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Enhancing Multiplication Skills in Grade 5 Using the Developed Mathematical Spinner Manipulatives

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Abstract

This study examined the effectiveness of mathematical spinner manipulatives in improving the multiplication abilities of Grade 5 learners in Doongan Integrated School. This study employed a descriptive evaluation design. A sample of 54 students was selected using purposive and stratified sampling to ensure representativeness across academic and socioeconomic factors. Results indicated significant enhancement in students' multiplication skills with spinner manipulatives, supported by expert evaluations, pre-test and post-test performance, and statistical analysis ($p < 0.001$). Physical manipulation of objects offered engaging learning experiences, aiding deeper comprehension and retention of math concepts. The improvement aligned with Vygotsky's Zone of Proximal Development, suggesting manipulatives bridge learning gaps and facilitate collaborative understanding. Besides enhancing numerical skills, manipulatives cultivated positive attitudes toward math. The study advocated integrating spinner manipulatives into fifth-grade math curricula to boost arithmetic proficiency and student engagement. Such integration enhanced multiplication skills while fostering a favorable outlook on mathematics among learners.

Keywords: *Mathematical spinner manipulatives, multiplication skills, Grade 5 learners, hands-on learning, constructivism, descriptive-evaluative design*

INTRODUCTION

The field of mathematics education has witnessed a paradigm shift in recent years, with educators and researchers incre asingly recognizing the value of manipulatives as essential tools for enhancing multiplication skills in fifth-grade learners. According to the study of Dinsmoor (2002), manipulatives are tangible objects and materials used to represent mathematical concepts and have the potential to facilitate the way mathematics is taught and learned. In the field of mathematics education today, using manipulatives has emerged as an essential teaching strategy (Perbowo et al., 2021).

During 2020, COVID-19 shifted the educational setting of the Philippines to distance learning. Due to this reason, effective math teaching practices, such as inquiry-oriented instruction, are harder to implement online. In view of this, the study of Shawchuk (2020) confirms that there is a decline in the relative performance of learners compared to other learners in previous years.

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A study conducted by Kuhfeld et al. (2022) found that elementary learners experienced significant learning losses in mathematics, particularly in foundational skills such as multiplication, as a result of prolonged school closures and the shift to remote learning during the COVID-19 pandemic. The researcher also noted that the disruptions to traditional classroom instruction led to gaps in learners' mathematical understanding and proficiency.

Research by Suh and Moyer-Packenham (2019) shows that educators have actively sought diverse instructional materials to enhance learners' mathematical comprehension. This includes the use of manipulatives, digital resources, and interactive simulations, reflecting efforts to cater to varied learning styles and deepen conceptual understanding.

The manipulative tool is one of the most common learning medium utilized by teachers, even those in remote areas (Perbowo et al., 2021). Several studies suggest that the use of manipulatives in teaching mathematics is more effective than the use of conventional methods (Abarquez, 2020). Also, many mathematics teachers continue to struggle with resolving the concept-symbol divide for their learners, in part because comprehension of one is dependent on understanding of the other.

The primary objective of this study was to evaluate the effectiveness and quality of newly developed mathematical spinner manipulatives in enhancing learners' multiplication skills. Specifically, the study aims to assess these manipulatives in terms of their content, presentation, organization, accuracy, and instructional design. Furthermore, it sought to measure the learners' performance levels through pre-test and post-test assessments, comparing the results to determine if there are any significant differences. Moreover, the study also aimed to gather insights into how these educational tools can be further improved based on the findings from the evaluations and test performances.

Theoretical Framework of the Study

The study provides a conceptual underpinning for understanding the role of manipulatives in fifth-grade mathematics education. This study is anchored on these theories, such as Constructivism, Piagetian Cognitive Development, and Vygotsky's Zone of Proximal Development (ZPD).

In the study, the constructivist approach provided the theoretical framework, asserting that children actively construct their own understanding through interactions with their environment (Piaget, 1973; Vygotsky, 1978). This perspective emphasizes active participation in the learning process rather than passive reception of knowledge. Manipulatives align with constructivist principles by enabling hands-on, experiential learning (Bruner, 1966). According to Piaget (1973), children progress through cognitive stages, including the concrete operational stage around age seven, where they engage in operational thought by manipulating mental representations of concrete objects. Manipulatives effectively leverage this developmental stage by offering physical representations of abstract mathematical concepts.

In the context of the study, integrating manipulatives into fifth-grade mathematics education aligns with Constructivism. When learners interact with these tangible objects, they actively construct their understanding of mathematical concepts. This active engagement reflects Constructivist beliefs that learning is most effective when learners are actively involved. Moreover, Constructivism highlights the role of social interaction and collaboration in learning. In mathematics education, manipulatives often facilitate group activities and discussions, where learners share insights and discoveries, fostering collaborative learning experiences that support knowledge construction.

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Furthermore, Jean Piaget's Theory of Cognitive Development underscores the importance of concrete operational thinking in early childhood (Piaget, 1954). In the study, manipulatives resonate with Piaget's notion that children progress through cognitive stages, particularly the concrete operational stage. This stage marks a crucial period when children can manipulate mental representations of concrete objects and apply logical reasoning to solve problems (Piaget, 1973). By providing tangible representations of abstract mathematical concepts, manipulatives help bridge the gap between concrete experiences and abstract mathematical thinking, facilitating children's cognitive development as outlined by Piaget.

Additionally, Lev Vygotsky's sociocultural theory highlights the role of social interaction and scaffolding in learning (Vygotsky, 1978). The Zone of Proximal Development (ZPD) is central to Vygotsky's theory, representing tasks that learners cannot yet perform independently but can achieve with guidance from a knowledgeable individual. When learners engage with manipulatives, educators or peers provide scaffolding tailored to individual needs, supporting learning within the ZPD. Manipulatives offer concrete tools for exploring abstract mathematical concepts, enabling learners to progressively internalize mathematical principles through collaborative problem-solving activities.

In conclusion, the study demonstrated how manipulatives in Grade-5 mathematics align with Constructivist principles by fostering active, experiential learning and leveraging cognitive developmental stages like Piaget's concrete operational stage.

