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ENHANCING NUMBER SENSE OF KINDERGARTNERS THROUGH NUMBER JIGSAW PUZZLE MANIPULATIVES: A FOCUS ON NUMBER RECOGNITION

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ABSTRACT

This study aimed to determine the effectiveness of number jigsaw puzzle manipulatives for number recognition skills among kindergartners at Cateel Central Elementary School during the 2023-2024. A quasi-experimental research design was utilized, with the control group received traditional instructions (15 students) and the experimental group received an intervention (18 students). Pre-test results revealed no significant differences between the control group and the experimental group with the grade percentages of 86.68 and 83.32. However, post- test results showed a significant improvement in the experimental group with the grade percentages of 97.73 compared to the control group with the grade percentage of 88.18. The statistical analysis confirmed this difference as significant, with a t-value of 2.532 and a p-value of 0.021. The results shows the exceptional efficacy of the number jigsaw puzzle manipulatives over traditional teaching methods in enhancing number recognition skills among kindergartners.

Keywords: Manipulatives, Number Recognition, Number Sense, And Numeracy.

I. INTRODUCTION

About 60% of kids need help to name the number symbols in order accurately, measure with the number symbols, match the number to the number sign, or arrange the number symbols from 1 through 20 in the proper order (Stramel, 2021). Children's readiness for kindergarten often depended on their ability to identify letters and numbers. Parents typically introduce the alphabet early but often only focus on basic counting for numbers education, which may not help children recognize numbers or understand the concept (Loveless, 2024). The need for more interest in mathematical learning is also a result of teachers' continued use of traditional methods and their refusal to incorporate interactive learning resources (Yeh et al., 2019).

Many students find mathematics difficult because it is a demanding subject requiring much work. This is made worse by the reality that many students in the field still need to learn the foundational concepts of mathematics and are expected to keep up with the next lesson (Langoban, 2020). According to a study about What Makes Mathematics Difficult, Langoban (2020) resulted in three basic categories: Delivery of Instruction by the teacher, Learners' Ability and Experiences, and School Environment and Facilities (Yeni et al., 2020). It was determined that mathematics is complicated for students due to three factors: teachers, students themselves, and the limiting environment (Arenillo & Cruzado, 2014). One or more of these three factors, when left unnoticed, might as well lead to the waste of most students' potential (Langoban, 2020).

However, number sense includes children's skills in counting, recognizing patterns, comparing numbers, and estimating (Dyson et al., 2015). When children work with numbers, they improve these skills and deepen their understanding and thinking about numbers (Guhl, 2019). They also represent and count numbers differently and develop ideas about processes. They continue to deepen their understanding of numbers through the spontaneous use of operations and different solution strategies for operations (Yilmaz, 2017).

Thus, manipulatives are tangible objects explicitly created for mathematics or other purposes that teachers and students can use to illustrate and discover mathematical concepts. Walle et al. (2013) define a manipulative as any object, picture, or drawing representing a concept on which the relationship can be imposed. Using manipulatives, students can explore concepts at the first or concrete level of comprehension. When students manipulate objects, they make the vital first steps toward internalizing and developing an understanding of mathematical processes and procedures (Horan et al.; M., 2018). According to Larbi and Marvins (2016), manipulatives are things that children can touch, move, reorganize, and otherwise handle. In mathematics classes, manipulatives are natural objects used as instructional tools to engage students in hands-on learning-based approaches to enhance number recognition in young learners (McDonough, A. 2016). While there is existing research on the use of manipulatives in early mathematics education, there is a need for more focused investigations on the specific impact of manipulatives on number recognition skills in kindergartners (Larbi & Mavis, 2016). Understanding the effectiveness of different manipulatives, instructional strategies, and materials can inform educators and curriculum developers' design evidence (Laski et al., 2015).

This research aimed to contribute to the existing literature by examining the effectiveness of number jigsaw puzzle manipulatives in enhancing number recognition skills in kindergartners. The findings could provide insights into the optimal use of manipulative materials, instructional techniques, and strategies to promote effective number recognition instruction in early mathematics education.

II. METHODOLOGY

Research Locale and Duration

The study was conducted in Cateel Central Elementary School at Castro Avenue, Poblacion, Cateel, Davao Oriental. The Kindergarten classrooms were found in buildings 18 and 19. Additionally, the intervention or data gathering from the respondents was completed in May 2024, when each group was given three sessions weekly.

