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Enhancing Division Mastery Among Grade 2 Learners Through the Use of InnoDiD (Innovative Division Device)

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A B S T R A C T

This study aimed to improve division mastery among Grade 2 learners at Emilio Boro Central School, Cataingan West District, Schools Division of Masbate through the use of the Innovative Division Device (InnoDiD). Using a one-group pretest-posttest design, the study assessed the effectiveness of InnoDiD in enhancing learners' understanding of division. Thirty Grade 2 learners participated in the intervention. A validated pretest and posttest aligned with the K to 12 Mathematics Curriculum were used to measure students' conceptual and procedural grasp of division. The Shapiro-Wilk test confirmed normality for the pretest but not for the posttest, prompting the use of the Wilcoxon Signed-Rank Test to analyze the results. Findings revealed a statistically significant improvement in posttest scores ($p < 0.001$), indicating that learners developed a deeper understanding of division through the use of InnoDiD. The tactile and visual components of the device made abstract mathematical concepts more accessible and meaningful. Learners engaged more actively and showed increased confidence, improved problem-solving abilities, and stronger number sense. The study concluded that InnoDiD is an effective, low-cost, and learner-centered instructional tool for enhancing division mastery in early grades. It addressed the diverse learning needs of both boys and girls, promoted inclusive education, and supported curriculum goals for foundational numeracy.It is recommended that InnoDiD be integrated into regular math instruction for primary learners. Teachers should receive training on manipulative-based strategies to maximize the tool's impact. Further research is encouraged to explore its application to other math operations and contexts.

Keywords: Division mastery, Grade 2 learners, InnoDiD, Innovative Division Device, manipulative-based instruction

1. Introduction

In the Philippines, proficiency in the four basic mathematical operations—addition, subtraction, multiplication, and division—is essential for establishing a foundation for lifelong numeracy. Nonetheless, even though it is presented early in elementary school, division continues to be one of the most challenging concepts for students to understand. Division entails advanced cognitive processes and necessitates a conceptual grasp of equal partitioning, which numerous young students consider abstract and perplexing. Research has shown that inadequate foundational skills in early mathematics leads to persistent learning gaps and hinders students' preparedness for advanced subjects in higher grades (Tan & Bernardo, 2022).

Conventional methods for teaching division typically focus primarily on procedural exercises, lacking adequate attention to conceptual comprehension. This has resulted in minimal involvement and ongoing poor performance among students, particularly in early grades. Brown and Green (2018) highlighted that teaching methods devoid of practical and tailored strategies often lead to frustration and fatigue in learning. Likewise, local research (de los Santos & Mercado, 2023) indicates that Filipino students gain more when math teaching incorporates tangible resources and visual aids that enhance understanding. Therefore, there is an urgent requirement for creative, learner-focused strategies that assist challenged students in the early grades.

Previous studies endorse the utilization of manipulatives and interactive resources to enhance mathematical results. Zhou and Wang (2022) performed a meta-analysis demonstrating that learners who engage with visual and tactile learning resources surpass those instructed through conventional approaches. Attard and Northcote (2020) discovered that both virtual and physical manipulatives greatly enhance engagement and understanding of concepts. In the regional context, integrating these techniques aligns with the Department of Education's support for tailored instruction to meet varied student requirements and foster fairness in basic education (DepEd, 2016).

To address the persistent challenges in division mastery among Grade 2 learners at Emilio S. Boro Elementary School, an innovation called InnoDiD (Innovative Division Device) was developed. This tool utilized tangible, hands-on components that allowed learners to visualize and physically divide objects into equal parts. InnoDiD integrated interactive exploration with visual representation, making the abstract concept of division more concrete and easier to understand. It enabled young learners to manipulate quantities, recognize patterns, and solve division problems through experiential learning—bridging the gap between theory and practice while promoting engagement and foundational numeracy.

1.1 Statement of the Problem

This study primarily aimed to improve the mastery of division among Grade 2 learners at Emilio S. Boro Elementary School through the use of an innovative instructional tool known as the Innovative Division Device (InnoDiD). The device was designed to provide learners with a hands-on, visual approach to understanding division, thereby supporting the development of foundational numeracy skills. Specifically, the research addressed the following questions: (1) What was the mathematical operational level or numeracy profile of Grade 2 learners in division before and after the implementation of the InnoDiD intervention? and (2) How effective was the intervention in improving the learners' division skills?

2. Methods

2.1 Research Design

This study utilized a one-group pretest-posttest design to evaluate the effectiveness of the Innovative Division Device (InnoDiD) in improving division mastery among Grade 2 learners at Emilio S. Boro Elementary School. This design allowed the same group of learners to be assessed before and after the intervention, making it possible to determine any learning gains that occurred. It suited the study context where random assignment or a control group was not practical, especially in small or intact classroom settings (Brown & Green, 2018). This design has been widely used in education to test interventions in authentic classroom environments. Attard and Northcote (2020) emphasized that pretest-posttest methods provide direct evidence of impact in terms of student engagement and achievement when using innovative learning tools. Similarly, de los Santos and Mercado (2023) highlighted the value of manipulative-based instruction in improving the mathematical thinking of early-grade learners, supporting the integration of visual and tactile materials like InnoDiD.