Conceptual Framework of the Study

The conceptual framework of this study was rooted in Constructivist theories of learning, particularly as articulated by Piaget and Vygotsky, which emphasize active engagement, social interaction, and the progression through cognitive stages in children's development. According to Constructivism, learners actively construct their understanding through interactions with their environment and with others. Manipulatives, such as mathematical spinner tools, align with these principles by providing tangible objects that allow learners to actively engage in hands-on, experiential learning.

Jean Piaget's Theory of Cognitive Development posits that children progress through distinct stages, including the concrete operational stage, where they can manipulate mental representations of concrete objects and apply logical reasoning. In this study, the use of manipulatives supports Piaget's idea by offering physical representations of abstract mathematical concepts like multiplication. By manipulating these tangible objects, learners bridge the gap between concrete experiences and abstract mathematical thinking, enhancing their understanding and cognitive development.

Lev Vygotsky's sociocultural theory adds another layer to the conceptual framework by emphasizing the role of social interaction and scaffolding in learning. The Zone of Proximal Development (ZPD), a key concept in Vygotsky's theory, suggests that learners can achieve more with guidance from a knowledgeable other. In the study, educators provide scaffolding through manipulatives, guiding learners within their ZPD to deepen their understanding of multiplication concepts collaboratively. This collaborative problem-solving not only supports learning within the ZPD but also fosters a social context where learners share insights and strategies, enriching their learning experience.

Aligned with these theoretical concepts, the study evaluated the newly developed mathematical spinner manipulatives in enhancing learners' multiplication skills. It assessed the manipulatives in terms of their content quality, organization, and instructional design, reflecting Constructivist principles of active engagement and effective learning tools. Through pre-test and post-test assessments, the study measured

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changes in learners' performance, aiming to identify significant improvements in multiplication skills attributed to the use of manipulatives.

In summary, the conceptual framework integrated Constructivist theories of learning, Piaget's stages of cognitive development, and Vygotsky's sociocultural theory to support the study's objectives of evaluating and improving mathematical spinner manipulatives for enhancing learners' multiplication skills.

Statement of the Problem

This study examined the effectiveness of mathematical spinner manipulatives in improving the multiplication abilities of Grade 5 learners in Doongan Integrated School, Butuan City.

Specifically, this study sought to address the following questions:

1. How do the experts evaluate the developed mathematical spinner manipulatives in terms of:
   1.1 content, presentation, and organization;
   1.2 accuracy and up-to-dateness of information; and
   1.3 instructional design?
2. What is the level of pre-test performance of the learners?
3. What is the level of performance of the learners after using the deve loped mathematical spinner manipulatives?
4. Is there a significant difference in the pre-test and post-test performances of the learners?
5. Based on the findings, how may the developed mathematical spinner manipulatives be enhanced?

Hypothesis of the Study

The null hypothesis was tested at 0.05 level of significance.

H_o. There is no significant difference in the pre test and post test performances of the learners.

Significance of the Study

The findings and results of the study will give valuable insights into the field of education particularly in the enhancement of multiplication skills of Grade 5 learners using the developed mathematical spinner manipulatives.

Specifically, the results of the study will be significant to the following:

Learners. The result of the study will provide effective methods to make math easier to understand and more enjoyable using manipulatives. This can improve their math skills and how they feel about learning mat

Teachers. The findings will contribute practical ways to use manipulatives in classrooms that cater to different ways learners learn. This can enhance how teachers teach math and how well learners learn it.

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School Administrators. The result will help the school administrators to decide where to spend money on math resources and training for teachers. This can make sure schools have what they need to teach math effectively.

Future Researchers. The result will contribute to what we know about teaching math with manipulatives. This can also lead to more research on how to teach other subjects better and help learners at different ages.

Scope and Limitation of the Study

The primary focus of the study is to assess the impact of newly developed spinner manipulatives on learners' multiplication skills. Further, it also measures the changes in student performance and identifies significant differences. Additionally, the study aimed to gather insights for improving these educational tools based on evaluation findings and test results.

The scope of the study was conducted at a Doongan Integrated School Butuan City, Agusan del Norte school. The school has a total of 166 grade five learners enrolled in academic year 2023-2024.

The study is limited only to the identified population of the learners above, and significant differences in the learners' performance on the pre-test and post-test using the number exercises activities prepared by the researcher.

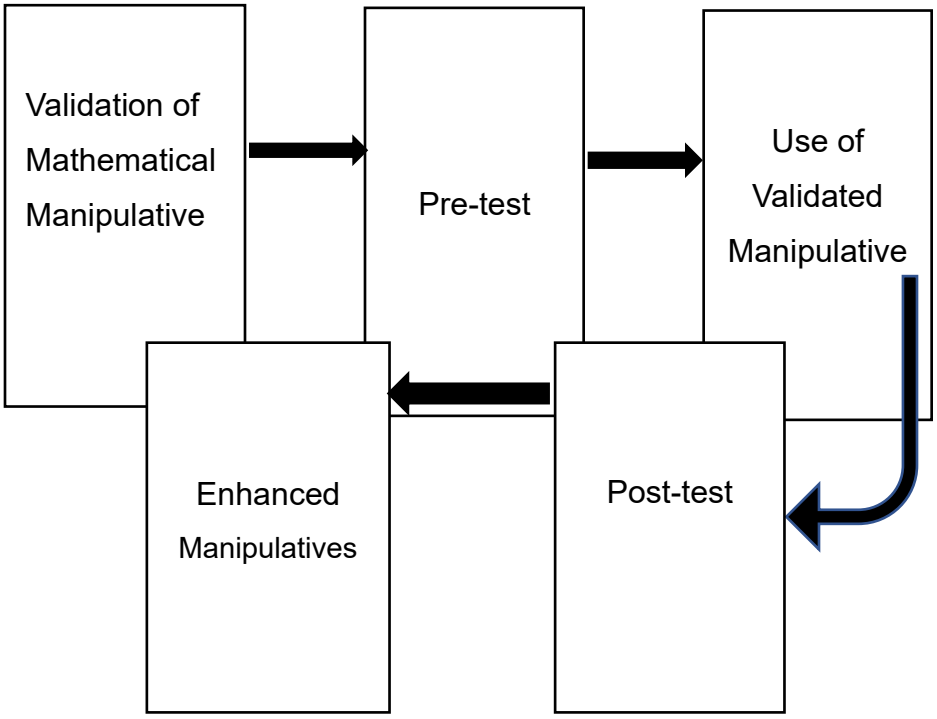

Figure 1. *Research Paradigm Showing the Research Flow of the Study*

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METHODS

This chapter presents the design of the study, research locale, the participants, sampling design, validity and reliability instrument, data gathering procedure, scoring and quantification of data, and statistical treatment of data. Details of the discussion are listed and enumerated in the succeeding paragraphs.