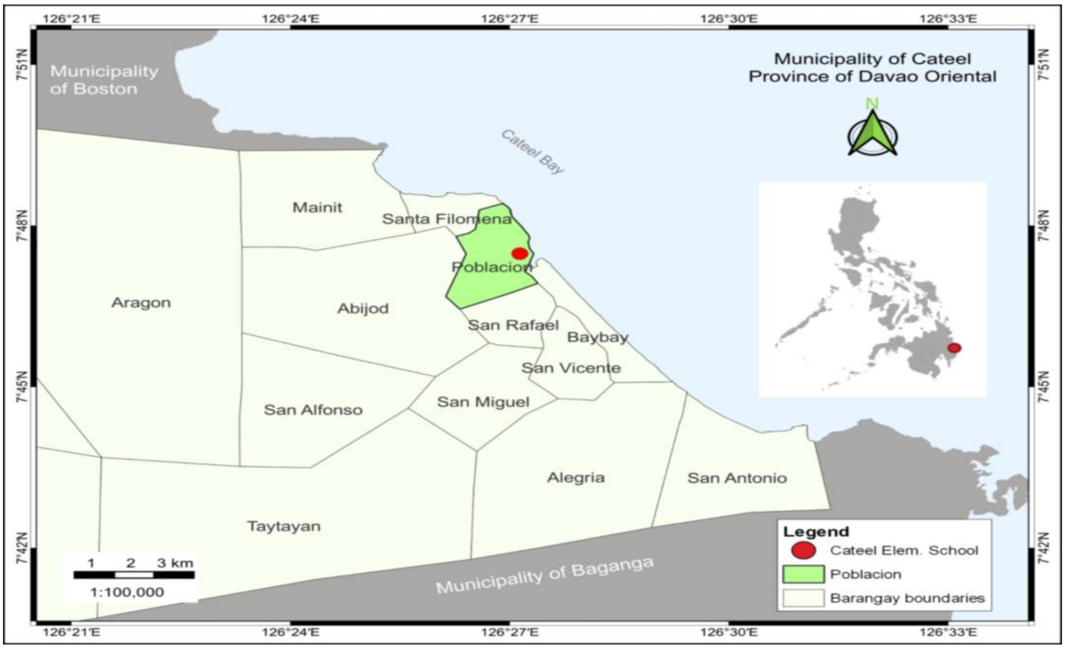

Figure 1. Map of Cateel, Davao Oriental, highlighting San Rafael Integrated School

Research Design.

This study employed a quantitative research design, more precisely, a quasi-experimental design with a control and experimental group, to show the efficacy of the intervention's implementation. A quasi-experimental design demonstrated a causal relationship between an independent and dependent variable (Thomas, 2022).

Respondents of the Study

The respondents of this study were the kindergartners in Cateel Central Elementary School. They were selected through a complete enumeration sampling technique. The study respondents were kindergarten pupils with morning and afternoon sessions in a selected section.

Data Gathering Procedure

The researchers followed several procedural steps to achieve the goal of the study. First, the researchers were closely focused on the problem. They proposed action for the study to acquire various ideas and information by exploring internet articles by thoroughly reading and finding out their correlation to their research. In the second step, the researchers sought ethical clearance in the Research Ethics Office (REO) at Davao Oriental State University - Cateel Extension Campus. Third, the researchers gave a letter to request permission from the School Principal and kindergarten advisers in Cateel Central Elementary School to confirm their approval to participate in the studied data collection. After, the researcher administered a pre-test to both groups. Through fairness from the respondents, researcher used tossing of coin with the cooperating teacher to determine what session were experimental group received an intervention and the control group received a traditional teaching.Next, was the intervention completed in May 2024,when each group was given three sessions per week(40 minutes per session). After,the instructional period,both groups administered a post -test to measure the effectiveness of the teaching methods comparing students performance before and after the intervention. The data collected to pre-test and post-test were compiled and analyzed by a research statistician to determine the statistical results ,providing a thorough assessment of the study's findings.

Research Instrument

In order to collect appropriate data, the researcher administered a researcher-made 11-item number recognition checklist. Both tests were designed to measure the pupils' number recognition skills. Moreover, the checklist was anchored in the K-12 Curriculum, specifically in the Standard and Competencies for Five-Year-Old Filipino Children, with the learning competency "recognize and identify numerals from 0-10."

