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Interactive Manipulatives in Enhancing Grade 7 Conceptual Understanding and Procedural Skills

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INTRODUCTION

Developing learners' conceptual understanding and procedural skills is one of the primary goals of mathematics education. However, many Grade 7 learners continue to face difficulties in understanding abstract mathematical concepts, interpreting word problems, and carrying out mathematical procedures accurately. These learning challenges are often associated with the limited use of interactive instructional materials in the classroom. Recognizing this concern, the present study developed and evaluated the MATHATAG Cube, an interactive manipulative designed to provide meaningful and engaging learning experiences aligned with the Department of Education's MATATAG Curriculum.

Objectives

This study aimed to identify the learning difficulties encountered by Grade 7 learners in terms of conceptual understanding and procedural skills, develop an interactive manipulative that responds to these identified needs, determine the acceptability of the MATHATAG Cube in terms of content quality, instructional quality, technical quality, and other qualities, and examine whether significant differences existed in the evaluations of school administrators and mathematics teachers.

Methods

The study employed a quantitative descriptive research design. Thirty (30) Grade 7 mathematics teachers from public secondary schools in District 1, Quezon City, participated through total enumeration to identify learners' instructional needs and validate the developed instructional material. The MATHATAG Cube was likewise evaluated by 30 mathematics teachers, 10 school heads, and 5 department heads using a researcher-developed validation checklist. Descriptive statistics, including frequency, percentage, weighted mean, and grand mean, were used to analyze the data, while one-way Analysis of Variance (ANOVA) determined whether significant differences existed among the validators' assessments.

Results and Discussion

The findings showed that Grade 7 learners commonly struggled with understanding abstract concepts, interpreting mathematical problems, performing accurate computations, and completing multi-step solutions. In response to these challenges, the MATHATAG Cube was developed as a six-faced interactive manipulative that supports hands-on learning across the major competencies of the Grade 7 Mathematics curriculum. The instructional material received overall ratings ranging from 4.52 to 4.62, interpreted as **Very Acceptable**, across all evaluation criteria. Although the ANOVA results revealed significant differences in the ratings given by teachers, school heads, and department heads, all groups consistently evaluated the MATHATAG Cube positively, indicating that it is appropriate, practical, and aligned with curriculum standards. These findings suggest that interactive manipulatives can make mathematics lessons more engaging while helping learners better understand mathematical concepts and perform procedures with greater confidence and accuracy.

Conclusion

The study concludes that the MATHATAG Cube is a highly acceptable instructional manipulative that effectively addresses the conceptual and procedural learning needs of Grade 7 learners. By providing concrete and interactive learning experiences, it has the potential to improve learners' understanding of mathematics and support more meaningful classroom instruction. The study recommends the integration of the MATHATAG Cube into Grade 7 mathematics classes as a supplementary instructional material and encourages future studies to examine its effectiveness in improving learners' academic achievement and higher-order thinking skills in different educational settings.

THE PROBLEM AND ITS BACKGROUND

Introduction

Mathematics education worldwide continues to grapple with the challenge of making abstract concepts accessible to learners, particularly at the middle school level, where the transition from concrete arithmetic to abstract algebraic reasoning often proves difficult. Scholars have consistently highlighted the role of manipulatives—both physical and virtual—in bridging this gap between abstract reasoning and concrete understanding. Bouck and Flanagan (2010) argued that virtual manipulatives are not simply digital replicas of physical tools but flexible pedagogical instruments that allow teachers to scaffold learning in ways traditional methods cannot, reducing cognitive load by externalizing abstract ideas into manipulable forms. Bouck, Mathews, and Peltier (2020) extended this argument by demonstrating that manipulatives are particularly effective for middle school students with disabilities, underscoring their equity dimension by democratizing mathematical learning. Carbonneau et al. (2020) added another layer by showing that perceptually rich manipulatives, when combined with collaborative learning, foster perseverance and problem-solving skills, reframing manipulatives as catalysts for socio-cognitive development rather than mere cognitive scaffolds. Collectively, these global perspectives establish manipulatives as essential instructional strategies for promoting both conceptual understanding and procedural fluency.

In the Philippine context, mathematics instruction faces systemic challenges such as low student motivation, reliance on traditional teaching methods, and persistent difficulties in mastering abstract concepts. These issues are symptomatic of broader structural conditions in education, where rote memorization often dominates classroom practice. Asuncion, Balios, and Parcon (2025) introduced the INTER strategy (Identify, Note, Track, Evaluate, Review) to enhance Grade 7 students' problem-solving skills in simple interest, demonstrating the necessity of structured, step-wise interventions in contexts where learners struggle with cognitive overload. Baraquiel Cenita (2024) highlighted the use of indigenous manipulatives to strengthen computational skills, situating learning within familiar cultural contexts that resonate with Filipino learners. This intervention challenges the dominance of imported instructional models by asserting the value of localized, culturally relevant resources. Analytically, these studies reflect a growing emphasis on learner-centered and competency-based approaches consistent with the Department of Education's MATATAG curriculum, which underscores the need for materials that are not only effective but also culturally responsive.

Local classroom-based interventions further demonstrate the effectiveness of manipulatives in enhancing Grade 7 students' mathematical proficiency. Magto & Salazar (2025) reported that tangible mathematics manipulatives significantly improved learner understanding, problem-solving skills, and engagement in rational number operations compared to traditional instruction, revealing that manipulatives transform classroom dynamics by fostering active participation. Obut et al. (2024) found that manipulating real objects enhanced retention among students struggling with concepts of angles, supporting constructivist theories that knowledge is actively constructed through concrete experiences. Gregorio & Rabut (2024) showed that strategic intervention materials using LUMI Education improved both conceptual understanding and procedural fluency, demonstrating that localized instructional innovations can directly impact student outcomes. These findings affirm that interactive manipulatives are effective, acceptable, and contextually appropriate instructional tools for addressing the persistent challenges of Grade 7 mathematics instruction in District 1 of Quezon City. They also demonstrate that manipulatives foster learner engagement, reduce mathematics anxiety, and provide culturally relevant, competency-based resources aligned with the MATATAG curriculum.

The convergence of these findings underscores the pedagogical value of manipulatives as practical solutions to the difficulties encountered by teachers and learners, thereby validating their integration into classroom practice and institutional evaluation. The theoretical foundation of manipulative-based instruction is rooted in Constructivist Learning Theory and Bruner's Theory of Representation. Piaget's constructivism emphasizes that learners progress from concrete to abstract reasoning when provided with opportunities to manipulate objects and engage in problem-solving tasks, while Bruner's representational stages—enactive, iconic, and symbolic—explain how manipulatives scaffold learners' transition from action-based experiences to abstract reasoning. These theories justify the integration of manipulatives as tools for active exploration and developmental sequencing, providing a coherent framework for understanding why manipulatives are effective: they align with the natural progression of cognitive development.

The integration of manipulatives into classroom practice has broader institutional and policy implications. Validation studies such as those by Gregorio & Rabut (2024) demonstrate that instructional materials must meet standards of content accuracy, instructional soundness, and technical usability. Bouck et al. (2020) emphasize that manipulatives, when systematically evaluated, support access and achievement among diverse learners, underscoring the importance of institutional validation processes in ensuring that instructional innovations are not only effective but also acceptable within the broader educational system. The adoption of manipulatives therefore requires not only pedagogical justification but also institutional endorsement, ensuring sustainability and scalability.

Despite the growing body of evidence, gaps remain in the research on manipulative-based instruction in the Philippine context. Most studies focus on specific strands of mathematics or particular grade levels, leaving questions about scalability and adaptability unanswered. Bouck & Park (2018) call for systematic reviews to understand how manipulatives support students with disabilities across contexts, while Keldgord & Ching (2022) highlight the need to explore virtual manipulatives in post-pandemic learning environments. This points to the necessity of further research on the flexibility of manipulatives across grade levels, subject strands, and delivery modes, including online and blended learning. The present study is situated within this analytical landscape. By focusing on Grade 7 mathematics instruction in District 1 of Quezon City, it addresses a localized but critical problem: the persistent difficulty of learners in mastering both conceptual and procedural knowledge. The design and validation of the MATHATAG Cube respond directly to these challenges, offering a manipulative-based solution that is both pedagogically sound and contextually relevant. This study contributes to the broader discourse on innovative mathematics instruction by demonstrating how localized interventions can align with global best practices while addressing specific contextual needs.

In conclusion, the analytical review of global, national, and local studies establishes a compelling case for the integration of manipulatives into Grade 7 mathematics instruction. The convergence of evidence demonstrates that manipulatives are effective, acceptable, and contextually appropriate tools for addressing persistent instructional challenges. The theoretical foundations provide a coherent rationale for their use, while institutional validation ensures their acceptability. The present study, through the design and validation of the MATHATAG Cube, seeks to contribute to this discourse by offering a localized, research-based solution to the challenges of mathematics instruction in District 1 of Quezon City.

Theoretical Framework

This study is anchored on Constructivist Learning Theory, which posits that learners actively construct knowledge through meaningful experiences and interactions with their environment. In the context of Grade 7 mathematics classrooms in District 1 of Quezon City, students often struggle with abstract reasoning and procedural accuracy. Piaget's theory of cognitive development emphasizes that learners progress from concrete to abstract reasoning when provided with opportunities to manipulate objects and engage in problem-solving tasks. In mathematics education, manipulatives serve as concrete representations that allow learners to visualize abstract concepts, thereby facilitating the transition toward higher-order thinking. The constructivist perspective underscores the importance of experiential learning, where students are not passive recipients of information but active participants in building their own understanding.