Research Design

This study employed a descriptive-evaluative research design to assess the impact of a specific intervention on a selected group of individuals. Specifically, the study designed an experiment to evaluate the efficacy of teaching multiplication skills using mathematical manipulatives compared to traditional teaching methods. By establishing an intact group, the researcher was able to compare outcomes and determine the effectiveness of each teaching approach. The findings indicated that these methods could enhance teaching practices and facilitate more effective learning among learners.

Research Locale

This study was conducted at Doongan Integrated School stands as a beacon of inclusive and holistic education. Doongan Integrated School is situated in Purok 2- Doongan , Butuan City. With a School ID No: 132056 , Doongan holds a diverse learners from Doongan area.

This school is renowned for its commitment to integrating learners from diverse backgrounds, fostering an environment where every child is valued and encouraged to thrive. The school's architecture blends functionality with child-friendly design, featuring bright, airy classrooms equipped with modern educational tools. Each space is thoughtfully crafted to stimulate learning and creativity among its young learners.

At the heart of Doongan's curriculum is a focus on both academic excellence and character development. The school offers a robust program encompassing traditional subjects like mathematics, science, and language arts, infused with innovative teaching methods to cater to various learning styles. The curriculum is enriched with arts, physical education, and technology, ensuring a well-rounded education.

What truly sets Doongan apart is its emphasis on community integration and cultural awareness. The school promotes inclusivity and respect for different cultures, preparing learners to be global citizens. Special programs highlighting environmental stewardship, community service, and leadership skills are part of the educational experience, instilling learners a sense of responsibility and empathy. The faculty at Doongan Integrated Elementary School is a dedicated team of educators who are not just teachers but mentors. They are committed to nurturing each student's potential, providing individualized attention to cater to their unique needs and aspirations.

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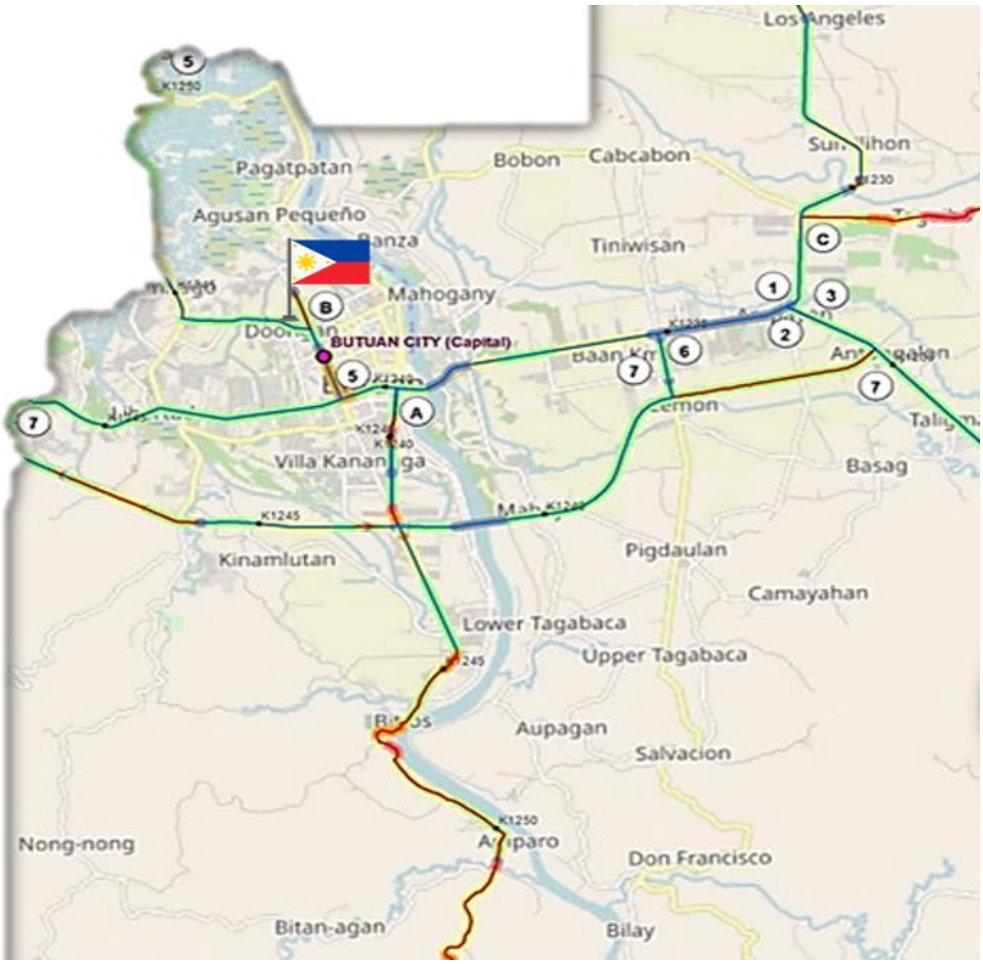

Figure. 2. Map of the Research Locale

Population and Participants of the Study

The study focused on a population comprising fifth-grade learners. The participants of the study are the Grade 5 students, in section Jade. The study used complete enumeration in selecting the participants. There are 22 male and 22 females in the distribution of the participants. The whole section was utilized as the intact group of the study.

