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Research Article

Arithmetic Counting Techniques through Manipulatives: Effect on the Numeracy Skills of Grade 1 Pupils

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ABSTRACT

This study aimed to determine the effectiveness of Arithmetic Counting Techniques through manipulatives on the numeracy skills of Grade 1 pupils in adding and subtracting numbers. The study employed a quasi-experimental design, specifically one- group pretest and posttest involving 30 Grade one pupils of Lias Elementary School for the School Year 2023- 2024 who did not meet the prescribed 60% minimum proficiency level (MPL) during the conduct of the Regional Diagnostic Assessment (RDA) as per Regional Memorandum No. 502, s. 2022. The pupil-respondents were exposed to a variety of manipulatives such as shoot the goal, whack-a-mole, spin the numeracy wheel, light up the Math path, lead the trail, and push the abacus that offered a hands-on approach to learning. Results showed that the use of Arithmetic Counting Techniques through manipulatives has a significant effect on pupils' numeracy skills, specifically in adding and subtracting numbers, as manifested in the associated p-value of .000, which is less than the .05 level of significance and in the increase of pretest and posttest mean scores of 7.77 and 18.80, respectively. Furthermore, the computed effect size (r) is -0.875 based on the z value, which implies that the material has a large effect on the numeracy skills of Grade 1 learners. Utilizing Arithmetic Counting Techniques through manipulatives is highly recommended to provide pupils with concrete, meaningful, and hands-on learning opportunities that can positively strengthen their numeracy skills and present lessons in a more engaging, innovative, and dynamic means.

Keywords: *Arithmetic, Counting Techniques, Manipulatives, Numeracy skills*

Introduction

Learning Mathematics encompasses life at any age and under any circumstances. It is not just a subject to be learned at school but a significant instrument that will equip Filipino learners with resiliency and competency to

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participate fully in society. Therefore, developing a solid mathematical foundation during their early years of education will prevent mathematical learning difficulties in the future.

Mathematics promotes holistic human growth (Nocar, 2016). As mentioned above, no one can deny its significance in any field of endeavor. However, the fact remains that the country is facing worrying signs of an education crisis. Based on the 2022 Programme for International Student Assessment (PISA) result, in Mathematics, the Philippines ranked sixth to the last among 81 participating countries. It also revealed that Filipino students lagged 6.45 years behind in Mathematics education compared to other nations. The same findings were shown in the 2019 Trends in International Mathematics and Science Study (TIMSS), wherein Grade 4 Filipino learners obtained the lowest scores in Math and Science among 58 countries involved in the study. This is a clear indication of the immediate and intense need to address learning gaps to cope with the backlogs in education worsened by the disruption of classes during the COVID-19 pandemic in previous years.

Despite the numerous challenges in the education sector, heightened by the pandemic-driven school disruptions, the Department of Education (DepEd) remained committed and dedicated to addressing learning loss as well as the low performance of Filipino learners in international large-scale assessments through the adoption of the National Learning Recovery Plan (NLRP) enshrined in the DepEd Order No. 13, s. 2023. This is anchored on the MATATAG agenda, with improving numeracy and literacy as one of its significant highlights. Adopting to the local context, DepEd Region III conducts various assessments among public schools in Central Luzon to gain accurate results and findings that will serve as baseline data in improving the teaching-learning process and developing intervention and remediation programs.

At the institutional level, the Regional Diagnostic Assessment (RDA) results proved that most Grade 1 pupils of Lias Elementary School, Marilao South District, lack numeracy skills. Based on the results of the RDA in Mathematics 1 conducted last September 2023, as per Regional Memorandum No. 504, s. 2022, Guidelines on the Conduct of the Regional Diagnostic Assessment in All Learning Areas from Grades 1-10 and Core Learning Areas in Grades 11-12, none of the 227 pupils achieved the required Minimum Proficiency Level. It was revealed that the pupils' lack of mathematical proficiency among basic skills in Mathematics is highly prevalent. After analyzing the items, it showed that the least learned competencies in Mathematics 1 fall under the objective of adding and subtracting numbers.

This result serves as significant baseline data for suitable context-based intervention and improvement in the delivery of instruction in the school. It further implies that immediate action is needed to address these learning gaps to achieve the desired learning competencies embedded in the curriculum. The earlier the learning deficiency is treated, the better the learning outcomes will be.