The approach aligned with the K to 12 Mathematics Curriculum of the Department of Education (2016), which promotes conceptual understanding through active learning. In addition, the use of manipulatives was supported by Zhou and Wang's (2022) meta-analysis, which concluded that physical tools significantly enhanced elementary students' mathematics performance. The pretest-posttest framework effectively captured the learners' progress while validating the use of experiential strategies for foundational numeracy development.

2.2 Data Sources

This research utilized both primary and secondary data sources to assess the efficacy of the Innovative Division Device (InnoDiD). The main data were gathered using a pretest and posttest tailored to evaluate the students' understanding of division. These evaluations, developed by the classroom educator, corresponded with the skills specified in the K to 12 Mathematics Curriculum Guide (Department of Education, 2016), confirming the tool's validity for Grade 2. Secondary sources comprised class records, including past math grades and learner profiles, which offered insight into students' previous performance. Literature support from both local and international writers further anchored the study, including the research of de los Santos and Mercado (2023), which revealed that instruction based on manipulatives boosted mathematical thinking among Filipino students, and Zhou and Wang (2022), who indicated via meta-analysis that manipulatives greatly improved math achievement among elementary learners.

The study involved 30 Grade 2 students from Section 2 of Emilio S. Boro Elementary School, including 14 boys and 16 girls. Every student in this complete class participated in the intervention and was taught using the InnoDiD throughout the study duration. Their involvement was recorded with equivalent teaching exposure, guaranteeing balanced participation in the tasks associated with mastering division.

2.3 Research Procedure

The research followed a systematic procedure to ensure both validity and ethical compliance throughout its implementation. A comprehensive research proposal detailing the objectives, methodology, instruments, and scope of the study was prepared and submitted to the school head of Emilio S. Boro Elementary School for approval. After receiving the necessary authorization, a coordination meeting with the Grade 2 class adviser was conducted to finalize the schedule and integrate the use of the Innovative Division Device (InnoDiD) into the learners' regular mathematics instruction. Before commencing the intervention, informed parental consent was obtained. A consent form was distributed to the parents or guardians of all 30 Grade 2 learners—14 males and 16 females—enrolled in Section 2. The form explained the purpose of the research, outlined the procedures, emphasized the confidentiality of learner data, and clarified the voluntary nature of participation. Only those learners whose parents or guardians provided written consent were included in the study. All ethical protocols were observed to ensure the protection, privacy, and well-being of the participants.

The study utilized a one-group pretest-posttest design. Initially, a validated pretest was administered to measure the learners' baseline understanding of division concepts. This was followed by the implementation of InnoDiD during classroom sessions, where learners engaged in structured and interactive division activities using the device. Upon completion of the intervention, a posttest was administered, and the results were compared with the pretest scores to assess the effectiveness of the device in improving division mastery among the participating learners.

3. Results and Discussion

3.1 CNumeracy Profile of Grade 2 Learners in Division Before and After the InnoDiD Intervention

To assess the initial and later numeracy level of Grade 2 students in division, the researchers conducted a pretest and posttest involving the Innovative Division Device (InnoDiD). Prior to assessing statistical significance, the Shapiro-Wilk test was employed to evaluate the data for normality. The findings, presented in Table 1, indicated that the pretest data followed a normal distribution (Stat-W = 0.930, $p > 0.05$), whereas the posttest data did not conform to the normality assumption (Stat-W = 0.351, $p < 0.05$). This warranted the application of a non-parametric statistical approach to evaluate the success of the intervention.

Table 1
Normality Test of the Data Using Shapiro-Wilk Test

Variables	N	Stat-W	P-value	Interpretation
Pretest	30	0.930	> 0.05	Normally Distributed
Posttest	30	0.351	< 0.05	Not Normally Distributed

As shown in Table 1, the shift from normal to non-normal distribution may reflect greater variability in posttest performance, likely due to individual learning gains after the intervention. These results offered insight into the learners' initial challenges with division and their cognitive readiness to absorb new conceptual tools, confirming the need for interventions like InnoDiD that support both conceptual and procedural understanding through hands-on, engaging strategies (de los Santos & Mercado, 2023; Zhou & Wang, 2022).

3.2 Effectiveness of InnoDiD in Improving Learners' Division Skills

After the implementation of the InnoDiD, the Wilcoxon Signed-Rank Test was utilized to assess the significance of the change between pretest and posttest results. As shown in Table 2, the statistical evaluation showed a p-value of 0.001, suggesting a very significant enhancement in students' division skills.