Table 1. *Distribution of the Participants*

Male	%	Female	%	Total
22	50	22	50	44

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Sampling Design

The Grade 5 section Jade was utilized as the intact group of the study. The section comprises 22 males and 22 females, which shows the equal distribution of males and females in the sample. The pre-test was conducted to measure the initial multiplication competency of the Grade 5 learners. This serves as the basis of the multiplication competencies of the learners before the integration of the developed mathematical manipulatives. The post-test was conducted in the same intact group after 1 month of integration of the mathematical manipulatives in teaching mathematics.

On the other hand, the validators of the study were comprised of 5 teacher experts in validating the developed mathematical manipulatives.

Research Instrument

This study utilized the Evaluation 6.5 template of Guidelines and Processes for LRMDS assessment and Evaluation of the Department of Education. The Evaluation 6.5 template from the Department of Education is a structured tool used to ensure that learning resources meet certain quality standards. The instrument consists of three parts. Factor A is the first part, which evaluates the content. Factor A evaluates the accuracy of the facts, up-to-datedness, suitability of the visuals to the age level and interests of the learners, and also the layout. Factor B is the second part of the instrument, which evaluates the other findings. Factor B evaluates the conceptual errors, factual errors, grammatical errors, and other errors. The last part is factor C, which evaluates the additional requirements for manipulatives. Factor C specifically evaluates the instructional design and technical design. The adapted instrument also provided a section for comments from the evaluators on the manipulatives to highlight the strengths and weaknesses of the developed manipulatives.

Validation and Reliability of the Research Instrument

The research instrument that was utilized in this study was adapted from the (DepEd) standardized LRMDS evaluation template; thus, validation of the evaluation instrument had already been done by the content experts.

The pre- and post-intervention numeracy assessments have undergone a thorough validation process. This involved confirming that the assessments measured multiplication competencies. Validation procedures included expert reviews to assess the content relevance, clarity, and alignment with the intended learning objectives. To establish the reliability of these assessments.

Data Gathering Procedure

Pre- and post-intervention numeracy assessments were administered before and after the manipulative-based instruction. These assessments were given twice: once before the manipulative-based instruction (pre-intervention) and once after the instruction (post-intervention). The assessments were administered in controlled settings, ensuring that learners had a consistent and standardized environment

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for taking the tests. The assessments covered a range of multiplication skills and conceptual understanding. These skills were aligned with the learning objectives of the manipulative-based instruction.

After validating the mathematical manipulatives and administering the pre-test, teachers integrated the mathematical manipulatives into teaching multiplication to Grade 5 learners. The intervention period for using mathematical manipulatives in teaching multiplication competencies and conceptual understanding lasted about a month.

After a month of using the mathematical manipulatives, the learners took the post-test to measure their improvement in multiplication. After the data was

gathered, the researcher tallied and analyzed the collected data.

Scoring and Quantification of Data

Data gathered after the survey was sorted and interpreted using the following quantification of data.

Table 1. *Validity of Manipulatives*

Range	Scale	Verbal Description	Interpretation
3.01 – 4.00	4	Very Satisfactory	Very Effective
2.01 – 3.00	3	Satisfactory	Effective
1.01 – 2.00	2	Unsatisfactory	Ineffective
0.00 – 1.00	1	Very Unsatisfactory	Very Ineffective

Statistical Treatment

To evaluate if there are significant variations in numeracy skill development across groups (manipulative-based training vs. traditional education), inferential statistics such as a paired T-test were used. Statistical significance was assessed by setting a predetermined significance level (e.g., $p < 0.05$). If the p-value obtained from the paired T-test is less than the chosen significance level, it indicates that the observed differences in numeracy skill development are unlikely to have occurred by chance.

RESULTS AND DISCUSSION

Experts' Evaluation of the Developed Mathematical Spinner in terms of Content, Presentation, and Organization

Table 2 shows the experts' evaluation of the developed mathematical spinner in terms of content, presentation, and organization. The evaluation of the developed mathematical spinner manipulatives by experts reveals a highly favorable assessment in terms of content, presentation, and organization. The

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overall weighted mean of 4.00, which corresponds to a "Very Satisfactory" verbal description, suggests that the manipulatives are deemed "Very Effective" in reinforcing, enriching, and leading to the mastery of the number sense for Grade 5 learners' multiplication.

The consistency of ratings across all indicators is remarkable, as evidenced by the weighted mean of 4.00, implying the highest possible rating in the experts' assessments. This high rating emphasizes the experts' consensus on the manipulatives' effectiveness in addressing various aspects of content, presentation, and organization.

Table 2. *Experts' Evaluation of the Developed Mathematical Spinner in terms of Content, Presentation, and Organization*

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
1. Content reinforces, enriches, and / or leads to the mastery of certain learning competencies for the level and subject it was intended.	4.00	.000	Very Satisfactory	Very Effective
2. Material has the potential to arouse interest of the target users.	4.00	.000	Very Satisfactory	Very Effective
3. Facts are accurate	4.00	.000	Very Satisfactory	Very Effective
4. Information provided is up-to-date	4.00	.000	Very Satisfactory	Very Effective
5. Visuals are Relevant	4.00	.000	Very Satisfactory	Very Effective
6. Visuals are suitable to the age level and interests of the target user	4.00	.000	Very Satisfactory	Very Effective
7. Visuals are clear and adequately convey the message of the subject or topic.	4.00	.000	Very Satisfactory	Very Effective
8. Typographic layout/design facilitates understanding of concepts presented	4.00	.000	Very Satisfactory	Very Effective
9. size of the material is appropriate for use in school	4.00	.000	Very Satisfactory	Very Effective
10. The material is easy and durable	4.00	.000	Very Satisfactory	Very Effective
Overall Weighted Mean	4.00	.000	Very Satisfactory	Very Effective

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Legend:1.00-1.49-Not Satisfactory/Very Ineffective; 1.50-2.49-Poor/Ineffective; 2.50-3.49-Satisfactory/Effective; 3.50-4.00- Very Satisfactory/Very Effective

This evaluation suggested that the manipulatives have the potential to arouse interest among the target users, which is a crucial factor in fostering active engagement and enhancing the learning experience.