Data Analysis

After the data gathering through the pre-test and post-test checklist was completed, tabulation of the raw data was the initial step in encoding the results. The Statistical Package for the Social Sciences (SPSS) was used to quantify data and analyze and achieve reliable, realistic, and proper interpretation of the gathered data. Analysis and the K-12 DepEd grading system were used to interpret remarks on data results and compare the two groups' performances. Moreover, the statistical tools used are the mean,standard deviation, and independent sample T-tests.

Mean. The mean helped answer statements of problem numbers 1 and 3 and was then transmuted to the DepEd grading system for interpretation using Table 1 below.

Table 1. DepEd K-12 grading system

GRADING SCALE	INTERPRETATION
90-100	Outstanding
85-89	Very Satisfactory
80-84	Satisfactory
75-79	Fairly Satisfactory
75 Below	Did Not Meet Expectations

Independent sample T-test. This statistical tool determined (2) the significant difference in pre-test results between the controlled and experimental groups and (4) the significant difference in post-test scores between the controlled and experimental groups.

III. RESULTS

Pre-Test Scores of the Control and Experimental Group

Before implementing the number jigsaw puzzle manipulatives, a pre-test comprised of items related to enhancing the number sense and focusing only on number recognition skills was given. Table 2 presents the results of the pre-tests in both the control and experimental groups. The control group achieved a mean score of 8.07 translating (GP=86.68)while the experimental group attained a mean score of 7.33,corresponding to (GP=83.32). Both percentage below the competent entry.This table answers the level of the pre-test score in terms of number recognition skills among Kindergarten pupils in Cateel Central Elementary School.

Based on the results presented, the respondents derived from control and experimental groups. The control group have remarked very satisfactory performance (GP=86.68). In contrast, the experimental group have remarked satisfactory performance (83.32) in their knowledge of number recognition skills. This implies that they still know number recognition of numerals 0-10.

Table 2. Level of pre-test scores between the control and experimental groups.

Group	Total Score	Standard Deviation	Mean	Grade Percentage	Remarks
Control	11	3.22	8.07	86.68	Very Satisfactory
Experimental	11	3.07	7.33	83.32	Satisfactory

Post-test Scores of the Control and Experimental Group

Table 3 shows that both the control and experimental groups progressed in their number recognition performance after properly implementing traditional instructions in the control group and using manipulatives as an intervention in the experimental group. This answers the post-test score in terms of number recognition numerals 0-10 among kindergarten pupils in Cateel Central Elementary School.

As the results were presented, there was a difference in remarks in both groups; the control group have remarked very satisfactory performance (GP=88.18) while the experimental group got outstanding remarks(GP=97.73). This means that using manipulatives was way more effective than traditional teaching about number recognition for kindergarten pupils. Both have different remarks and different grade percentage .

Table 3. Level of post-test scores between the control and experimental groups.

Group	Total Score	Standard Deviation	Mean	Grade Percentage	Remarks
Control	11	3.02	8.40	88.18	Very Satisfactory
Experimental	11	1.20	10.50	97.73	Outstanding

A significant difference was analyzed between the mean pre-test scores of the control and experimental groups. The statistical analysis of these scores is summarized in Table 4. This indicated that the mean pre-test score for the control group was 8.07 with a standard deviation of 3.22, while the experimental group had a mean score of 7.33 with a standard deviation of 3.07. The t-value was 0.669, and the p-value was 0.501, showing no significant difference between the two groups' pre-test scores. This lack of significant difference suggests that both groups started at a similar level of number recognition skills before introducing the teaching methods. The data strengthen the idea that number recognition skills among kindergartners were still in need for enhancing, highlighting the challenges kindergartners faced in number recognition.

Difference in Pre-test Scores between Control and Experimental Group

Table 4. Mean comparison between pre-test scores of control and experimental group.