Table 2
Significance of Pretest and Posttest Scores Using Wilcoxon Signed-Rank Test

Variables	N	Z	p-value	Interpretation
Control	30	0.00	<0.001	Statistically significant

This outcome validated the intervention's success in enhancing division abilities among Grade 2 students. This enhancement aligns with research that emphasizes the effect of hands-on, visual, and manipulative instruction on students' comprehension of mathematics (Attard & Northcote, 2020; Brown & Green, 2018). The implementation of InnoDiD, which incorporated visual supports and hands-on exploration, offered learners chances to create understanding and apply knowledge, an essential aspect of early mathematics education (Zhou & Wang, 2022).

The notable improvement in students' posttest results suggested that learners could progress past rote methods to a better grasp of what division means. Strategies based on manipulation, like InnoDiD, allowed students to create mental images of the concept, enhancing their basic number sense and problem-solving abilities. This is in agreement with the conclusions of de los Santos and Mercado (2023), who claimed that when students engage with physical models, their conceptual comprehension is strengthened, especially in numeracy for early grades.

Additionally, these results addressed the second research question: What was the effectiveness of the intervention in enhancing learners' division abilities? The evidence clearly indicated that InnoDiD greatly improved both conceptual comprehension and procedural proficiency. This reinforces the position of Clerkin et al. (2018), who highlighted that involving learners with manipulatives aids in bridging gaps in mathematical understanding by promoting deeper involvement and lessening anxiety. In this study, students showed enhanced confidence and autonomy in tackling division tasks, indicating that the incorporation of InnoDiD also favorably influenced their mathematical attitudes.

The intervention provided a teaching model that was flexible and inclusive. The notable enhancement observed in both male and female students demonstrated that the device addressed various learning needs, preferences, and speeds. In classrooms where students frequently find abstract calculations challenging, the tangible nature of InnoDiD enabled varied instruction—assisting learners at different readiness stages. This mirrored the concepts of Universal Design for Learning (UDL), which ensures that instruction is available to everyone via various methods of engagement and representation (CAST, 2018).

Moreover, the consistent progress from pretest to posttest indicated that the InnoDiD did more than just momentarily captivate learners—it contributed to developing essential skills vital for enduring mathematical achievement. Tan and Bernardo (2022) state that achieving early proficiency in fundamental operations such as division assists students in forming positive mathematical identities and prepares them for more intricate concepts in higher elementary

grades. In this respect, InnoDiD demonstrated its role not just as a remediation resource but also as a preparatory tool for upcoming mathematical education.

The outcomes of this intervention had wider significance for educators and curriculum designers. In situations where digital assets are scarce, InnoDiD showed that innovation doesn't have to be costly or high-tech to achieve effectiveness. Instead, the effectiveness of the device highlighted the importance of contextualized, low-tech teaching resources based on solid educational theory and tailored to local requirements. These results further endorse the Department of Education's (2016) promotion of manipulatives and performance-oriented tasks within the K to 12 curriculum to encourage learner-centered, engaging classrooms.

4. Conclusion

The results of this study clearly demonstrate that the Innovative Division Device (InnoDiD) was successful in improving the division skills of Grade 2 learners at Emilio S. Boro Elementary School. By addressing the research problems, the study provided concrete evidence that the learners' mathematical operational level in division significantly improved after using the InnoDiD intervention. The pretest-posttest scores indicated notable progress, with the Wilcoxon Signed-Rank Test confirming a statistically significant difference, thereby validating the effectiveness of the intervention. Before the introduction of InnoDiD, the learners displayed limited understanding of division concepts, as reflected in their pretest performance. This indicated a need for alternative instructional strategies to bridge conceptual and procedural gaps. The integration of InnoDiD into daily lessons introduced a tactile and visual approach to learning, which proved to be both engaging and effective. The hands-on interaction allowed learners to internalize division as a process rather than a mere operation, moving them beyond rote memorization toward deeper mathematical understanding.

The device provided differentiated support that accommodated various learning styles and readiness levels. The improvement was observed across the board, indicating that the intervention was inclusive and effective for both boys and girls, and for learners with diverse abilities. It provided scaffolding that promoted confidence, encouraged exploration, and minimized learning anxiety—factors that are crucial in shaping positive attitudes toward mathematics at an early age. Furthermore, the study highlighted the significance of data-informed instruction. Through consistent assessment and responsive teaching, learners were guided through meaningful learning experiences. The process demonstrated that small-scale, teacher-led innovations could produce substantial learning outcomes even in resource-constrained contexts. The InnoDiD's design proved that educational tools grounded in curriculum standards and learner needs can be both practical and powerful in achieving mastery of basic operations. In conclusion, the study affirmed that InnoDiD is an effective, scalable, and low-cost solution to improving division mastery in early grade learners. It supports the vision of the K to 12 curriculum to make mathematics learning active, contextualized, and learner-centered. The insights gained through this intervention may serve as a model for other teachers seeking innovative yet accessible ways to support foundational numeracy development in the primary classroom.

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