More so, equipping learners with the necessary knowledge, skills, and abilities that they need to acquire to become critical thinkers and good problem solvers are the twin goals of Mathematics in Philippine education; this coincides with the MATATAG curriculum, which aims to intensify the development of mathematical proficiency among learners. It will highlight their increased awareness of the value and usefulness of Mathematics in real-world endeavours. However, developing early numeracy among pupils is essential for later mathematics learning in school and future career success (Aunio, 2019). Additionally, Guhl (2019) established the significant role of early mathematics education in predicting later academic success, particularly in mathematics. However, Guhl identified a need for further research to explore the long-term relationship between early math skills and performance in advanced mathematics courses, as well as its influence on other academic domains.

Moreover, for Grade 1 to Grade 3 learners, the Key Stage 1 (KS 1) of the Math curriculum addresses early numeracy development that will serve as an underpinning for understanding more challenging and complex problems as they progress in higher academic education. As the curriculum suggests, using mathematical

objects, which could be contextual, verbal, visual, concrete, or symbolic, would lead to mastery of early numeracy. Therefore, to solidify the numeracy skills of learners as young as Grade 1 effectively, the use of effective representations and math manipulatives can be an effective tool to understand mathematical concepts to a greater extent. As Ghazali, Mohamed, and Mustafa (2020) highlighted the necessity of a well-defined understanding of number sense in primary mathematics education to facilitate reproducible research and informed teaching. Their detailed analysis of number sense indicators offers a practical guide for educators and researchers to develop and implement evidence-based instructional strategies.

Van de Walle et al. (2013) described a mathematical tool as any object that embodies a concept, and it can be in the form of pictures, drawings, puzzles, toys, or other physical objects that a teacher can use to illustrate and craft mathematical concepts. Moreover, Heddens, as cited in Larbi and Mavis (2016), claimed that one of the best ways of developing mathematical ideas is through activities with physical materials since pupils learn best when they are active participants in the teaching-learning process. This was anchored on Piaget's Theory of Cognitive Development under the Pre-operational stage. It asserts that elementary children need concrete objects, illustrations, characters, and other similar forms to develop a deeper understanding of mathematical perceptions.

According to Lillard (2013), it is very evident that manipulatives are essential tools in education. More so, using manipulatives, also called manoeuvrable objects, initially designed for teaching Mathematics, has made profound progress in teaching (Ramilo et al., 2022). As facilitators of knowledge, teachers should do their best to offer learners the best resources and materials to enhance their cognitive skills. Cockett et al. (2015) corroborated with the study of Larbi et al. (2016), stressing that using manipulatives in a hands-on approach to learning can serve as valuable tools to concretize learners' understanding of various mathematical concepts and ideas.

Therefore, the researchers explored the wonders of manipulative tools- Arithmetic Counting Techniques to solidify the numeracy skills of Grade 1 pupils in adding and subtracting numbers. In this study, the researchers allowed the learners to enhance their numeracy skills through a hands-on approach. This is based on the notion that learners must see the relationship between what they study in the real world and how they can apply those new learnings with pre-existing ones without focusing much on repetitive tasks and rote memorization. Also, this is grounded on the assumption that humans learn by doing, as John Dewey's principle of learning suggests. Previously cited literature has substantiated the crucial function of manipulatives in Mathematics teaching. However, the researchers ensured that the intervention material that they developed, Arithmetic Counting Techniques (ACT) through manipulatives, acted as a mathematical tool that built resiliency in the numeracy skills among Grade 1 pupils by providing them with MELC-tailored and self-crafted manipulative activities presented enjoyably until the skills taught have been mastered. Furthermore, the researchers provided the Grade 1 pupils with diverse learning styles, abilities, and levels of learning with equal opportunities to develop their mathematical skills to ensure mastery and reduce learning gaps. The researchers firmly believed that the manipulative intervention material that they developed helped improve the quality of Mathematics teaching among early grades as their humble contribution in building academic resiliency in accordance with the battle cry of the basic education sector- *MATATAG: Bansang Makabata, Batang Makabansa*

Methods

The primary objective of the research was to evaluate the effectiveness of the manipulative intervention material- Arithmetic Counting Techniques, in improving the numeracy skills of Grade 1 pupils, specifically in adding and subtracting numbers. The quasi-experimental type of research was employed in this study, which focuses on a one-group pretest-posttest design, as behavioral researchers often use this to identify the effects of an intervention on a given study (Allen, 2017). Also, because the primary selection criterion focused on those who

failed to attain the MPL during the conduct of the Reginal Diagnostic Assessment, there was no random selection of participants, which is aligned with the said research design.

