of Grade 7 students on the operations of integers. The researcher has selected this competency because it is one of the least mastered skills of the school where the study was conducted. There are different mathematical tools suggested in the Conceptual Framework of Mathematics Education that could help in the delivery of Mathematics instruction.

The present study utilized indigenous manipulatives to enhance the computational skills involving operations on integers, hence improving the level of numeracy of students in Mathematics such as integer mat chart with karagumoy chips and plastic bottle caps, pili nut shells, money manipulatives using kayabon leaves, number line manipulatives, tahong shell manipulatives, and bamboo strips.

- *Theoretical Framework*

David A. Kolb, an American psychologist, professor, and educational theorist, introduced the Experiential Learning Theory in 1984, which posits that learning occurs through direct experiences. According to Kolb, knowledge is created by transforming experiences, combining the processes of grasping and transforming them. His theory highlights the role of cognitive processes, environmental factors, and emotions in shaping how individuals learn. Experiential learning allows students to develop a deeper understanding of concepts, collaborate with peers, and build self-confidence and leadership skills.

Kolb's Experiential Learning Model outlines two ways of grasping experiences: abstract conceptualization and concrete experience**,** as well as two methods for transforming experiences: active experimentation and reflective observation**.** These four learning modes form a cyclical process. The cycle begins when an individual encounters an experience and reflects on it, leading to the development of abstract concepts. These concepts are then tested through active experimentation in various contexts. By engaging students in hands-on activities followed by reflection, they connect theoretical concepts to practical, real-world applications.

This theory aligns with the study's goal of providing students with hands-on experiences. Using indigenous manipulatives, students transition from concrete experiences to abstract reasoning, demonstrating that learning involves both mental and physical activities.

Jerome Bruner's Theory of Representation (1966) describes three stages through which students construct and organize knowledge: enactive**,** iconic**,** and symbolic. In the enactive stage, students require physical interaction with materials to understand concepts. At the iconic level, they create mental representations of objects without needing to manipulate them physically. In the symbolic stage, students operate with symbols alone, abstracting concepts without relying on objects. These stages form a framework for understanding how students internalize knowledge.

In the context of using indigenous manipulatives, this theory offers a foundation for designing teaching strategies. Students gain valuable enactive experiences by manipulating tools, develop iconic understanding through visual support, and enhance symbolic reasoning by connecting these experiences to abstract concepts. Teachers should incorporate activities that combine all three stages to maximize learning.

The Skill Development Theory, proposed by Romiszowski (2009), defines skill as the ability to perform a task with efficiency, accuracy, and speed. He distinguishes between intellectual skills involving mental processes, psychomotor skills involving physical actions, personal skills tied to emotional responses, and interpersonal skills essential for interaction. Romiszowski emphasized that skills are developed through practice and experience, and instructional strategies should consider students' prior knowledge and readiness to perform tasks.

This theory underpins the current study by focusing on skill development through the manipulation of mathematical tools and fostering teamwork among students. Activities involving indigenous manipulatives enable students to collaborate, solve problems, and engage in hands-on learning, aligning with the principles of skill development and practice.

Herbert J. Walberg's Theory of Educational Productivity (1981) identifies factors that influence academic performance. These include personal attributes such as ability, motivation, and developmental stage; teaching factors like clarity and relevance of information; and environmental aspects, including home and classroom settings. Walberg argued that these factors determine why students may not reach their full potential. Academic performance is crucial for producing globally competitive graduates who contribute to economic and social progress.

This theory reinforces the study's emphasis on improving academic performance. Indigenous manipulatives motivate students by providing tangible and relatable learning experiences. These tools are tailored to the students' level, promoting engagement and better learning outcomes. Hands-on activities with manipulatives help students grasp mathematical processes and procedures, enhancing their performance.

Collectively, these theories underscore the need for quality teaching to improve student performance. Effective pedagogy involves using innovative tools and engaging strategies to create productive learning environments. In this study, the use of indigenous manipulatives offers Grade 7 students affordable, accessible, and interactive resources to enhance their computational skills with integers. These tools capture students' interest and provide active learning experiences, fostering understanding and internalization of mathematical concepts. The theoretical framework, as depicted in Figure 2, supports the integration of these manipulatives in teaching to create engaging, effective, and meaningful learning experiences.

- *Conceptual Framework*

This study primarily aimed to determine the effects of indigenous manipulatives in teaching operations on integers in Grade 7 students at Pili National High School, Bacacay West District. To determine the effects, the research compared the performance of Grade 7 students using the traditional method of teaching to their performance employing the use of indigenous manipulatives.

This means that the input intended to measure the performance level in the pre - test and post - test of the control and experimental groups along with adding subtracting, multiplying, and dividing integers. The process was done after a series of validation of research instruments, including the dry run. After the 30 – day experiments, post - test was administered to the control and experimental groups followed by the data analysis and interpretation. The output of this research was a session plan applying the indigenous manipulatives to the operations on integers.