Capturing learners' interest can promote intrinsic motivation, leading to increased attention, persistence, and ultimately, better learning outcomes (Harackiewicz, J. et. al, 2018).

Furthermore, the affirmation of accurate and up-to-date information aligns with the principles of effective instructional design, which emphasize the importance of providing learners with reliable and relevant content (Pilgrim, 2020). By incorporating accurate and current information, the manipulatives can foster a deeper understanding of multiplication concepts and potentially mitigate the development of misconceptions.

The positive evaluation of the visuals' relevance, suitability, and clarity suggested that the manipulatives adhere to principles of multimedia learning, which suggests that well-designed visuals can enhance learning by complementing and reinforcing verbal information (Shabiralyani, 2015). This alignment with research-based principles increased the likelihood of the manipulatives effectively conveying the intended messages and concepts related to multiplication.

The favorable assessment of the typographic layout/design and the appropriateness of the material's size and durability for school use implied that the manipulatives are not only educationally sound but also practical and user-friendly. These factors contribute to a positive user experience, potentially increasing the manipulatives' acceptance and adoption among teachers and learners. This claim was supported by (Toh, 2021) that user-friendly instructional material can promote engagement and facilitate the learning process.

Overall, the experts' evaluation of the developed mathematical spinner manipulatives as "Very Effective" in terms of content, presentation, and organization suggests that the manipulatives have the potential to facilitate the learning of multiplication concepts for Grade 5 learners. The consistency of ratings across indicators reinforces the experts' consensus on the manipulatives' effectiveness, lending credibility to the evaluation.

Experts' Evaluation of the Mathematical Spinner in terms of Accuracy and Up-to-Date-ness of Information

The evaluation of the developed mathematical spinner manipulatives by experts, as depicted in Table 3, revealed a highly favorable assessment in terms of accuracy and up-to-datedness of information. The overall weighted mean of 4.00, corresponding to a "Very Satisfactory" verbal description, suggested that the manipulatives are deemed "Very Effective" in maintaining accuracy and providing current information related to the intended learning competencies for Grade 5 learners in the subject area of multiplication.

The consistency of ratings across all indicators is remarkable, as evidenced by the Weighted Mean of 4.00, implying the highest possible rating in the experts' assessments. This high rating emphasized the experts' consensus on the manipulatives' effectiveness in addressing various aspects of accuracy and up-to-datedness of information.

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Table 3. *Experts' Evaluation of the Mathematical Spinner in terms of Accuracy and Up-to-Date-ness of Information*

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
1. Conceptual errors	4.00	.000	Very Satisfactory	Very Effective
2. Factual errors	4.00	.000	Very Satisfactory	Very Effective
3. Grammatical and/or typographical errors	4.00	.000	Very Satisfactory	Very Effective
4. Other errors (i.e. computational errors, obsolete information, errors in the visuals, etc.)	4.00	.000	Very Satisfactory	Very Effective
Overall Weighted Mean	4.00	.000	Very Satisfactory	Very Effective

Legend:1.00-1.49-Not Satisfactory/Very Ineffective; 1.50-2.49-Poor/Ineffective; 2.50-3.49-Satisfactory/Effective; 3.50-4.00- Very Satisfactory/Very Effective

The evaluation indicated that the manipulatives are free from conceptual errors, factual errors, grammatical and typographical errors, as well as other errors such as computational errors, obsolete information, or errors in the visuals.

This level of accuracy is essential in ensuring that learners receive correct and reliable information, which can contribute to the development of accurate mental models and a solid understanding of multiplication concepts (Frankie & Yu, 2023). This was also supported by Bozdogan (2017), who stated that accurate instructional materials can help prevent the formation of misconceptions and facilitate effective learning

Furthermore, the absence of obsolete information in the manipulatives suggests that the content is up-to-date and aligned with current curricular standards and best practices in mathematics education. This alignment is crucial in ensuring the relevance and applicability of the manipulatives in the rapidly evolving educational landscape (Larbi, 2016). Up-to-date instructional materials can better prepare learners for future learning experiences and real-world applications of the acquired knowledge and skills.

According to Saunders (2020). The accurate and current information presented in the manipulatives can also contribute to building learners' confidence in their understanding of multiplication concepts. When learners encounter consistent and reliable information, they are more likely to trust the instructional materials and feel more confident in their ability to master the subject matter. This sense of confidence can

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foster a positive attitude towards learning and encourage further exploration and engagement with the subject.

Overall, the experts' evaluation of the developed mathematical spinner manipulatives as "Very Effective" in terms of accuracy and up-to-datedness of information suggested that the manipulatives have the potential to provide a robust foundation for learning multiplication concepts for Grade 5 learners. The consistency of ratings across indicators reinforces the experts' consensus on the manipulatives' effectiveness, lending credibility to the evaluation.

Experts' Evaluation of the Content in terms of Instructional Design

Spinner manipulatives demonstrated a highly positive assessment in terms of instructional design. The overall weighted mean of 3.80, corresponding to a "Very Satisfactory" verbal description, suggested that the manipulatives are deemed

Table 4. *Experts' Evaluation of the Content in terms of Instructional Design*

Indicators	Weighted Mean	SD	Verbal Description	Interpretation
1. Adequate support material is provided	3.20	.447	Satisfactory	Effective
2. Activities are summarized; extension activities are provided.	4.00	.000	Very Satisfactory	Very Effective
3. Suggested activities support innovative pedagogy.	4.00	.000	Very Satisfactory	Very Effective
4. Manipulative is safe to use.	4.00	.000	Very Satisfactory	Very Effective
5. Size and composition of manipulatives are appropriate for the intended audience.	4.00	.000	Very Satisfactory	Very Effective
6. Suggested Manual tasks within the activities are compatible with the motor skills of the intended users.	3.60	.548	Very Satisfactory	Very Effective
Overall Weighted Mean	3.80	.137	Very Satisfactory	Very Effective

Legend:1.00-1.49-Not Satisfactory/Very Ineffective; 1.50-2.49-Poor/Ineffective; 2.50-3.49-Satisfactory/Effective; 3.50-4.00- Very Satisfactory/Very Effective

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"Very Effective" in adhering to sound instructional design principles and facilitating the learning of multiplication concepts for Grade 5 learners.