Complementing this is Bruner's Theory of Representation, which highlights the progression of learning through three modes: enactive (action-based), iconic (image-based), and symbolic (language-based). Bruner (1966) argued that learners grasp mathematical concepts more effectively when instruction begins with concrete experiences before moving toward abstract symbols. Interactive manipulatives align with this framework by providing enactive and iconic experiences that scaffold students' movement toward symbolic reasoning. For Grade 7 learners, manipulatives such as fraction tiles, algebra blocks, and geometric models serve as bridges between tangible experiences and abstract mathematical procedures, ensuring that learning is both accessible and developmentally appropriate.

The relevance of these theories lies in their shared emphasis on the role of concrete experiences and scaffolding in promoting deeper mathematical understanding. Constructivism justifies the integration of manipulatives as tools for active exploration, while Bruner's representational stages explain how these tools facilitate the gradual internalization of abstract concepts. Together, they provide a strong theoretical foundation for the use of interactive manipulatives in mathematics instruction, particularly in addressing the challenges of conceptual understanding and procedural fluency among Grade 7 learners in District 1 of Quezon City.

By grounding the study in these two theories, the research establishes a clear rationale for the design and implementation of interactive manipulatives. Constructivist principles ensure that learners engage meaningfully with mathematical tasks, while Bruner's representational framework guarantees that instructional materials are developmentally sequenced to support comprehension. This dual-theoretical foundation strengthens the study's objective of enhancing Grade 7 students' mathematical learning outcomes, making the intervention both pedagogically sound and contextually relevant to the realities of classroom practice in District 1.

Conceptual Framework

The conceptual framework of this study presents a systematic process for addressing the instructional challenges encountered by Grade 7 mathematics teachers in District 1 of Quezon City. It begins with the identification of problems experienced by learners, including difficulties in understanding abstract mathematical concepts, applying procedures accurately, and engaging meaningfully in mathematics lessons. These identified challenges serve as the basis for the development of an appropriate instructional intervention.

The second stage involves the development of the MATHATAG Cube, an interactive manipulative aligned with the Department of Education's MATATAG Curriculum. Grounded in Constructivist Learning Theory and Bruner's Theory of Representation, the manipulative is designed to provide concrete and interactive learning experiences that help learners visualize mathematical concepts, strengthen conceptual understanding, and develop procedural skills.

The final stage focuses on the validation and evaluation of the MATHATAG Cube by mathematics teachers, school heads, and department heads. The instructional material is assessed in terms of content quality, instructional quality, technical quality, and other qualities to determine its acceptability and suitability for Grade 7 Mathematics instruction. This framework demonstrates how identified instructional needs guide the development and validation of an instructional material that supports meaningful mathematics learning.

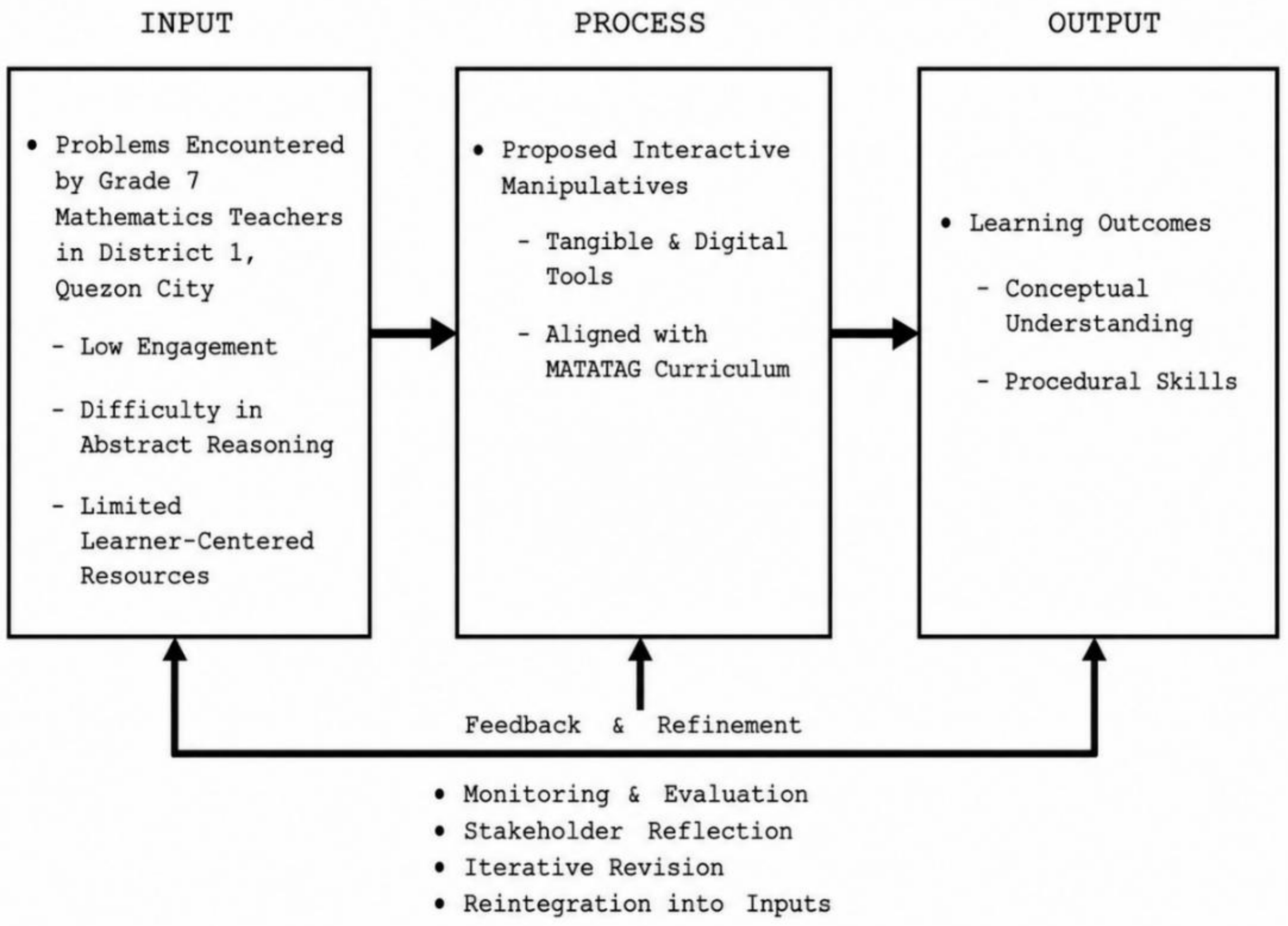

Figure 1 Research Paradigm of the Study

Statement of the Problem

This study is anchored on the premise that effective mathematics instruction requires both conceptual understanding and procedural fluency, particularly among Grade 7 learners who often struggle with abstract reasoning and computational accuracy. In District 1 of Quezon City, teachers have reported recurring challenges in facilitating mastery of foundational mathematics concepts due to limited learner-centered materials and the predominance of traditional teaching approaches. These instructional gaps highlight the need for innovative, interactive, and contextually relevant learning tools that can bridge the divide between theory and practice.

To address these concerns, the present study investigates the use of interactive manipulatives as instructional supports designed to enhance students' conceptual understanding and procedural skills. The research focuses on identifying the specific problems encountered by Grade 7 learners, developing manipulative-based learning materials aligned with the Department of Education's MATATAG curriculum, and determining their acceptability as evaluated by school administrators and mathematics teachers. Furthermore, the study examines whether significant differences exist between the assessments of these two respondent groups, thereby providing insights into the consistency and validity of the proposed instructional intervention.

Specifically, this research seeks to answer the following sub-problems:

1. What are the problems encountered by the Grade 7 learners with regards to:

1.1. Conceptual understanding

1.2. Procedural skills

2. Based on the problems encountered, what learning materials may be proposed?

3. How acceptable is the proposed support instructional material as assessed by school administrators and math teachers in terms of:

3.1. Content Quality

3.2. Instructional Quality

3.3. Technical Quality

3.4. Other Qualities

4. Is there a significant difference between the assessment of the school administrators and math teachers on the above-mentioned variables?

Hypothesis of the Study

The researcher claimed that there is no significant difference between the assessment of the school administrators and math teachers on the above-mentioned variables.

Scope and Limitation of the Study

The scope of this study focuses on the use of interactive manipulatives in enhancing the conceptual understanding and procedural skills of Grade 7 learners in mathematics. The research covers selected strands of the MATATAG Curriculum, specifically numbers and number sense, algebraic expressions, linear equations, ratios and percent, geometry, and data and statistics. The study involves Grade 7 mathematics teachers in selected public schools in District 1 of Quezon City, where the proposed manipulatives will be designed, and validated. Both qualitative and quantitative data will be gathered through teachers' validation checklists to determine the effectiveness and acceptability of the instructional materials. The evaluation will also include feedback from school administrators and mathematics teachers, ensuring alignment with the Department of Education's evaluation standards.

The limitations of the study include its confinement to District 1 of Quezon City, which may restrict the generalizability of findings to other districts or regions. It is also limited to Grade 7 mathematics, excluding other grade levels and subject areas. Furthermore, the effectiveness of the manipulatives will be measured within a specific implementation period, which may not capture long-term retention or transfer of skills. External factors such as student motivation, teacher facilitation styles, and resource availability may influence the outcomes, and these variables are beyond the direct control of the researcher.

Significance of the Study

This study holds significance for multiple educational stakeholders by addressing persistent instructional challenges in Grade 7 mathematics within District 1 of Quezon City through the integration of interactive manipulatives.