Type of Test	Mean	Standard Deviation	t-value	p-value	Interpretation
Control	8.07	3.22	0.669	0.501	Pre-test scores between the two groups do not differ significantly.
Experimental	7.33	3.07			

The Difference of Post-Test Scores between Control and Experimental Group

The mean comparison between post-test scores between control and experimental group was analyzed, with results summarized in Table 5. It revealed a substantial difference in post-test mean scores between the control and experimental groups. The high standard deviation of 3.02 in the control group suggests a more significant variability in the post-test number recognition scores compared to the experimental group, which has a standard deviation of 1.20. This means that the scores in the control group are more dispersed around the mean, suggesting that students in this group had a more comprehensive range of performance levels. This suggests that students in the control group had very different levels of achievement on the post-test, reflecting inconsistency in their performance. Furthermore, the t-value of -2.532 and a p-value of 0.021 suggested a statistically significant difference between the two groups. This significant difference suggests that the experimental group which received the intervention using the jigsaw puzzle, demonstrated remarkably improved number recognition skills compared to the control group, which followed traditional methods. The results confirm the effectiveness of the number jigsaw puzzle maniputales as a more successful teaching strategy in enhancing kindergartners' number recognition skills.

Table 5. Mean comparison between post-test scores of control and experimental group.

Type of Test	Mean	Standard Deviation	t-value	p-value	Interpretation
Control	8.40	3.02	-2.532	0.021	Post test scores between the two groups differ significantly
Experimental	10.50	1.20			

IV. DISCUSSIONS

The results presented in the pre-test were affected by many factors, which resulted in their satisfactory performance. For this reason, children are influenced by early educational experiences, where children are exposed to early literacy, numeracy, and communication patterns(Silver & Libertus, 2022). This exposure helps numeracy development and lays a foundation for understanding abstract concepts like mathematical ideas(Council, 2015). Although having an early advantage, researchers note an ongoing issue: students' number recognition skills often need to reach the desired levels but gradually improve over time (Maghfirah & Mahmudi, 2018).

Another factor influenced was the congenital factors or inherent biological traits in shaping a person's ability to understand and work with numbers (Grotkamp et al., 2020). For instance, research has shown that there might be a genetic component to mathematical abilities, with some individuals naturally predisposed to excel in this area due to their genetic makeup (Visibelli et al., 2024). Genetic factors can play a role in determining a child's overall cognitive abilities, including their aptitude for numerical tasks with certain genetic conditions or family history of learning difficulties may influence how easily a child grasps number recognition skills (Vogel & De Smedt, (2021).

The results clearly show the effect of the respondents' progress in learning number recognition.

On the other hand, several factors affect the post-test results of both groups. First, Innova (2022) believed that the traditional, antiquated method of instruction, often known as conventional education, which involves memorization and repetition of facts, was also influential in student performance. Group activities and collaborative exercises are frequent features of traditional teaching methods, which can foster social interaction and help students learn from one another (Israel, 2020). This type of interaction has been shown to positively impact student learning and performance (Doubet & Hockett, 2018). Additionally, teachers' attitudes towards teaching also affect learning. It was discovered that teachers' positive attitudes inspired students' confidence, which helped them adopt a positive outlook on learning mathematics (Mensah et al., 2013).

In contrast, manipulatives in the classroom vary, with teachers employing them during lessons when introducing, practicing, or refining mathematical concepts (Hidayah et al., 2021). Furthermore, research has shown that the frequency of playing with jigsaw puzzles and similar puzzles was related to the ability to mentally transform 2D shapes in 54 months, suggesting that puzzle games promote spatial skills. Young et al. (2014) provide partial evidence supporting this idea. They provided instruction during puzzle play with 4- to 5-year-old children. According to Hurrell (2018), using manipulatives is a prerequisite for student learning, and physically manipulating materials benefits learners. In addition, Hurrell (2018) conducted a quantitative study examining how kindergarten students use manipulative tactics, and he studied how kindergartners physically manipulated materials and discussed with students to understand better how manipulatives in mathematics contribute to conceptual development.

Their level of knowledge in answering pre-test scores was almost the same without any intervention. The control group got the higher mean score. This means that they obtained a higher-grade percentage on the pre-test itself. Another factor was that the instructional strategies and methods of the teachers were the first and most important aspect in teaching and learning mathematics, and demographic characteristics also affected the learning (Moyer-Packenham et al., 2013). It was affected by many factors that contributed to the higher performance. One reason was that the pupils had previous experience with numeracy. Previous familiarity with the materials aided in acquiring proficiency in the subject matter and was advantageous for advanced educational achievements (Dong et al., 2020).