Shown in Table 4 is the evaluation of the developed mathematical Spinner manipulatives, which demonstrates a highly positive assessment in terms of instructional design. The overall weighted mean of 3.80, corresponding to a "Very Satisfactory" verbal description, suggests that the manipulatives are deemed "Very Effective" in adhering to sound instructional design principles and facilitating the learning of multiplication concepts for Grade 5 learners.

While the overall assessment is favorable, it is noteworthy that the ratings across indicators exhibited a high rating, as evidenced shown in indicator 2,3,4 and 5 with a weighted mean of 4.00. Although a majority of the indicators were rated with a perfect score,it cannot be neglected that indicators 1 and 6 was, although high, rated below perfect score .This warrants a closer examination of the individual indicator ratings.

According to UNESCO (2023) their evaluation in manipulative indicates that the it provide adequate support materials, with a weighted mean of 3.20 and a verbal description of "Satisfactory." While this rating is positive, it suggested that there may be room for improvement in terms of supplementary materials or resources to further enhance the effectiveness of the manipulatives. Providing comprehensive support materials can aid in the proper implementation and integration of instructional resources (UNESCO, 2023).

On the other hand, the study of Koskinen & Pitkäniemi (2022). The experts have given high ratings for indicators related to the provision of summarized activities, extension activities, and support for innovative pedagogy. These positive evaluations suggested that the manipulatives aligned with contemporary approaches to mathematics instruction, which emphasize active learning, problem-solving, and the development of higher-order thinking skills. By incorporating these elements, the manipulatives have a high potential to foster a deeper understanding of multiplication concepts and promote student engagement.

Larbi (2016) stated that the manipulatives are safe to use and that their size and composition are appropriate for the intended audience of Grade 5 learners. These factors contribute to a positive learning experience and create an environment conducive to exploration and hands-on learning. The consideration of age-appropriate materials and safety aligns with best practices in instructional design and facilitates the effective utilization of the manipulatives.

Furthermore, the experts have rated the compatibility of suggested manual tasks with the motor skills of the intended users as "Very Satisfactory." This was supported by the study of Pullen & Lane (2021), who stated that evaluation suggests that the manipulatives are designed in a manner that aligns with the developmental capabilities of Grade 5 learners, promoting a seamless integration of physical interactions with the learning experience

Overall, their evaluation of the developed mathematical spinner manipulatives as "Very Effective" in terms of instructional design suggests that the manipulatives have the potential to facilitate the learning of multiplication concepts for Grade 5 learners through well-designed activities, appropriate support materials, and alignment with innovative pedagogical approaches. The variability in ratings across

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indicators highlighted areas for potential improvement while reinforcing the overall effectiveness of the manipulatives in adhering to sound instructional design principles.

Level of pre-test performance of the learners

The results of the pretest performance evaluation, as shown in Table 5, present a concerning picture, revealing significant gaps in the learners' proficiency in multiplication skills.

Table 5. *Pretest performance of the learners*

Grading Scale	Multiplying 1 digit by 1 digit		Multiplying 3 digits by 2 digits		Descriptive Rating
	n	%	n	%	
90-100	13	29.5	2	4.5	Outstanding
85-89	0	0	1	2.3	Very Satisfactory
80-84	0	0	1	2.3	Satisfactory
75-79	0	0	1	2.3	Fair
Below 75	31	70.5	39	88.6	Did not meet expectations
Total	44	100.0	44	100.0	

The data suggest that a substantial portion of the learners are struggling to meet the expected levels of competency in these crucial mathematical operations, which serve as foundational building blocks for more advanced concepts and problem-solving strategies.

In the area of multiplying single-digit numbers, a population of 70.5% of learners scored below 75, indicating that they "Did not meet expectation." This finding is particularly alarming, as mentioned by the study of Aguhayon, et. al. (2023), the ability to fluently multiply single-digit numbers is a fundamental skill that forms the basis for more complex mathematical operations and problem-solving

Without a solid grasp of this foundational skill, learners may face significant challenges in comprehending and applying more advanced concepts that build upon this knowledge at the higher grade level.

The situation becomes even more concerning when examining the learners' performance in multiplying three-digit numbers by two-digit numbers. An overwhelming majority of 88.6% of learners scored below 75, failing to meet expectations in this area. Only 4.5% of learners achieved an "Outstanding" rating, and a combined 4.6% scored in the "Very Satisfactory" and "Satisfactory" ranges. This explains that the learners did not meet the expected outcomes during their schooling in distance learning due to COVID-19-related reasons.

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As supported by Sönmez and Alptekin (2020), most learners are grappling with multi-digit multiplication, a skill that is essential for solving real-world problems and advancing in higher-level mathematics.

The implications of these pretest results are complex, emphasizing the importance of implementing specific measures and instructional strategies to address the identified multiplication skill gap. Firstly, the low performance levels in these foundational areas may hinder the learners' ability to grasp more advanced mathematical concepts and problem-solving techniques that build upon these basic operations (Sönmez, & Alptekin, 2020). This could potentially lead to a widening achievement gap and further learning difficulties as learners progress through the curriculum, ultimately impacting their overall academic performance and future prospects.

Furthermore, Aguhayon et al. (2023) mentioned that the lack of proficiency in multiplication skills may also impact learners' self-confidence and motivation in mathematics. Learners who struggle with these basic operations may develop negative attitudes towards the subject, leading to disengagement, anxiety, and a perpetuation of the learning challenges. This, in turn, can create a vicious cycle where low self-confidence and motivation further exacerbate the existing learning gaps.

Level of post-test performance of the learners after using the developed mathematical spinner manipulatives.

Table 6 shows the posttest result of the study. The posttest performance results reveal a remarkable improvement in the learners' proficiency in multiplication skills after utilizing the developed mathematical spinner manipulatives. This positive shift suggests that the intervention, which involved the use of these manipulatives, has been effective in enhancing the learners' understanding and mastery of these fundamental mathematical operations.