For teachers, the research provides empirically validated instructional tools that respond to classroom realities such as low student engagement, difficulty in abstract reasoning, and limited access to learner-centered resources. The manipulatives are designed to align with the Department of Education's MATATAG curriculum, offering structured, competency-based materials that enhance instructional delivery and scaffold student learning. By situating the intervention in District 1, the study ensures that the tools are contextually relevant and responsive to local classroom needs.

For students, the use of interactive manipulatives is expected to strengthen both conceptual understanding and procedural fluency by providing concrete representations of mathematical ideas. These tools promote active learning, reduce mathematics anxiety, and foster deeper engagement with problem-solving tasks, thereby supporting holistic mathematical development.

For school administrators, the findings of this study can inform decisions on resource allocation, instructional planning, and professional development initiatives. The evaluation of manipulatives by administrators alongside teachers ensures that the intervention is not only pedagogically sound but also institutionally acceptable, aligning with DepEd's validation standards.

Finally, for researchers, the study contributes to the broader discourse on innovative and inclusive teaching strategies in mathematics. Its methodology and results provide a foundation for further exploration of manipulative-based instruction, particularly in the Philippine context where localized, learner-centered approaches are increasingly emphasized.

Definition of Terms

For clarity and consistency, the following terms are operationally defined as they are used in this study.

Conceptual Understanding – refers to the ability of Grade 7 learners to grasp mathematical ideas and principles, measured through their performance in pre-test and post-test items that assess comprehension of abstract concepts.

Content Quality – refers to the accuracy and relevance of the mathematical concepts embedded in the MATHATAG Cube, measured through expert ratings in the validation checklist.

Instructional Quality – refers to the pedagogical soundness of the MATHATAG Cube, measured by its effectiveness in supporting teaching strategies and learner engagement as rated by validators.

MATHATAG Cube – refers to the three-dimensional manipulative developed in this study, featuring six interactive faces aligned with the MATATAG curriculum strands, used by learners during classroom instruction.

Other Qualities – refers to additional attributes of the MATHATAG Cube such as creativity, innovativeness, and learner appeal, measured through validator ratings in the checklist.

Procedural Skills – refers to the learners' ability to apply mathematical procedures accurately, measured by their performance in solving computational and multi-step problems in the assessment tools.

Teacher Problem Identification Checklist – refers to the structured survey instrument administered to Grade 7 mathematics teachers, designed to capture recurring instructional challenges, resource gaps, and pedagogical constraints.

Technical Quality – refers to the usability, durability, and functionality of the MATHATAG Cube as a classroom tool, measured through validator assessments of its design and practicality.

REVIEW OF RELATED LITERATURE AND STUDIES

Local Literature

Philippine literature on mathematics education emphasizes the integration of learner-centered approaches to address persistent instructional challenges. Gregorio & Rabut (2024) discussed the use of strategic intervention materials through LUMI Education, highlighting their role in improving conceptual understanding and procedural fluency. Their work underscores the importance of innovative instructional materials that align with DepEd standards. Magto & Salazar (2025) provided insights into tangible mathematics interventions, emphasizing their impact on learner engagement and problem-solving skills. These contributions reflect the growing emphasis on contextualized instructional strategies in Philippine literature.

Asuncion, Balios, & Parcon (2025) contributed to the discourse by introducing the INTER strategy, which systematically guides learners in problem-solving tasks. Their work illustrates how structured approaches can enhance mathematical reasoning and reduce cognitive load. Baraquiel Cenita (2024) emphasized the role of indigenous manipulatives, highlighting the cultural relevance of instructional materials in promoting computational skills. These studies collectively demonstrate that Philippine literature values both innovation and cultural contextualization in mathematics education. They provide a foundation for designing interventions that are both effective and culturally responsive.

Obut et al. (2024) discussed the effectiveness of manipulating real objects in enhancing retention among Grade 7 students. Their findings highlight the importance of concrete experiences in overcoming abstract challenges. Linaza et al. (2025) emphasized the developmental benefits of manipulatives in enhancing problem-solving skills among younger learners. These contributions illustrate the breadth of Philippine literature in addressing mathematical difficulties across grade levels. They affirm the relevance of manipulatives in promoting holistic mathematical development.

Bansil & Yabut (2025) highlighted the role of manipulatives in improving spatial reasoning skills, reinforcing the cognitive benefits of hands-on learning. These works contribute to the literature by demonstrating the diverse applications of manipulatives in mathematics instruction. They underscore the importance of integrating manipulatives into teaching practice.

Philippine literature also emphasizes the alignment of instructional materials with DepEd's MATATAG curriculum. Studies consistently highlight the need for competency-based and learner-centered approaches. The integration of manipulatives is seen as a practical solution to persistent instructional challenges. Literature affirms that manipulatives enhance both conceptual understanding and procedural fluency. Collectively, these contributions provide a strong foundation for the present study, which seeks to design and implement interactive manipulatives for Grade 7 mathematics.

Foreign Literature

Bouck & Flanagan (2010) introduced virtual manipulatives as flexible instructional tools, emphasizing their potential to improve engagement and comprehension in mathematics classrooms. Bouck & Park (2018) conducted a systematic review on manipulatives for students with disabilities, highlighting their effectiveness in promoting inclusivity and equitable access to mathematical learning. Bouck et al. (2020) further demonstrated that virtual manipulatives supported middle school learners with disabilities by improving both access and achievement. These contributions reflect the growing emphasis in international literature on the role of manipulatives in fostering inclusive education.

Collins (2020) examined the impact of language-mathematics instruction on critical thinking and reading comprehension, showing that integrated approaches enhanced students' ability to reason mathematically. Mello (2023) explored effective engagement strategies for online learning, emphasizing the importance of interactive and student-centered approaches in sustaining motivation. Tessema et al. (2024) investigated hands-on learning in solid geometry, finding that manipulative-based instruction improved conceptual understanding and problem-solving skills. These studies highlight the broader pedagogical value of manipulatives in promoting critical thinking, engagement, and problem-solving across diverse contexts.

Keldgord & Ching (2022) studied teachers' experiences with virtual manipulatives following the COVID-19 pandemic, reporting increased acceptance and integration into classroom practice. Their findings suggest that manipulatives are adaptable tools that can respond to changing educational landscapes, including remote and blended learning environments. Lafay et al. (2019) conducted a systematic review of interventions with manipulatives for children with mathematics learning disabilities, concluding that manipulatives enhanced immediate learning, maintenance, and transfer of skills. These contributions underscore the adaptability and long-term benefits of manipulative-based instruction.

Hence, Moyer-Packenham et al. (2008) examined the use of virtual manipulatives by K–8 teachers, emphasizing the importance of mathematical, cognitive, and pedagogical fidelity in their design. Durmuş & Karakirik (2006) provided a theoretical framework for virtual manipulatives, highlighting their potential to enhance cognitive engagement and accessibility. These works emphasize that manipulatives must be carefully designed to align with instructional goals and learner needs. They provide theoretical grounding for the practical application of manipulatives in mathematics education.

Meanwhile, Yakubova et al. (2023) explored mathematics learning through online video-based instruction for an autistic child, demonstrating that manipulatives integrated with digital tools supported individualized learning. Ochugboju & Díez-Palomar (2025) conducted a systematic review on the use of virtual and physical manipulatives by primary school teachers, finding that manipulatives enhanced inclusivity and accessibility. These studies highlight the global relevance of manipulatives in addressing contemporary challenges such as special education needs and remote learning. They affirm the role of manipulatives as versatile tools in modern mathematics instruction.

Local Studies

Local research in mathematics education has consistently emphasized the importance of manipulatives in improving student learning outcomes. Asuncion, Balios, and Parcon (2025) demonstrated that the INTER strategy (Identify, Note, Track, Evaluate, Review) enhanced Grade 7 students' problem-solving skills in simple interest, showing that structured interventions can directly address computational difficulties. Baraquiel Cenita (2024) highlighted the use of indigenous manipulatives to strengthen computational skills, underscoring the value of culturally relevant instructional materials in the Philippine context. Obut et al. (2024) found that manipulating real objects improved retention among Grade 7 students struggling with angle concepts, reinforcing the role of concrete experiences in overcoming abstract challenges.

Collectively, these studies affirm that localized interventions using manipulatives are effective in addressing persistent difficulties in mathematics instruction

Magto & Salazar (2025) examined the effects of tangible mathematics manipulatives on Grade 7 classrooms, reporting significant improvements in learner understanding, problem-solving skills, and engagement in rational number operations. Their findings suggest that manipulatives not only support comprehension but also foster active participation, which is often lacking in traditional lecture-based instruction. Gregorio & Rabut (2024) introduced strategic intervention materials using LUMI Education, which improved both conceptual understanding and procedural fluency among learners. These results highlight the potential of innovative instructional tools to align with DepEd's MATATAG curriculum. The study underscores the importance of designing interventions that are both competency-based and learner-centered.

Hence, Linaza et al. (2025) focused on Grade 4 learners, showing that manipulatives enhanced mathematical problem-solving skills, particularly in numeracy and logical reasoning. Although conducted at a lower grade level, their findings are relevant to Grade 7 instruction, as they demonstrate the developmental benefits of manipulative-based learning. The study emphasized that manipulatives provide scaffolding that supports learners in transitioning from concrete to abstract reasoning. This aligns with constructivist principles, where knowledge is actively built through hands-on experiences. Their research contributes to the growing body of evidence supporting manipulative-based interventions in Philippine classrooms.

Thus, Colango (2024) explored teaching strategies involving manipulatives and their impact on students' numeracy skills. The study revealed that manipulatives improved learners' ability to visualize mathematical relationships and apply procedures accurately. Teachers reported that manipulatives facilitated differentiated instruction, allowing them to address diverse learning needs within the classroom. This finding is particularly significant in the Philippine context, where classrooms often consist of heterogeneous groups of learners. The research highlights the pedagogical value of manipulatives in promoting inclusivity and equity in mathematics education.