The use of indigenous manipulatives must be well – crafted, appropriate, and suited to the learning needs of the students. The students were involved in different hands – on experiences involving manipulatives for active participation happen. Aside from determining the effects of the indigenous manipulatives, this study also aimed to determine whether there is a significant difference between the performance of the control and experimental group in the post – test. Moreover, the research identified the least mastered skills in operations on integers and an intervention plan that may be proposed to address the least mastered skill.

II. REVIEW OF RELATED LITERATURES

Buasen et al. (2020) emphasized the importance of exposing students to interactive tools to improve their performance in mathematics and foster interest in mathematics-related fields. They noted that students perceived an improvement in their classroom performance when interactive tools were used. In instances where such resources are scarce, teachers are encouraged to create practical materials that students can utilize. This approach helps in cultivating a positive attitude towards mathematics, potentially influencing future career decisions.

Similarly, Danio Jr. (2016) highlighted the value of using locally available materials in teaching. He defined indigenous materials as naturally and abundantly available resources from specific areas, characterized by renewability and minimal environmental impact. These materials are cost-efficient, energy-saving, and reusable, making them sustainable teaching aids.

Teachers play a pivotal role in enhancing students' success in mathematics and preparing them for lifelong achievement. Providing engaging learning experiences through mathematical tools and effective teaching strategies can actively involve students in the learning process. For instance, Larbi and Mavis (2016) conducted a study to assess the impact of algebra tile manipulatives on junior high school students. This study, involving 56 students from two schools, compared the performance of a group taught with algebra tiles to a group taught with traditional methods. Statistical analysis, including t-tests, showed that students using algebra tiles significantly outperformed their peers, demonstrating the efficacy of this teaching tool in improving algebraic problem-solving skills. It was recommended that algebra tiles be integrated into teaching algebraic concepts to enhance students' understanding and reasoning abilities.

The connection between this earlier study and the current research lies in their shared focus on manipulatives to teach mathematical concepts and their use of statistical methods to compare the outcomes of experimental and control groups. However, while the earlier study employed an experimental design and used algebra tiles, the current study involves pre-experimental research with indigenous manipulatives and focuses on a single school as its setting.

Margaret C. Neubig's action research examined the use of manipulatives in teaching fractions. Conducted in a suburban elementary school, the study divided a second-grade class into two groups, one using manipulatives and the other not. Data from pre-tests and post-tests showed that manipulatives effectively helped students grasp abstract concepts. Neubig suggested future studies should include a larger sample, as her research was limited to 17 students. This research relates to the current study as both investigate the use of manipulatives as teaching aids. However, they differ in focus, participants, and settings. Neubig's work centered on teaching fractions to second graders in a suburban school, while the present study explores improving seventh graders' integer operations in a rural high school.

Manipulatives have proven useful in helping students visualize mathematical ideas. In a mixed-method study, Doias (2013) explored the use of concrete and virtual manipulatives in a seventh-grade classroom over seven months. Observations, interviews, and student reflections provided qualitative data, while pre- and post-tests measured quantitative outcomes. The study revealed that combining concrete and virtual manipulatives significantly enhanced students' mathematical abilities. The study recommended incorporating both types of manipulatives to maintain student engagement and deepen understanding of concepts. While both this study and the present research focus on manipulatives for seventh graders, they differ in design and methodology. Doias employed a mixed-method approach with dual manipulative interventions, whereas the current study uses a true experimental design, comparing conventional teaching methods with the use of concrete manipulatives.

Kwon and Capraro (2018) investigated instructors' perspectives on using manipulatives to teach problem-posing skills. Working with students in grades 2 through 5, they used manipulatives such as pattern blocks and counters during 13 problem-posing lessons. Students were tasked with creating problems using these tools, and the findings highlighted an increase in motivation, engagement, and enthusiasm during learning. While this study and the present one both aim to improve student engagement in mathematics, they diverge in focus. The earlier study addressed problem-posing activities, while the current study aims to develop computational skills in integers among seventh-grade students using indigenous manipulatives.

III. METHODOLOGY

This study utilized the experimental method of research. Experimental research according to Calderon (2017)[1] is a highly controlled procedure in which manipulated treatments or actions from a factor or condition, called the experimental or independent variable, are applied upon another factor or condition, called the dependent variable, to determine the effect of the former upon the latter, all other factors or variables being kept constant or equal so that any change in the dependent variable is attributable only to the experimental or independent variable.

The basic purpose of experimental research as mentioned by Manuel (1976) is to discover the influence of one or more factors upon a condition, group, or situation, the purpose of which is to discover “what will be”. It describes and analyzes variables in carefully controlled conditions as a basis for inferring or concluding. Experimental research, therefore, consists of manipulating an experimental variable under highly controlled conditions to determine how and why a particular event occurs.

This study was experimental in nature since the experimental and control groups were utilized to determine the performance of Grade 7 students using indigenous manipulatives at Pili National High School, Bacacay, Albay.