In the area of multiplying single-digit numbers, a striking 90.9% of learners achieved an "Outstanding" rating, scoring between 90-100. This significant improvement from the pretest results, where only 29.5% of learners were in the "Outstanding" category. Abarquez (2020) highlighted the potential of the mathematical spinner manipulatives in fostering a deeper understanding of multiplication. The concrete and hands-on nature of the manipulatives may have facilitated the development of a stronger conceptual foundation, leading to improved procedural fluency and accuracy.

Table 6. *Posttest performance of the learners*

Grading Scale	Multiplying 1 digit by 1 digit		Multiplying 3 digits by 2 digits		Descriptive Rating
	n	%	n	%	
90-100	40	90.9	22	50	Outstanding
85-89	2	4.5	5	11.4	Very Satisfactory
80-84	1	2.3	4	9.1	Satisfactory

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75-79	0	0	2	4.5	Fair
Below 75	1	2.3	11	25	Did not meet expectations
Total	44	100.0	44	100.0	

The concrete and hands-on nature of the manipulatives may have facilitated the development of a stronger conceptual foundation, leading to improved procedural fluency and accuracy.

Similarly, in the domain of multiplying three-digit numbers by two-digit numbers, there was a notable increase in the number of learners performing at higher levels. A combined 70.5% of learners scored in the "Outstanding", "Very Satisfactory", and "Satisfactory" categories, compared to only 9.1% in the pretest. This improvement explains that the students were really engaged in the manipulatives.

Abarquez (2020) mentioned that the manipulatives were effective in supporting the learners' understanding of multiplication, a skill that is essential for problem-solving and higher-level mathematics.

The positive posttest outcomes associated with the integration of manipulatives in mathematics instruction offer complex implications. Primarily, the enhanced student performance suggested a more concrete understanding of multiplication skills. These foundational concepts serve as critical building blocks for comprehending advanced mathematical constructs and problem-solving methodologies, as mentioned by Abarquez (2020). This enhanced understanding can potentially reduce the achievement gap and better prepare learners for future academic challenges.

Furthermore, the study of Hwang and Son (2021) stated that the success experienced by learners after using the manipulatives may have a positive impact on their self-confidence and motivation in mathematics. When learners experience tangible progress and achievement, it can foster a growth mindset and increase their willingness to persist in the face of challenges. This positive attitude towards mathematics can create a virtuous cycle where improved self-confidence and motivation further reinforce learning and academic success.

Overall, the posttest performance results highlighted the potential of the developed mathematical spinner manipulatives in enhancing multiplication skills among Grade 5 learners. The positive outcomes emphasized the importance of incorporating research-based instructional strategies and resources that cater to diverse learning needs and facilitate the development of foundational mathematical concepts.

Test of significant difference in the pre-test and post-test performances of the learners

The Table presents the results of a paired t-test analysis conducted to compare the pretest and posttest scores of learners in three specific competencies: multiplying 1 digit by 1 digit, multiplying 3 digits and by 2 digits. The paired t-test was employed to determine if there was a significant difference in the pretest and posttest scores of the learners. Results showed that there were very significant differences between the pretest and posttest scores of the learners along the competencies of multiplying 1 digit by 1 digit (t=9.441; p=.000); multiplying 3 digits and by 2 digits (t=14.075; p=.000). Thus, the null hypothesis is rejected. The result implies that the mathematical spinner was effective in enhancing learners' performance across three

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competencies (multiplying 1 digit by 1 digit, multiplying 3 digits and by 2 digits). This explains that the manipulative helped the students to engage in learning.

Table 7. *Paired t-test between Pretest and Posttest Scores of the Learners*

Competencies	Mean Difference	SD	t	p-value	Decision on H_o	Interpretation
Multiplying 1 digit by I digit	44.98	31.602	9.441**	.000	Reject H_o	Significant
Multiplying 3 digits by 2 digits	10.84	5.120	14.075**	.000	Reject H_o	Significant

**significant @ p<.01

These findings resonate with the study of Murad and Daniel (2022), which stressed that manipulatives can make abstract mathematical concepts more tangible, leading to better comprehension and engagement among learners.

The significant improvements observed across all three competencies suggested that the developed mathematical spinner manipulatives have the potential to address learning gaps and enhance conceptual understanding in a holistic manner. As mentioned by the theory of Vygotsky (1987) who states that by providing a hands-on and interactive approach to learning, these manipulatives may have fostered increased engagement, motivation, and active participation among learners, factors that are known to contribute to better learning outcomes.

Initially, learners felt unsure about using manipulatives for multiplication, a common hesitation when introducing concrete representations according to research, but with practice and guidance, they became more comfortable and engaged, leading to a deeper understanding. Notably, learners showed a shift from finger counting to a stronger grasp of multiplicative structures in single-digit multiplication, while manipulatives helped visualize the challenging regrouping process in multi-digit multiplication. Overall, the use of manipulatives led to increased confidence, a washiness to tackle harder problems, a growth mindset in math, more probing questions, collaborative learning experiences, and an appreciation for manipulatives as learning tools, suggesting their alignment with Vygotsky's (1978) Zone of Proximal Development Theory, where they function as a temporary support system bridging the gap between current abilities and potential understanding, ultimately leading to independent mastery of multiplication skills.

Based on the findings, how may the developed mathematical spinner manipulatives be enhanced?

The study highlighted the effectiveness of the mathematical spinner manipulatives in improving multiplication skills. However, it is important to note that there are areas of the manipulatives that need to be improved.

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In terms of targeted instruction, to address skill gaps identified in the pretest, teachers can use a differentiated instruction guide with activities tailored to various learning styles. Visual learners might benefit from multiplication charts or color-coded manipulatives, while struggling learners can benefit from scaffolding techniques with the manipulatives.

As to enriching instructional materials, a detailed activity is mentioned by UNESCO (2023). Guides with clear instructions and lesson plans can aid teacher adoption and curriculum integration

Supported by Larbi et al. (2016), as he mentioned that clear manipulative guides should include learning objectives, activities, assessment strategies, and differentiation suggestions. Additionally, incorporating word problems that utilize multiplication in real-world contexts can promote deeper understanding and critical thinking.