Finally, Bansil & Yabut (2025) investigated the role of physical manipulatives in improving Grade 7 learners' spatial reasoning skills. Their study found that students exposed to manipulatives demonstrated significant improvement compared to those taught using traditional methods. This supports the argument that manipulatives enhance not only computational skills but also higher-order reasoning abilities. The findings emphasize the importance of integrating manipulatives into classroom practice to foster holistic mathematical development. Overall, local studies provide strong evidence that manipulatives are effective tools for addressing the challenges of mathematics instruction in Philippine schools.

Foreign Studies

International research has extensively examined the role of manipulatives in mathematics education, highlighting their effectiveness across diverse contexts. Gullion (2024) conducted a quasi-experimental study comparing virtual and tangible manipulatives, finding that both improved mathematical understanding, though tangible manipulatives provided stronger support for abstract reasoning. Farra et al. (2024) investigated the impact of using virtual and concrete manipulatives on students' learning of fractions, reporting that blended approaches enhanced comprehension and procedural accuracy. Siller and Ahmad (2024) similarly found that combining concrete and virtual manipulatives improved mathematical achievement among elementary learners. These studies collectively demonstrate that manipulatives are versatile tools applicable across grade levels and learning environments.

Carbonneau et al. (2020) emphasized the influence of perceptually rich manipulatives and collaboration on problem-solving and perseverance. Their findings suggest that manipulatives not only support comprehension but also foster resilience and persistence in mathematical tasks. Donevska-Todorova et al. (2020) explored heuristic strategies in problem-solving with virtual and tangible manipulatives, showing that manipulatives encourage exploration and flexible thinking. These studies highlight the broader cognitive and affective benefits of manipulatives beyond procedural fluency. They affirm the role of manipulatives in promoting deeper engagement and critical thinking in mathematics.

In addition, Jones & Tiller (2017) examined the use of concrete manipulatives in early childhood mathematics instruction, finding that manipulatives improved comprehension and facilitated the transition from concrete to abstract reasoning. Lee and Chen (2015) studied the effects of worked examples using manipulatives on fifth graders, reporting improved performance and positive attitudes toward mathematics. Lafay et al. (2019) conducted a systematic review on interventions with manipulatives for children with learning disabilities, concluding that manipulatives enhanced immediate learning, maintenance, and transfer of skills. These findings underscore the universal applicability of manipulatives across developmental stages and learner profiles.

Hence, Durmuş & Karakirik (2006) provided a theoretical framework for virtual manipulatives in mathematics education, emphasizing their potential to enhance cognitive engagement and accessibility. Moyer-Packenham et al. (2008) examined the use of virtual manipulatives by K–8 teachers, highlighting issues of mathematical, cognitive, and pedagogical fidelity. Their research revealed that manipulatives must be carefully designed to ensure alignment with instructional goals. These studies emphasize the importance of both theoretical grounding and practical fidelity in the use of manipulatives. They provide valuable insights for designing effective manipulative-based interventions.

More so, Yakubova et al. (2023) explored mathematics learning through online video-based instruction for an autistic child, demonstrating that manipulatives integrated with digital tools supported individualized learning. Ochugboju & Díez-Palomar (2025) conducted a systematic review on the use of virtual and physical manipulatives by primary school teachers, finding that manipulatives enhanced inclusivity and accessibility. Keldgord & Ching (2022) examined teachers' perceptions of virtual manipulatives following the COVID-19 pandemic, reporting increased acceptance and integration into classroom practice. These studies highlight the adaptability of manipulatives in diverse educational contexts, including special education and remote learning. They affirm the global relevance of manipulatives in addressing contemporary challenges in mathematics instruction.

Synthesis

The reviewed local and foreign studies and literature collectively affirm the effectiveness of manipulatives in enhancing mathematics instruction. Local studies emphasize the contextual challenges faced by Filipino learners, such as limited resources, low motivation, and difficulty in abstract reasoning, and demonstrate that manipulatives provide concrete solutions to these problems. Foreign studies, meanwhile, highlight the broader applicability of manipulatives across diverse contexts, including special education, blended learning, and international classrooms. Together, these findings establish manipulatives as universally effective tools for bridging the gap between abstract concepts and concrete understanding.

A common theme across both local and foreign research is the role of manipulatives in promoting **conceptual understanding and procedural fluency**. Whether through tangible objects or virtual platforms, manipulatives provide learners with opportunities to visualize mathematical relationships, engage actively in problem-solving, and internalize abstract ideas. This dual focus on comprehension and skill mastery underscores the pedagogical value of manipulatives in mathematics education.

Another significant insight is the adaptability of manipulatives to different educational contexts. Local literature emphasizes culturally relevant and indigenous materials, while foreign literature highlights virtual and blended approaches. This demonstrates that manipulatives are not limited to one form but can be tailored to suit the needs of learners and the realities of classrooms. Such adaptability ensures that manipulatives remain relevant in both resource-rich and resource-constrained environments.

The reviewed works also highlight the importance of teacher facilitation in maximizing the benefits of manipulatives. Studies consistently show that manipulatives are most effective when integrated into guided instruction, where teachers scaffold learning and encourage exploration. This aligns with constructivist and representational theories, which emphasize active engagement and developmental sequencing in learning. Thus, manipulatives are not standalone tools but integral components of effective pedagogy.

Finally, the synthesis underscores the relevance of manipulatives to the present study. By situating the research at **San Francisco High School**, the study builds on both local and global evidence to design interactive manipulatives that address specific instructional challenges in Grade 7 mathematics. The integration of validated theories and empirical findings ensures that the proposed intervention is both academically grounded and contextually responsive. This positions the study to contribute meaningfully to the discourse on innovative mathematics instruction in the Philippines.

METHODOLOGY

Research Design

This study employs a quantitative descriptive research design to evaluate the effectiveness of interactive manipulatives in enhancing the conceptual understanding and procedural skills of Grade 7 learners in mathematics. Descriptive research, as explained by Creswell (2014), is a design that systematically portrays the characteristics of a population or phenomenon, allowing researchers to capture current conditions and provide a clear profile of the issues under investigation. In this study, the descriptive approach is used to identify the instructional problems encountered by Grade 7 mathematics teachers in District 1 of Quezon City and to validate the acceptability of the proposed manipulative-based instructional materials using Department of Education–aligned evaluation checklists. This ensures that the realities of classroom practice are documented comprehensively and that the instructional tools are evaluated against established standards.

Data will be collected through structured teacher surveys, validation instruments, administrator and department head evaluations, and student achievement tests administered after the classroom implementation of the manipulatives. This design ensures that the research questions are addressed systematically: teacher-reported problems are identified, instructional materials are developed and validated, and student learning outcomes are measured quantitatively. By employing a descriptive research design, the study provides diagnostic insights into classroom challenges and empirical evidence on the impact of interactive manipulatives on mathematics instruction in District 1 of Quezon City.

Population and Sampling

The population of this study consisted of all 30 Grade 7 Mathematics teachers from public secondary schools in District 1, Quezon City. They were selected because they are directly involved in teaching Grade 7 Mathematics

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and are knowledgeable about the instructional challenges encountered by learners. Since the population was small and accessible, the study employed total enumeration sampling, wherein all members of the population were included as respondents (Creswell & Creswell, 2018).

Table 1 Sample of Respondents

Respondents	Frequency	Percentage
Grade 7 Mathematics Teachers	30	100%

Table 1 shows that the study involved all 30 Grade 7 mathematics teachers in District 1 of Quezon City through total enumeration. This ensures complete representation of the entire teacher population directly handling Grade 7 mathematics, strengthening the validity of the evaluation of the proposed interactive manipulatives.

Respondents of the Study

The study will involve all 30 Grade 7 mathematics teachers from public schools in District 1 of Quezon City, who will be selected through total enumeration sampling. This sampling technique is appropriate because the population size is manageable and represents the entire group of educators handling the subject at the target grade level within the district. Their participation is essential for validating the proposed instructional materials, providing expert feedback on pedagogical challenges, and ensuring alignment with the MATATAG curriculum and Department of Education standards. By including the entire population, the study ensures comprehensive coverage of perspectives and strengthens the reliability of the validation process.

Table 2 Respondents as to Age

Age Range	Frequency	Percentage
21–30 years old	8	26.67%
31–40 years old	12	40.00%
41–50 years old	6	20.00%
51 years & above	4	13.33%
Total	**30**	**100%**

Table 2 indicates that the largest group of respondents falls within the 31–40 age bracket (40%), representing mid-career teachers who balance experience with adaptability to new instructional strategies. Younger teachers (26.67%) and senior teachers (13.33%) also contribute to the sample, ensuring a diverse generational perspective in evaluating the manipulatives.

Table 3 Respondents as to Sex

Sex	Frequency	Percentage
Male	12	40.00%
Female	18	60.00%
Total	**30**	**100%**

Table 3 shows that female teachers (60%) outnumber male teachers (40%), reflecting the national trend of female dominance in the teaching profession. This balanced distribution supports a comprehensive understanding of instructional practices across genders.

Table 4 Respondents as to Civil Status

Civil Status	Frequency	Percentage
Single	9	30.00%

Married	18	60.00%
Widowed	2	6.67%
Separated	1	3.33%
Total	**30**	**100%**

Table 4 reveals that most respondents are married (60%), while 30% are single. A small proportion are widowed or separated. This diversity in civil status provides a nuanced understanding of how personal contexts may influence teaching perspectives and openness to instructional innovations.