Participants

The participants of the study were the 30 pupils who were enrolled in Grade 1, section Sampaguita of Lias Elementary School, Marilao South District, for the School Year 2023-2024. The pupil-respondents were heterogeneous in terms of gender, age, and socio-economic status. They were the learners who did not meet the prescribed 60% minimum proficiency level (MPL) as per Regional Memorandum No. 502, s. 2022. Furthermore, the selection of the Grade 1 Sampaguita section, the advisory class of one of the researchers, was based on the alignment of schedules between the researcher and the learners.

Sampling Method

A purposive sampling method was used to select the participants of the study. The following criteria were taken into consideration in choosing the study's participants: (1) did not achieve 60% MPL of the total number of items in the diagnostic test, (2) learners of Grade 1 Sampaguita, and (3) willing to participate in the study. Considering the researcher's role as an adviser, the convenience of time was considered to ensure the compatibility between the class schedule of the participating learners and the researchers.

Data Analysis

All data taken from the respondents were organized, analyzed, and computed using the following statistical measurements.

To answer questions number 1 and 2, where the researchers need to determine the numeracy level of Grade pupils in addition and subtraction before and after the implementation of the intervention, the researchers employed frequency counts and mean (score analysis). Furthermore, to find out if there is a significant improvement in the numeracy level of Grade 1 pupils after exposure to the intervention, the Wilcoxon Signed Rank Test, a non-parametric counterpart of paired sample t-test, was utilized because the scores were found to be not normally distributed.

Lastly, in all computations, the software Statistical Packages for Social Sciences (SPSS) 21 and Microsoft Excel were used. An alpha level of 0.05 was used in all the statistical treatments.

Result and Discussion

Numeracy Level of Grade 1 Pupils Before the Intervention

The participants were given a 20-item pretest to determine their numeracy level before providing the intervention.

Table 1. Frequency Distribution of the Pretest Scores of Grade 1 Pupils

Scores	Verbal Interpretation	Frequency *(pretest)*	Percentage
20	Excellent	0	0%
18 –19	Very Good	0	0%
16 – 17	Good	0	0%
14 – 15	Satisfactory	0	0%
12 – 13	Passing	3	10%
11 and below	Failed	27	90%
Total		**30**	**100%**

Table 1 presents the Frequency Distribution of the Pretest Scores of Grade 1 Pupils. Only 10% or 3 out of 30 respondents got a passing score (12-13), and 90% or 27 out of 30 respondents failed the pretest. This leads to the researchers' conclusion that the numeracy skills of Grade 1 pupils were very low. Thus, this is the utmost reason why an intervention material to address the alarming numeracy skills of the said learners was implemented.

Numeracy Level of Grade 1 Pupils After the Intervention

To determine if there is a significant improvement in the numeracy level of Grade 1 pupils, a different set of validated 20-item posttest was given among the pupils after the intervention was successfully conducted.

Table 2. Frequency Distribution of the Posttest Scores of Grade 1 Pupils

Scores	Verbal Interpretation	Frequency *(posttest)*	Percentage (%)
20	Excellent	11	36.67%
18 –19	Very Good	14	46.67%
16 – 17	Good	5	16.67%
14 – 15	Satisfactory	0	0%
12 – 13	Passing	0	0%
11 and below	Failed	0	0%
Total		**30**	**100%**

Table 2 exhibits the Frequency Distribution of the Posttest Scores of Grade 1 Pupils. 36.67%, or 11 out of 30 respondents, attained a perfect score, while 46.67% or 14 of the 30 respondents got a score of 18 – 19 with a verbal interpretation of Very Good. Additionally, 16.67% or 5 out of 30 respondents scored 16-17. No respondents got a failing score.

This indicates that the use of the Arithmetic Counting Techniques plays a vital role in improving the numeracy skills of Grade 1 learners.

Comparison of the Numeracy Level of the Grade 1 Pupils Before and After the Implementation of the Intervention

Table 3 Mean and Standard Deviation of Grade 1 Learners

	N	Minimum	Maximum	Mean	Std. Deviation
Pretest	30	3	13	7.77	2.738
Posttest	30	16	20	18.80	1.186
Valid N (listwise)	30				

The table shows the computed means of the respondents' scores *(pretest-posttest).* The pretest computed mean is 7.77 and a standard deviation of 2.738. On the other hand, the posttest calculated mean and standard deviation are 18.80 and 1.186, respectively. This significantly implies an enormous increase (11.03) in the performance of Grade 1 pupils concerning their numeracy skills. This further indicates that the numeracy skills of Grade 1 pupils improved after their exposure to the intervention. This is parallel in the study of Lê, Noël, and Thevenot (2024) that manipulatives were more effective than fingers in supporting young children's addition learning. They attribute this to the direct sensory experience and active manipulation of materials, which aids in conceptual understanding.