Another explanation for the interpretation of the table was the home numeracy environment, which is one of the reasons that supported and fostered the arithmetic skills of a pupil (Elliott & Bachman, 2018). Resnick (2020) stated that children start acquiring knowledge of numbers and fundamental math ideas very early, sometimes even before they begin formal education. The place where they spend much time, their home, is where they first learn about numbers, counting, and basic math through everyday activities such as counting toys or recognizing numbers on household items (Susperreguy et al., 2020). Furthermore, Cheung et al. (2021) also posited that parents' activities encouraged their kids' numeracy skills at home, and their general attitudes and beliefs regarding kids' learning together comprise the home learning environment. The academic post-test is crucial because, in this section, students' learning could succeed because there is a relationship between the intervention and the results of their performance regarding the lesson, and a comparison can be made with ease (Ursara & Reisoglu, 2017). Based on the interpretation above, it could be stated that after the intervention utilizing number jigsaw puzzle manipulatives to the experimental group during the duration of the lesson, it has been found that this type of intervention was indeed effective because of the higher post-test scores of experimental respondents compared to the control group.

Research has shown that if students can explore using manipulatives, they will master number sense better and will gain more knowledge when using the material (Venketsamy, 2019). The use of manipulatives in those activities might have an impact on student achievement. The teaching and learning process should be enhanced using manipulatives as cognitive tools, inspiring student reflection on information retention (Agujar, 2018). Before the intervention in the utilization of manipulation, the pre-test results were remarked as satisfactory in performance. However, it goes beyond when the intervention has already been conducted.

The experimental group got 97.73, which was interpreted as outstanding. This means that the experimental group has enhanced their learning in number recognition. Therefore, the number jigsaw puzzle manipulatives effectively teach number recognition to kindergarteners for several reasons. One reason is that young children typically excel in learning through practical experiences, and manipulatives offer a concrete means to engage with abstract mathematical ideas such as numbers (Rodić & Granić, 2021). Another reason is that manipulatives involve various senses, such as touch and sight, potentially improving learning and memory (Walsh & Magana, 2023). According to Clark et al. (2020), children strengthen their comprehension of numbers by visually perceiving them and physically manipulating objects during counting or sorting activities. Thus, engaging in hands-on, manipulative activities can capture children's curiosity and promote active involvement in learning (Byrne et al., 2023).

Moreover, it is related to Maria Montessoris' Montessori Method, which, according to Montessori (Gettman, 2016), engaging in sensory activities can help children select from a range of experiences that are obtained through human senses, the experience of recognizing the concept of numbers in early childhood through concrete exploration of objects. By connecting educational objectives with hands-on, relevant, real-life encounters, educators can increase excitement and foster deeper engagement from students (Academy, 2023). Overall, the implementation of Maria Montessoris' Method in enhancing the number sense of kindergartners through jigsaw puzzle manipulatives aimed to provide a comprehensive, adaptive approach to learning through concrete experience and recognition. Concrete experiences included physically manipulating puzzle pieces, feeling shapes, and connecting them to form numbers manipulating puzzle pieces (MSEd, 2023).

V. CONCLUSION

The findings of this study emphasizes the necessity for innovative approaches to enhance number recognition skills among kindergartners. While some students demonstrated proficiency in recognizing numbers, the use of number jigsaw puzzle manipulatives significantly contributed to the improvement of this skill. Traditional pedagogical methods frequently fall short in effectively addressing the challenges that kindergartners face in number recognition. In contrast, the implementation of number jigsaw puzzle manipulatives has been shown to facilitate a more engaging and manageable learning experience, thereby enhancing educational outcomes for young learners.

Provided that the pre-test results did not meet the anticipated standards, it is imperative to renew efforts in teaching number recognition, potentially through the introduction of increased support or additional learning activities. The absence of a significant difference in pre-test scores between the experimental and control groups indicates that any adjustments to instructional strategies should be uniformly applied across all kindergarten classes to ensure equitable learning opportunities. The positive post-test results from the control group, which align with K-12 standards, suggest that traditional teaching methods may require revision and should be complemented with more innovative strategies and interventions. Furthermore, the Department of Education (DepEd) might consider integrating number jigsaw puzzle manipulatives into classroom activities as a pedagogical strategy, thereby equipping educators with effective tools for teaching number recognition.

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