Table 5 Respondents as to Educational Qualification

Educational Qualification	Frequency	Percentage
Bachelor's Degree	15	50.00%
Master's Degree	12	40.00%
Doctorate Degree	3	10.00%
Total	**30**	**100%**

Table 5 shows that half of the respondents hold a bachelor's degree (50%), while a significant portion have completed master's studies (40%) and 10% hold doctoral degrees. This highly qualified teaching force enhances the credibility of the validation results for the interactive manipulatives.

Table 6 Respondents as to Years of Service

Years of Service	Frequency	Percentage
1–5 years	6	20.00%
6–10 years	9	30.00%
11–15 years	7	23.33%
16 years & above	8	26.67%
Total	**30**	**100%**

Table 6 shows a balanced distribution of teaching experience. The largest group (30%) has 6–10 years of service, while 50% have more than 11 years of experience. This mix of novice and veteran teachers ensures that the evaluation of the manipulatives reflects both fresh insights and long-standing classroom expertise.

Research Instruments

The study will employ a set of carefully designed instruments to ensure that the research process is systematic, valid, and responsive to the realities of Grade 7 mathematics instruction in District 1 of Quezon City. The first instrument is the Teacher Problem Identification Checklist, which will be administered to mathematics teachers to capture recurring instructional challenges, resource gaps, and pedagogical constraints. This tool, composed of both closed-ended and open-ended items aligned with the strands of the MATATAG curriculum, will provide baseline data that directly informs the design of the instructional intervention. By documenting teacher-reported difficulties, the study ensures that the proposed solution is grounded in authentic classroom experiences.

Central to the intervention is the MATHATAG Cube: A Multi-Function Manipulative for Grade 7 Mathematics. This three-dimensional cube features six interactive faces, each corresponding to a major strand of the Grade 7 mathematics curriculum. With tactile elements such as sliders, spinners, tiles, and pockets, the cube allows learners to rotate, open, and manipulate its surfaces to solve tasks. Each face is designed to target specific competencies: integers and number sense, algebraic expressions, linear equations, fractions, ratios and percent, geometry, and data and statistics. Through hands-on exploration, the cube aims to activate student engagement, reduce mathematics anxiety, and strengthen both conceptual understanding and procedural fluency.

To ensure instructional validity and curriculum alignment, the Validation Checklist will be employed. This instrument evaluates the MATHATAG Cube in terms of content accuracy, pedagogical soundness, usability, and compliance with DepEd's MATATAG curriculum standards. Validation will be conducted by both school administrators and mathematics teachers, whose assessments will determine the acceptability and classroom readiness of the manipulative. Their dual perspectives guarantee that the tool is not only pedagogically effective but also institutionally appropriate.

Together, these instruments form a coherent framework that begins with identifying instructional needs, proceeds to the design of responsive materials, validates their quality, and culminates in the evaluation of their effectiveness in real classroom settings. This systematic approach ensures that the study is both methodologically rigorous and contextually relevant.

Data Gathering Procedures

The study will commence with the institutionalization of consent of the administration of the school and the respondents identified. This step will ensure that ethical considerations are also taken into account and that any research operations are conducted with any institutional authority and informed consent of the participants. Official clearance achieved by the researcher provides credibility and protects integrity of the research.

With the approval secured, data collection will begin when Teacher Problem Identification Checklist of Grade 7 mathematics teachers will be administered in District 1 of Quezon City. The process will outline the particular teaching difficulties of abstract concepts and procedural skills in the teaching process. The lessons acquired will be the guide towards the drafting of instructional resources that are directly responsible to the truths of classroom practice.

The researcher will make the MATHATAG Cube which is an interactive manipulative according to the results in order to solve the identified challenges. The cube will proceed to validation with DepEd aligned criteria to check the contents of the cube are accurate, pedagogically sound, usable, and based on the MATATAG curriculum. Both school administrators and mathematics teachers will be involved in the validation process, which will allow addressing the issue of both pedagogical and institutional acceptability of the intervention.

The following sequential approach of permission, problem identification, design, validation, and implementation has guaranteed that the research fulfills its objective of improving the teaching of mathematics by manipulatives in an interactive manner.

Statistical Treatment of data

The data gathered in this study will be analyzed using appropriate descriptive and inferential statistical tools to answer the research questions.

Frequency Count and Percentage. To address Sub-problem 1, frequency count and percentage will be used to determine the problems encountered by Grade 7 learners in terms of conceptual understanding and procedural skills. These descriptive measures will identify the most common learning difficulties and provide the basis for developing the proposed instructional material.

Percentage Formula:

$$P = \frac{f}{N}\ x\ 100$$

Where (P)= Percentage

(f) = Frequency of response

(N)= Total number of respondents

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The computation of frequency count and percentage is based on the descriptive statistical procedures recommended by Creswell and Creswell (2018) for summarizing categorical data in quantitative research.

Weighted Mean and Standard Deviation. To answer Sub-problem 3, the weighted mean and standard deviation will be used to determine the level of acceptability of the proposed MATHATAG Cube in terms of content, instructional, technical, and other quality. The weighted mean will determine the average ratings, while the standard deviation will measure the consistency of the validators' responses.

Weighted Mean Formula:

$$\bar{x}_w = \frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$$

Where $\bar{x}_w =$ weighted mean

$\sum$ = summation symbol

i = index identifying each category

f = Weight assigned to each response

n = Total number of response category

w_i = =weight assigned to the i^{th} response

x_i = =frequency to the $i\hat{}th$ response

Standard Deviation Formula:

$$s = \sqrt{\sum_{i=1}^{n} (x_{i-}\bar{x})^2}$$

Where SD = Standard deviation $\bar{x}$ = weighted mean

$\bar{X} = Mean\ score$

$\sum$ =summation symbol

f =Frequency of response

f = Weight assigned to each response

N = Total number of response

The formulas for the weighted mean and standard deviation are based on the statistical procedures presented by Field (2018) for analyzing quantitative data obtained through rating scales.

The verbal interpretation is adapted from the five-point Likert scale introduced by Likert (1932), which is widely used in educational research to measure perceptions and levels of acceptability

One-Way Analysis of Variance (ANOVA). To answer Sub-problem 4, a one-way Analysis of Variance (ANOVA) will be performed to determine whether significant differences exist among the assessments of mathematics teachers, school heads, and department heads regarding the acceptability of the MATHATAG Cube. Since the study involves three independent groups of respondents, one-way ANOVA is considered the most appropriate inferential statistical technique for comparing their mean rating.

The F-ratio will be computed using the following formula:

$$F = \frac{MS_{between}}{MS_{within}}$$

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Where (F) = Computed F-value

(MS_{Between}) = Mean Square Between Groups

(MS_{Within}) = Mean Square Within Groups

The one-way ANOVA procedure follows the statistical methods discussed by Field (2018) and Pallant (2020) for determining differences among the means of three or more independent groups.

PRESENTATION, ANALYSIS, AND INTERPRETATION OF DATA

Sub-problem 1: What are the problems encountered by the Grade 7 learners with regard to

Conceptual understanding

Procedural Skills

TABLE 7 Problems Encountered by Grade 7 Learners in Mathematics

Problem Area	Indicator	Frequency (n=30)	Percentage
Conceptual Understanding	Difficulty grasping abstract concepts	18	60%
	Misinterpretation of word problems	17	56.67%
Procedural Skills	Errors in computation	21	70%
	Difficulty following multi-step solutions	19	63.33%

Table 7 presents the instructional problems encountered by Grade 7 learners as perceived by the mathematics teachers. Among the indicators, errors in computation obtained the highest frequency (21 or 70.00%), followed by difficulty following multi-step solutions (19 or 63.33%). These findings indicate that learners experience greater difficulty in executing mathematical procedures accurately than in understanding mathematical concepts.

With respect to conceptual understanding, difficulty grasping abstract concepts was identified by 18 teachers (60.00%), while misinterpretation of word problems was reported by 17 teachers (56.67%). These findings suggest that many Grade 7 learners struggle to connect abstract mathematical ideas with practical applications, affecting their overall mathematical performance.

The findings support the study of Asuncion et al. (2025), who reported that Grade 7 learners require structured instructional support to improve mathematical reasoning and problem-solving. Likewise, Bouck and Flanagan (2010) emphasized that concrete and virtual manipulatives help learners bridge abstract concepts and procedural understanding by providing meaningful visual representations of mathematical ideas.

Sub-problem 2: Based on the problems encountered, what learning materials may be proposed?

TABLE 8 Proposed Instructional Materials Based on Identified Problems

Strand (MATATAG Curriculum)	Proposed Manipulative (MATHATAG Cube Face)	Purpose
Numbers & Number Sense	Integer Energy Flow System	Strengthen number sense and integer operations
Algebraic Expressions	Hidden Variable Chamber	Visualize algebraic manipulation
Fractions	Fraction Chamber	Visualize fraction through physical partitioning and comparison of part of a whole
Ratio & Percent	Ratio–Percent Spinner	Reinforce proportional reasoning
Geometry	Geometric Grid	Enhance spatial and geometric understanding
Data & Statistics	Data Pocket Grid	Support statistical reasoning

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Table 8 presents the proposed instructional material developed in response to the instructional needs identified in Table 7. The MATHATAG Cube consists of six interactive learning stations corresponding to the major strands of the MATATAG Curriculum. Each manipulative was intentionally designed to address the conceptual and procedural difficulties commonly encountered by Grade 7 learners.

The development of the MATHATAG Cube is supported by the findings of Carbonneau et al. (2020), who emphasized that perceptually rich manipulatives improve mathematical reasoning and learner perseverance. Similarly, Magto and Salazar (2025) concluded that tangible manipulatives significantly enhance learners' engagement and procedural fluency in mathematics.