On the other hand, manipulative design and functionality can also be improved. While the manipulatives were user-friendly, incorporating multi-sensory elements like texture or sound can further cater to diverse learners (Pullen & Lane, 2021). Ensuring durable materials and providing appropriate storage containers are crucial for long-term use.

Also, in the perspective of teacher training in crafting manipulatives, ensuring successful implementation, professional development workshops can equip teachers with the necessary skills and strategies as cited by UNESCO (2023). Online resources and an educator community can provide ongoing support and encourage collaboration.

Summary

The integration of manipulatives, physical objects that represent mathematical concepts, has become increasingly popular in math education, especially in improving multiplication skills among fifth-grade students. These tangible tools cater to various learning styles, making math more engaging, accessible, and understandable for learners of different abilities.

This study aimed to investigate how effectively manipulatives can be used in teaching to enhance conceptual understanding, problem-solving skills, and overall math proficiency. The study explored questions such as how experts assess newly developed mathematical spinner manipulatives in terms of content, accuracy, and instructional design. It also examined the performance differences between pre-tests and post-tests among students, evaluating whether these differences can be attributed to the use of manipulatives. Using a descriptive evaluation approach, the research compared the impact of manipulatives versus traditional teaching methods, offering insights into effective educational practices. The study focused on grade 5 learners from a specific school in Butuan City, with a sample of 166 students selected through purposive and stratified sampling to ensure representation across academic and socioeconomic factors.

Findings

Firstly, the developed mathematical spinner manipulatives received highly favorable evaluations from experts in terms of content, presentation and organization (Overall Weighted Mean of 4.00), accuracy and up-to-datedness of information, (Overall Weighted Mean is 4.00) and instructional design (Overall Weighted Mean is 3.80).

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Another finding that this study found is that the pretest results revealed significant gaps in learners' proficiency in multiplication skills, with a substantial member of learners failing to meet expectations in these areas.

Moreover, the posttest results showed remarkable improvement in the learners' performance after using the mathematical spinner manipulatives, with a significant increase in the number of learners achieving "Outstanding" ratings in multiplying single-digit numbers, multiplying three-digit and by two-digit numbers.

The paired t-test analysis revealed statistically significant differences between the pretest and posttest scores across all three competencies (multiplying 1 digit by 1 digit, multiplying 3 digits and by 2 digits), indicating that the mathematical spinner manipulatives were effective in improving learners' performance. the paired t-test was conducted to determine whether there was a significant difference between the learners' pretest and posttest scores in multiplication. In multiplying 1 digit by 1 digit, the mean difference was 44.98, with a t-value of 9.441 and a p-value of 0.000. Since the p-value is less than 0.01, the result is statistically significant. In multiplying 3 digits by 2 digits, the mean difference was 10.84, with a t-value of 14.075 and a p-value of 0.000, also showing a highly significant difference

5. Furthermore, the use of manipulatives facilitated a deeper understanding of multiplication concepts, promoted engagement, motivation, and active participation among learners, and aligned with Vygotsky's Zone of Proximal Development theory by providing temporary support to bridge the gap between current abilities and potential understanding.

Conclusions

Based on the results and the findings of the study, the conclusions are drawn.

1. The developed mathematical spinner manipulatives were evaluated as highly effective instructional tools. Experts gave favorable ratings in content, accuracy, presentation, and instructional design, confirming their quality and potential to facilitate learning.

2. The pretest results, which revealed significant gaps in learners' multiplication skills, emphasized the importance of intervention. The manipulatives directly addressed these gaps by providing structured, engaging, and research-based learning support.

3. The posttest results confirmed the effectiveness of the intervention, with remarkable improvements in learners' multiplication performance. Most learners achieved outstanding levels in both single-digit and multi-digit multiplication after using the manipulatives.

4. Statistical analysis through paired t-tests further validated the effectiveness of the manipulatives. Significant differences between pretest and posttest scores across all multiplication competencies confirmed their strong positive impact on learners' performance.

5. Finally, the use of manipulatives not only improved performance but also deepened learners' conceptual understanding, fostered motivation, engagement, and participation, and aligned with Vygotsky's Zone of Proximal Development theory by providing scaffolding support that bridged gaps between current and potential learning.

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6. Overall, the findings of this study provided compelling evidence for the potential of the developed mathematical spinner manipulatives in revolutionizing the teaching and learning of multiplication concepts for Grade 5 learners. The positive outcomes, supported by expert evaluations, quantitative data, and observations, emphasized the importance of integrating research-based manipulatives and interactive instructional strategies in mathematics education.

Recommendations

Based on the findings of the study, the following recommendations are drawn.

1. The teachers may integrate mathematical spinner manipulatives into their regular instructional practices to enhance student engagement and understanding. Providing differentiated instruction that caters to individual learning needs and proficiency levels may ensure that all learners benefit from manipulative-based learning experiences. Ongoing professional development opportunities focused on innovative pedagogical approaches and the effective use of manipulatives may empower teachers to maximize the impact of these tools in the classroom.
2. School administrators play a vital role in supporting the implementation of manipulative-based instructional strategies. They may allocate resources and provide logistical support to facilitate the integration of manipulatives into classroom instruction. Promoting professional collaboration among teachers and fostering a culture of sharing best practices may amplify the impact of manipulative-based approaches across the school community. Advocating for the inclusion of manipulative-based strategies in school improvement plans may emphasize their importance in enhancing student achievement and engagement.
3. Department of Education leaders may provide comprehensive guidelines and resources for effectively integrating manipulative-based approaches into mathematics education at all levels. Supporting research and development initiatives aimed at exploring innovative instructional methods may drive continuous improvement in math education. By prioritizing initiatives focused on improving foundational math skills through effective pedagogy and instructional tools like manipulatives, the Department of Education can contribute to the overall enhancement of math education outcomes nationwide.
4. Future researcher may leverage the transformative potential of mathematical spinner manipulatives to enhance student proficiency in multiplication through a separate study. The different direction of a further study may ultimately foster a deeper and more meaningful understanding of fundamental mathematical concepts among Grade 5 learner.

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