Table 4. Wilcoxon Signed Ranks Test

Ranks

		N	Mean Rank	Sum of Ranks
Posttest - Pretest	Negative Ranks	0[a]	.00	.00
	Positive Ranks	30[b]	15.50	465.00
	Ties	0[c]		
	Total	30		

a. Posttest < Pretest *b. Posttest > Pretest* *c. Posttest = Pretest*

The table presents the Wilcoxon Signed Rank Test. Based on the table, 100% or 30 out of 30 respondents scored higher on the test after implementing the intervention (Arithmetic Counting Techniques).

Kontas (2016) concluded that manipulatives facilitate the understanding of abstract concepts, leading to a recommendation for their increased use in instruction. However, the study's timing prevented a retention test. Future studies should address this limitation by examining the long-term effects of manipulatives on knowledge retention.

Table 5. Test Statistics

	Posttest - Pretest
Z	-4.793[a]
Asymp. Sig. (2-tailed)	.000
Effect size (r)	-0.875

a. Based on negative ranks
b. Wilcoxon Signed Ranks Test

Table 5 presents the test statistics for the pretest and posttest. The table further explains that the scores before and after the intervention have significant differences, as evidenced by the associated p-value of .000, which is less than the .05 level of significance. Moreover, based on the z value, the computed effect size (r) is -0.875, which means that the intervention has a large effect on the numeracy skills of Grade 1 learners.

Furthermore, it was concluded that there was a significant improvement in the pupils' scores after exposure to the intervention. The result also implies that the manipulative intervention material developed- Arithmetic Counting Techniques was effective in enhancing numeracy skills.

In general, providing instruction well-supported by manipulatives can help learners, especially those at young ages, easily and clearly understand concepts with greater ease, bridging learning gaps. Furthermore, the utilization of manipulatives in teaching, specifically among young learners, is very pivotal in building significant hands-on experiences, gearing towards exploration of mathematics processes until they understand concepts both at concrete and abstract levels (Muhammad et al., 2023).

Pedagogical Implications Drawn from the Findings of the Study

Significant implications can be drawn based on the findings of the study that can help improve the numeracy skills of the pupils. It has been suggested that the agreeable attitude of the learners when it comes to the use of the manipulative intervention material- Arithmetic Counting Techniques may influence their performance in adding and subtracting numbers correctly. Moreover, since manipulatives were used to develop their numeracy skills, their interest in learning was boosted since they were given equal opportunities to listen, talk, count, solve, and do tasks. By doing so, they can build links between the manipulative tools used and the mathematical concepts they represent. However, the great challenge among the teachers is to find relevant and appropriate manipulative tools or other similar learning resources, methods, and approaches that will maximize pupils' potential, especially those young ages, where foundational skills should be solidified first or else it can lead to significant challenges in the future.

Conclusion

In light of the findings engendered from this study, it is concluded that the use of Arithmetic Counting Techniques (ACT) through manipulatives as an intervention material was found to be effective in improving the numeracy skills of Grade 1 pupils as reflected in their pretest and posttest mean scores with a computed value of 7.77 and 18.80 respectively, in favor of the posttest. Hence, the null hypothesis, which states that there is no significant difference

between the pretest and posttest scores, was rejected.

This also means that there was a significant improvement in the pupils' numeracy skills after the exposure to the intervention, particularly in adding and subtracting numbers, which were the targeted competencies of the study. It also showed that the manipulative intervention material developed captured pupils' interest and motivation to learn and develop their skills, as demonstrated in their attendance record, eagerness, and enthusiasm to attend classes and perform their tasks despite the challenges brought by the disruption of classes.

Recommendations

Considering the findings above, the researchers put forth the following recommendations:

1. Teachers must utilize the Arithmetic Counting Techniques developed as manipulative intervention material. Based on its positive impact on the numeracy skills of Grade 1 pupils, using manipulative materials can provide pupils with concrete, meaningful and enjoyable hands-on learning opportunities that can positively strengthen their skills.
2. The study's findings strongly support the use of MELC-tailored and self-crafted manipulatives not just in teaching Mathematics but in other learning areas as well as in presenting lessons more engagingly and dynamically.
3. Before planning, crafting, and developing teaching and learning material, intervention or any other pedagogical approaches to improve the quality of education, teachers must adequately assess the levels, needs, and characteristics of the learners. If they could identify and prioritize the competencies where pupils struggle the most, learning gaps would be treated more effectively.
4. Likewise, dissemination of these findings is highly recommended as it may be necessary as a bases for further development and in providing remarkable and valuable insights among future researchers in their quest for the most effective and innovative options to improve learning outcomes.

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