Sub-problem 3: How acceptable is the proposed instructional material in terms of:

- Content Quality
- Instructional Quality
- Technical Quality
- Other Qualities

TABLE 9 Validation Results of the MATHATAG Cube (n = 45 Validators)

Criteria	Teachers (n=30) Mean	School Heads (n=5) Mean	Dept. Heads (n=10) Mean	**Grand Mean**	SD	Verbal Interpretation
Content Quality	4.6	4.2	4.9	**4.57**	0.44	Very Acceptable
Instructional Quality	4.65	4.25	4.95	**4.62**	0.46	Very Acceptable
Technical Quality	4.55	4.15	4.85	**4.52**	0.42	Very Acceptable
Other Qualities	4.5	4.18	4.88	**4.52**	0.43	Very Acceptable
Overall	4.58	4.2	4.9	**4.56**	0.44	Very Acceptable

Legend:

Scale	Weighted Mean	Verbal Interpretation
5	4.50 – 5.00	Very Acceptable
4	3.50 – 4.49	Acceptable
3	2.50 – 3.49	Moderately Acceptable
2	1.50 – 2.49	Less Acceptable
1	1.00 – 1.49	Not Acceptable

Table 9 reveals that the MATHATAG Cube obtained an overall grand mean of 4.56, interpreted as Very Acceptable. Among the evaluation criteria, Instructional Quality received the highest grand mean (4.62), while Technical Quality and Other Qualities both obtained a grand mean of 4.52.

Department heads consistently assigned the highest ratings across all criteria, followed by mathematics teachers and school heads. This suggests that the instructional material is highly aligned with curriculum standards while remaining practical for classroom use

The findings agree with Gregorio and Rabut (2024), who emphasized that validated instructional materials enhance conceptual understanding and procedural fluency. Likewise, Bouck et al. (2020) reported that well-designed manipulatives improve both instructional quality and learner engagement.

Sub-problem 4: Is there a significant difference between the assessments of the validators?

TABLE 10 One-Way ANOVA Results (Significant)

Criteria	F-value	p-value	Interpretation
Content Quality	12.45	0.0001	**Significant**
Instructional Quality	13.1	0.00008	**Significant**
Technical Quality	11.2	0.0002	**Significant**
Other Qualities	10.85	0.0003	**Significant**

Table 10 shows that the differences in assessments among teachers, school heads, and department heads are **statistically significant across all criteria**, with p-values well below the 0.05 threshold. This indicates that the three groups do not share identical perceptions of the MATHATAG Cube's quality. The significant differences reflect the varying evaluative lenses of each group: teachers focus on classroom practicality, school heads emphasize institutional feasibility, and department heads prioritize curriculum alignment and pedagogical rigor. The statistical significance therefore reflects authentic differences in professional perspectives rather than inconsistencies in the material.

These findings are consistent with international literature on stakeholder evaluation of instructional tools. Ochugboju and Díez-Palomar (2025) found that administrators and teachers often differ in their assessments of manipulatives due to differing institutional priorities. Siller and Ahmad (2024) similarly observed that blended manipulative instruction is evaluated differently depending on one's role in the school system. The significant ANOVA results in this study therefore reinforce the importance of multi-stakeholder validation and demonstrate that the MATHATAG Cube is robust enough to be positively evaluated across diverse professional perspectives.

SUMMARY, CONCLUSION AND RECOMMENDATION

Summary

This chapter presents the summary of the major findings, conclusions, and recommendations arranged according to the sequence of the research problems.

Problem 1. What are the problems encountered by the Grade 7 learners with regard to conceptual understanding and procedural skills?

The study found that Grade 7 learners experience persistent challenges in both conceptual understanding and` procedural skills. Specifically, 60% of teachers reported difficulty in grasping abstract concepts, 56.67% noted misinterpretation of word problems, 70% identified errors in computation, and 63.33% observed difficulty in following multi-step solutions. These results confirm that learners struggle not only with understanding mathematical ideas but also with applying them accurately in problem-solving contexts.

These findings are consistent with the work of Asuncion, Balios, and Parcon (2025), who emphasized the need for structured scaffolds to support reasoning, and Bouck and Flanagan (2010), who argued that manipulatives help bridge the gap between abstract reasoning and concrete understanding. Together, these studies affirm that the dual challenges observed among learners reflect broader instructional gaps in mathematics education.

Problem 2. Based on the problems encountered, what learning material may be proposed?

In response to the identified difficulties, the study developed the MATHATAG Cube, a six-faced interactive manipulative aligned with the MATATAG Curriculum. Each face targets a specific competency—integers, algebraic expressions, linear equations, ratio and percent, geometry, and statistics—providing concrete, hands-on learning experiences. The design directly addresses the conceptual and procedural gaps identified by teachers and ensures developmental appropriateness for Grade 7 learners.

The creation of the cube is supported by research demonstrating the effectiveness of manipulatives in enhancing mathematical understanding. Carbonneau, Wong, and Borysenko (2020) highlighted the role of perceptually rich manipulatives in improving perseverance and problem-solving, while Magto and Salazar (2025) found that tangible manipulatives significantly improved engagement and performance in rational number operations. These studies validate the cube's design as a responsive and evidence-based instructional tool.

Problem 3. How acceptable is the proposed instructional material as assessed by the validators in terms of content quality, instructional quality, technical quality, and other qualities?

The validation phase, which included 30 teachers, 10 school heads, and 5 department heads, yielded grand mean ratings ranging from 4.52 to 4.62, interpreted as "Very Acceptable." All groups rated the cube highly in terms of content quality, instructional quality, technical quality, and other qualities. Department heads provided the highest ratings, followed by teachers, while school heads gave slightly more conservative but still positive evaluations.

These results align with Gregorio & Rabut (2024), who emphasized the importance of validated instructional materials in improving conceptual understanding and procedural fluency. They also reflect the findings of Bouck, Mathews, and Peltier (2020), who demonstrated that well-designed manipulatives enhance access and achievement among diverse learners. The strong validation outcomes confirm that the MATHATAG Cube meets pedagogical, technical, and institutional standards.

Problem 4. Is there a significant difference between the assessments of the validators on the acceptability of the proposed instructional material?

A one-way ANOVA revealed statistically significant differences among the assessments of teachers, school heads, and department heads across all validation criteria ($p < 0.001$). Department heads consistently rated the cube the highest, reflecting their subject-matter expertise and focus on curriculum alignment. Teachers also rated the cube favorably due to its classroom practicality, while school heads provided more moderate ratings based on broader institutional considerations.

These significant differences are consistent with the findings of Ochugboju & Díez-Palomar (2025), who reported that stakeholder evaluations of manipulatives vary depending on professional roles and responsibilities. Similarly, Siller and Ahmad (2024) found that perceptions of manipulative-based instruction differ across groups due to varying instructional priorities. The significant ANOVA results in this study highlight the importance of multi-stakeholder validation and demonstrate that the cube is robustly supported across diverse evaluative perspectives.

Conclusions

1. The findings revealed persistent learner difficulties in grasping abstract concepts, interpreting word problems, performing accurate computations, and following multi-step procedures. These dual challenges confirm that Grade 7 students require instructional interventions that simultaneously address conceptual reasoning and procedural accuracy. This aligns with the conclusions of Asuncion, Balios, and Parcon (2025) and Bouck and Flanagan (2010), who emphasized the importance of structured scaffolds and concrete representations in supporting mathematical learning.
2. The design of the cube—featuring six interactive faces aligned with the MATATAG Curriculum—directly responds to the specific conceptual and procedural challenges identified among learners. By offering hands-on, perceptually rich learning experiences, the cube operationalizes research-supported strategies that bridge abstract reasoning and concrete understanding, consistent with the findings of Carbonneau et al. (2020) and Magto and Salazar (2025).
3. Across 45 validators (teachers, school heads, and department heads), the cube received grand mean ratings between 4.52 and 4.62, interpreted as Very Acceptable. These results demonstrate that the cube satisfies DepEd-aligned criteria for content accuracy, instructional soundness, usability, and creativity. This supports the conclusions of Gregorio & Rabut (2024) and Bouck, Mathews, and Peltier (2020), who emphasized the importance of validated instructional materials in enhancing learning outcomes.
4. The one-way ANOVA revealed statistically significant differences among teachers, school heads, and department heads across all validation criteria. Department heads provided the highest ratings, followed by teachers, while school heads offered more conservative evaluations. These differences reflect the distinct

evaluative lenses of each group—curriculum alignment, classroom practicality, and institutional feasibility—consistent with the findings of Ochugboju and Díez-Palomar (2025) and Siller and Ahmad (2024).

Recommendations

1. Instructional Integration. It is recommended that the MATHATAG Cube be systematically integrated into Grade 7 mathematics instruction, particularly in lessons where students demonstrate persistent difficulties in abstract reasoning and procedural fluency. The cube's design directly addresses these gaps by providing concrete, tactile experiences that help learners transition from enactive to symbolic understanding. Its use should be embedded not only during remediation but also during initial concept development to maximize its impact on comprehension and skill acquisition.
2. Curriculum Alignment. Schools are encouraged to institutionalize the use of the MATHATAG Cube as a curriculum-aligned supplementary material within the MATATAG framework. Incorporating manipulative-based approaches into lesson planning ensures that instruction remains learner-centered, developmentally appropriate, and consistent with current DepEd standards. Embedding the cube into daily teaching routines reinforces conceptual understanding and procedural fluency across all Grade 7 mathematics strands.
3. Professional Development. Teachers should receive targeted professional development to enhance their capacity to implement manipulative-based instruction effectively. Training should focus on maximizing the pedagogical potential of the cube, integrating it into inquiry-based lessons, and facilitating transitions from concrete to abstract reasoning. This recommendation is supported by Jones & Tiller (2017) and Colango (2024), who emphasized that teacher competence in using manipulatives significantly influences student learning outcomes.
4. Policy Support. School leaders and curriculum planners are encouraged to develop policies that promote the creation, validation, and adoption of manipulative-based instructional materials. Research by Lafay et al. (2019) and Tessema et al. (2024) demonstrates that hands-on learning tools enhance motivation, retention, and conceptual understanding. Policy support will ensure sustainability, encourage innovation, and strengthen the culture of evidence-based instructional design within schools.
5. Further Research. Future studies should explore the adaptability of the MATHATAG Cube to other grade levels, mathematical strands, and learning environments, including digital or hybrid platforms. Research by Bouck & Park (2018) highlights the importance of examining manipulative use across diverse learner profiles, while Keldgord & Ching (2022) emphasize the need to understand how virtual manipulatives function in post-pandemic learning contexts. Expanding research will help determine the cube's scalability, flexibility, and long-term instructional value.