IV. FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

A. Findings

➢ *The Findings of the Study were as Follows:*

- *The Performance of the Control Group in the Pre - Test.*

Operations on integers were the skills covered by this study. In the twelve (12) items test along with *adding integers* the computed mean score was 4.52 with the corresponding performance level of 38 percent. It was described as *low mastery*. On *subtracting integers*, twelve (12) items were allocated, and the group was able to obtain a mean score of 4.85, and a performance level of 40 percent with a description of *low mastery*. However, eight (8) items in the test were given along *multiplying integers*, and the students were able to obtain a mean score of 2.79 with a corresponding performance level of 35 percent. This result was considered as *low mastery*. Along with *dividing integers*, the item allocated in the test was eight (8), and the computed mean score was 3.27 with a 41 percent performance level and correspondingly described as *low mastery*.

- *The Performance of the Experimental Group in the Pre - Test*.

The twelve (12) items test along with *adding integers* the group was able to obtain a mean score of 5.30. The performance level was 44 percent which was considered as *low mastery*. On *subtracting integers*, in the twelve (12) items test, they were able to get a mean score of 5.39 with a

45 percent performance level, described as *low mastery*. Along with *multiplying integers*, the score of the group in the eight (8) items test was a mean score of 3.15, and the performance level was 39 percent which was described as *low mastery*. In *dividing integers*, eight (8) items test were given. This provided a mean score of 3.18 with a 40 percent performance level. *Low mastery* was used to describe the said performance.

- *The Performance of the Control Group in the Post - Test.*

In the twelve (12) items test along with *adding integers*, the group provided a mean score of 7.45 with an equivalent performance level of 62 percent. However, on *subtracting integers* the scores in the twelve (12) items test have a computed mean score of 6.55. The performance level in this skill was 55 percent. On the other hand, in the eight (8) items test along with *multiplying integers*, they obtained a mean score of 4.48 with the corresponding performance level of 56 percent. Meanwhile, in *dividing integers* the scores in the eight (8) items test have an average of 4.24, this provides a performance level of 53 percent. Nevertheless, the performance level in all the competencies was described as *Near Mastery*.

- *The Performance of the Experimental Group in the Post - Test.*

The post-test showed that in *adding integers*, on the twelve (12) items test they obtained a mean score of 10.18 with an 85 percent performance level, which was described as *near full mastery*. Under *subtracting integers*, the computed mean score was 8.91 with a performance level of 74 percent. *Near mastery* was used to describe the said performance. Along with *multiplying integers*, in the eight (8) items test the mean score obtained was 7.12. The performance level on this skill was 89 percent, correspondingly described as *near full mastery*. The group obtained an average score of 6.88 in the eight (8) items test on *dividing integers*. This provided a performance level of 86 percent, described as *near full mastery*.

- The calculated mean score of the control group was 22.72 and for the experimental group 33.09 with a mean difference of 10.37. The computed variance for the control group was 8.22 while for the experimental group, it was 6.14. Based on this data the t - computed value arrived at -15.72. This t - computed value was beyond the t - critical value of ±1.69 at 0.05 level of significance with 64 degrees of freedom, with this the null hypothesis was rejected. This means that there was a significant difference in the performance of the control group and experimental group in the post - test.
- After the intervention, among the skills tested in this study *subtracting integers* obtained the lowest mean score in the post - test which was 8.91 with a corresponding performance level of 74 percent only. The performance of the group was considered as *near mastery*.
- Teaching materials were developed by the researcher to enhance the computational skills of Grade 7 students on integers.

B. Conclusions

➢ *The Following Conclusions were drawn:*

- The performance level of the control group in the pre - test along with adding integers, subtracting integers, multiplying integers, and dividing integers were considered *low mastery*. Likewise, the same performance level among the different skills was observed in the experimental group in the pre - test.
- The performance level of the control group in the post - test was described as *near mastery* along the four (4) skills tested. However, the performance level of the experimental group was described as *near full mastery* along adding integers, multiplying integers, and dividing integers, while *near mastery* along subtracting integers.
- There was a significant difference in the performance between the control and experimental groups in the post - test.
- Among the skills tested in the experimental group, subtracting integers got the lowest performance level which was described as *near mastery*.
- The researcher developed teaching materials to enhance the computational skills of Grade 7 students on integers.

C. Recommendations

➢ *Based on the Findings and Conclusions, the Following Recommendations are Offered:*

- Mathematics teachers need to pay attention to operations on integers because it is one of the least mastered skills of students. When students do not master it, they will have difficulty understanding other mathematical concepts.
- Teachers need to develop in students the prerequisite skills such as the operations on integers because it is necessary to advance in mathematics. Furthermore, it is fundamental in enhancing students' academic performance, engagement, and understanding of the concepts.
- Appropriate and varied indigenous manipulatives be provided by teachers to engage students in hands – on learning methods. Thus, to make the learning of mathematics interesting and enjoyable to the students.
- Teachers may attend seminars, training, and workshops on the indigenization of the curriculum to help them develop varied indigenous manipulatives in the classroom.
- The teaching materials developed by the researcher be utilized by the Mathematics teachers to enhance the computational skills of the students on integers.

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