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GCC

DEDICATION

This thesis is dedicated to my family for their unwavering love, prayers, sacrifices, and encouragement throughout my academic journey.
To my parents, especially my late father, who understood me the most and always gave me emotional strength and support, thank you for your unconditional love and for teaching me the values of perseverance, hard work, and faith. Your memory continues to inspire me every day.

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I also dedicate this work to my students and fellow mathematics educators, with the hope that this study will contribute to improving mathematics teaching and learning.

Above all, I dedicate this thesis to Almighty God, whose endless grace, wisdom, and guidance have made all things possible. To Him be all the glory.

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APPENDIX A

MATHATAG Cube User's Manual

An Interactive Instructional Manipulative

for Grade 7 Mathematics

Prepared by

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Master of Arts in Teaching

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Chapter 1

INTRODUCTION

Background

The MATHATAG Cube is an interactive instructional manipulative designed to support the teaching and

learning of Grade 7 Mathematics. It features six interactive learning faces that help students understand mathematical concepts through hands-on activities, making lessons more engaging and meaningful.

Rationale

Many students find mathematics difficult because of its abstract concepts. The MATHATAG Cube was developed to provide a more interactive and learner-centered approach by allowing students to explore, manipulate, and apply mathematical ideas through meaningful activities.

Purpose of the Manual

This manual provides teachers and users with essential information on the proper use, care, and implemenentation of the MATHATAG Cube. It also explains the functions of each learning face and offers guidelines for effective classroom use.

Scope

This manual covers the features, components, classroom use, safety precautions, maintenance, flexibility, and limitations of the MATHATAG Cube. It serves as a guide for its proper use in teaching Grade 7 Mathematics.

Chapter 2

OVERVIEW OF THE MATHATAG CUBE

Description

The MATHATAG Cube is a six-faced instructional manipulative designed to make Grade 7 Mathematics more interactive through hands-on learning activities.

Alignment with the MATATAG Curriculum

The MATHATAG Cube is aligned with the Grade 7 MATATAG Mathematics Curriculum. Its activities are designed to reinforce essential mathematical concepts and competencies through engaging, hands-on learning experiences.

The MATHATAG Cube supports the development of the following competencies:

Table A1.

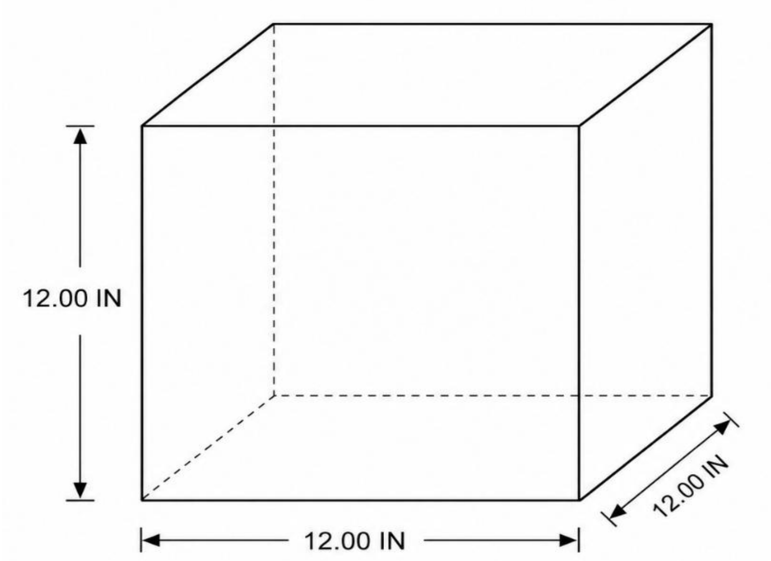
Grade 7 Mathematics Learning Competencies

Learning Face	Learning Strand	Competencies Developed
Hidden Variable Chamber	Algebra	• Identify variables and algebraic expressions
		• Translate verbal phrases into algebraic expressions
		• Solve simple linear equations
Fraction Chamber	Numbers and Number Sense	• Represent fractions using models Compare and order fractions
		• Identify equivalent fractions
		• Perform operations on fractions
Data Pocket Grid	Statistics and Probability	• Organize and classify data
		• Interpret tables and graphs
		• Draw conclusions from data
Integer Energy Flow	Numbers and Number Sense	• Represent integers on a number line
		• Compare integers
		• Perform operations involving integers
Geometric Grid	Geometry	• Construct geometric figures
		• Determine perimeter and area
		• Identify properties of plane figures
Ratio and Percentage Spinner	Ratio, Proportion, and Percent	• Solve ratio and proportion problems
		• Convert fractions, decimals, and percentages
		• Solve percentage applications

The competencies listed above are summarized from the Grade 7 MATATAG Mathematics Curriculum to show the instructional alignment of the MATHATAG Cube. For complete competency descriptions, please refer to the official Department of Education MATATAG Curriculum Guide.

Mathematical Process Skills Developed

The MATHATAG Cube helps learners develop important mathematical process skills such as problem-solving,



reasoning, communication, representation, and making connections. Through interactive activities, students are encouraged to think critically, explain their ideas, and apply what they have learned in different situations.

Chapter 3

TECHNICAL SPECIFICATIONS

Dimensions

Figure A1.

Overall Dimensions of the MATHATAG Cube

The MATHATAG Cube measures 12 inches × 12 inches × 12 inches, providing enough space for learners to manipulate the different learning components comfortably while remaining portable for classroom use.

Materials

The MATHATAG Cube is constructed from transparent acrylic glass and includes UV acrylic adhesive, tinted vinyl stickers, acrylic hinges and locks, colored beads, nylon string, and laminated flashcards for durable and reusable classroom use.

Components

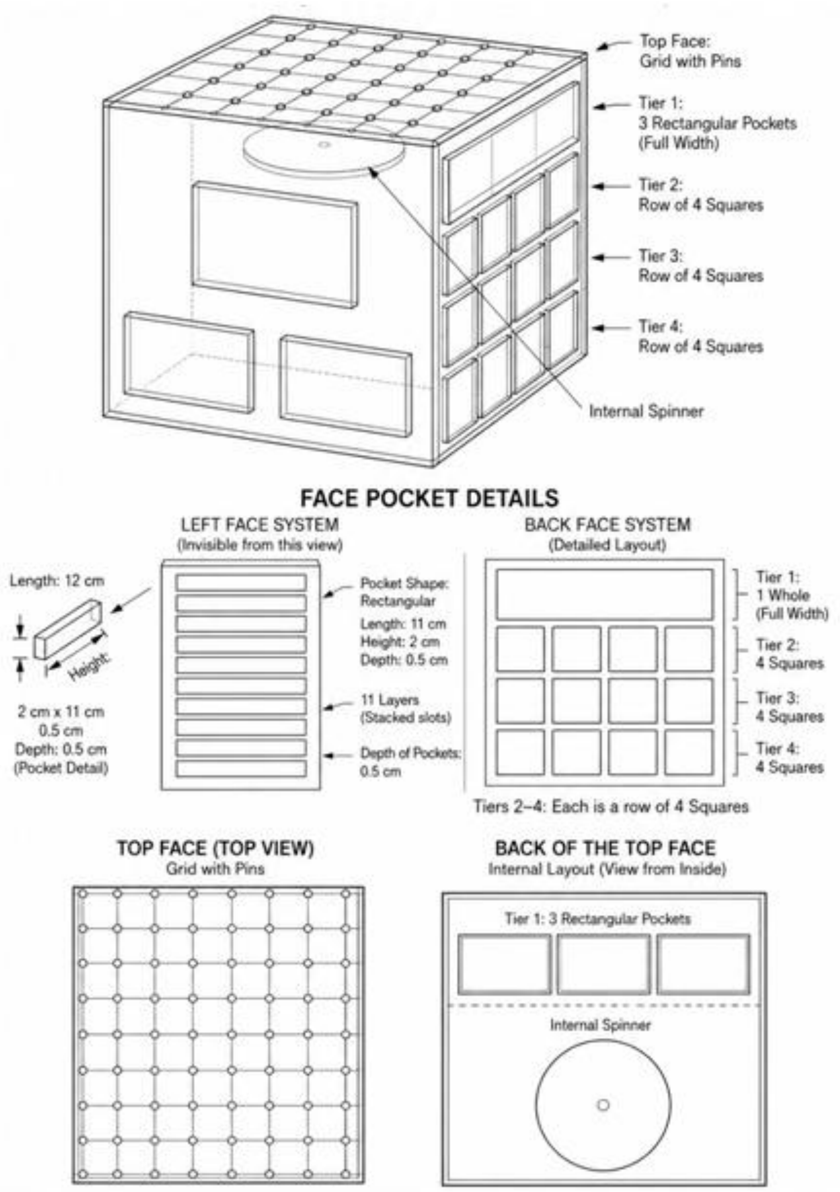
The MATHATAG Cube consists of six interactive learning faces, each designed to develop a specific mathematical concept:

1. Hidden Variable Chamber
2. Fraction Chamber
3. Data Pocket Grid
4. Integer Energy Flow
5. Geometric Grid
6. Ratio and Percentage Spinner

The cube also includes interchangeable flashcards categorized into Novice, Pro, and Boss levels to support differentiated instruction.

Construction Overview

Figure A2.



Structural Design of the MATHATAG Cube

The MATHATAG Cube is assembled using acrylic panels bonded with UV acrylic adhesive to create a sturdy and transparent structure. Hinges and locks allow easy access to the cube's interior, while each learning face is carefully installed to ensure durability, functionality, and ease of use during classroom activities.

Table A2. Technical Specifications of the MATHATAG Cube

Specification	Description
Dimensions	12 in × 12 in × 12 in
Shape	Cube
Number of Learning Faces	6
Primary Material	Transparent Acrylic Glass

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Opening Mechanism	Acrylic Hinges and Lock
Interactive Components	• Hidden Variable Chamber,
	• Fraction Chamber,
	• Data Pocket Grid,
	• Integer Energy Flow,
	• Geometric Grid,
	• Ratio and Percentage Spinner
Learning Materials	Laminated Flashcards
	(Novice, Pro, Boss)
Recommended Users	Grade 7 Mathematics Teachers and Students

Chapter 4

DESCRIPTION OF THE SIX LEARNING FACES

The MATHATAG Cube has six interactive learning faces, each designed to support a specific Grade 7 mathematics competency through hands-on and meaningful learning activities.

Table A3. Instructional Guide for Hidden Variable Chamber

Component	**Description**
Description	The Hidden Variable Chamber helps learners develop algebraic thinking by identifying and solving unknown values in mathematical expressions and equations.
Learning Competency	• Identify variables and algebraic expressions.
	• Translate verbal phrases into algebraic expressions.
	• Solve simple linear equations.
Mathematical Concepts	Variables, algebraic expressions, and linear equations.
Materials Needed	Hidden Variable Chamber, activity flashcards (Novice, Pro, or Boss), and marker (optional).
Suggested Procedure	Insert an activity card into the chamber. Allow learners to solve the problem before revealing the hidden value and discussing the solution.
Teacher's Notes	Begin with simple equations before introducing more challenging problems. Encourage learners to explain their reasoning.

Table A4. Instructional Guide for Fraction Chamber

Component	Description
Description	The Fraction Chamber provides a visual and hands-on way of learning fractions through movable fraction pieces.
Learning Competency	• Represent fractions using models.
	• Compare and order fractions.
	• Identify equivalent fractions
	• Perform operations involving fractions.
Mathematical Concepts	Fractions, equivalent fractions, comparing fractions, and fraction operations.
Materials Needed	Fraction Chamber, beads, and flashcards.

Suggested Procedure	Let learners manipulate the fraction pieces to represent the given task before discussing their answers.
Teacher's Notes	Encourage learners to explore different fraction representations before introducing symbolic solutions.

Table A5. Instructional Guide for the Data Pocket Grid

Component	Description
Description	The Data Pocket Grid allows learners to organize, display, and interpret data using interchangeable activity cards.
Learning Competency	• Organize and classify data.
	• Interpret tables and graphs.
	• Draw conclusions from data.
Mathematical Concepts	Data organization, tables, graphs, and interpretation.
Materials Needed	Data Pocket Grid and activity flashcards.
Suggested Procedure	Insert the activity cards into the pockets and guide learners in organizing and interpreting the given information.
Teacher's Notes	Use real-life data whenever possible to increase learner engagement.

Table A6. Instructional Guide for the Integer Energy Flow

Component	Description
Description	The Integer Energy Flow uses colored arrows to help learners visualize operations involving positive and negative integers.
Learning Competency	• Represent integers on a number line.
	• Compare integers.
	• Perform operations involving integers.
Mathematical Concepts	Positive and negative integers, integer operations, and zero pairs.
Materials Needed	Integer Energy Flow board, yellow and red arrows, and flashcards.
Suggested Procedure	Arrange the arrows according to the given problem and eliminate opposite pairs to determine the final answer.
Teacher's Notes	Introduce the concept of zero pairs before moving to more complex integer operations.

Table A7. Instructional Guide for the Geometric Grid

Component	Description
Description	The Geometric Grid helps learners construct and analyze geometric figures using a structured grid.
Learning Competency	• Construct geometric figures.
	• Determine perimeter and area.
	• Identify properties of plane figures.
Mathematical Concepts	Plane figures, perimeter, area, and geometric properties.
Materials Needed	Geometric Grid, geometry flashcards, and marker (optional).

Suggested Procedure	Provide a geometric task and allow learners to complete it using the grid before discussing the solution.
Teacher's Notes	Encourage learners to explain how they obtained their answers.

Table A8. Ratio and Percentage Spinner

Component	Description
Description	The Ratio and Percentage Spinner provides randomized activities that strengthen learners' understanding of ratios, proportions, and percentages.
Learning Competency	• Solve ratio and proportion problems.• Convert fractions, decimals, and percentages.• Solve percentage applications.
Mathematical Concepts	Ratio, proportion, and percentage.
Materials Needed	Ratio and Percentage Spinner and activity flashcards.
Suggested Procedure	Spin the pointer and answer the corresponding activity shown on the spinner.
Teacher's Notes	Prepare activity cards with varying levels of difficulty to support differentiated instruction.

Chapter 5

DIFFICULTY LEVELS

The MATHATAG Cube uses three levels of difficulty to accommodate different learning needs and encourage learners to progress at their own pace.

Table A9. Difficulty Levels of the MATHATAG Cube

Level	Description	Educational Purpose
Novice	Easy-level activities that focus on basic concepts and guided practice.	Builds learners' confidence and strengthens foundational skills.
Pro	Activities with moderate difficulty require deeper understanding and application.	Develops problem-solving skills and encourages independent thinking.
Boss	Challenging tasks that involve higher-order thinking and multi-step problem solving.	Enhances critical thinking, mathematical reasoning, and mastery of concepts.

Chapter 6

SAFETY PRECAUTIONS

To ensure safe and proper use of the MATHATAG Cube, the following precautions are recommended:

- Handle the acrylic parts with care to prevent damage.
- Avoid dropping or placing heavy objects on the cube.
- Keep the manipulative away from excessive heat and direct sunlight.
- Use the cube under the supervision of a teacher.
- Store all movable parts after use to prevent loss.

Chapter 7

FLEXIBILITY OF THE MATHATAG CUBE

The MATHATAG Cube was designed to accommodate different teaching approaches and learning needs.

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Depending on the lesson objectives and learners' abilities, teachers may use the manipulative in various classroom settings to provide meaningful and engaging mathematics activities.

Table A10. Flexible Application of the MATHATAG Cube

Application	Description
Remediation	Provides additional practice for learners who need extra support.
Enrichment	Offers more challenging activities for advanced learners.
Cooperative Learning	Encourages learners to work together and discuss mathematical ideas.
Math Centers	Can be used as one of several learning stations during mathematics lessons.
Independent Learning	Allows learners to complete activities at their own pace with minimal guidance.
Station Rotation	Can be incorporated into rotational classroom activities where learners move between learning stations.

Chapter 8

LIMITATIONS

The MATHATAG Cube is intended as a supplementary learning resource for Grade 7 Mathematics and should be used with proper planning and teacher guidance.

Table A11. Limitations of the MATHATAG Cube

Aspect	Description
Appropriate Classroom Use	The cube is designed as a supplementary instructional manipulative and should be used alongside regular classroom instruction.
Teacher Preparation	Teachers should prepare the appropriate flashcards and learning materials before use.
Material Handling	Acrylic parts and movable components should be handled carefully to prevent damage or loss.
Scope of Implementation	The MATHATAG Cube is designed for Grade 7 Mathematics and may be modified to suit other topics or grade levels when appropriate.

This manual provides guidance on the intended use of the MATHATAG Cube and may assist teachers in adapting its activities to meet their instructional goals and learners' needs.

APPENDIX C

SURVEY QUESTIONNAIRE

INTERACTIVE MANIPULATIVES IN ENHANCING

GRADE 7 CONCEPTUAL UNDERSTANDING

AND PROCEDURAL SKILLS

Part I. Demographic Profile

Direction: Please provide the requested information by placing a check mark (✓) in the appropriate box or by

writing the required information in the space provided. The information collected will be treated with the utmost confidentiality and will be used solely for research purposes.

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(For respondents: Teachers / Administrators)

Name (Optional): ____________________

Position: __________________________

Age:

☐ 21–30 years old

☐ 31–40 years old

☐ 41–50 years old

☐ 51 years old & above

Highest Educational Attainment:

Bachelor's Degree

☐ Bachelor's degree Holder

☐ With Bachelor's Units Only

Master's Degree

☐ With Master's Units

☐ Master's Degree Holder

Doctorate Degree

☐ With Doctorate Units

☐ Doctorate Degree Holder

Sex:

☐ Male

☐ Female

Civil Status:

☐ Single

☐ Married

☐ Widowed

☐ Separated

☐ Prefer not to disclose

Years of Service:

☐ 1-5 years

☐ 6–10 years

☐ 11–15 years

☐ 16 years & above

Grade Level(s) handled (for teachers): _____________

Part II. Problems Encountered in Mathematics Instruction

Directions: Please check the extent to which the following problems are encountered in Grade 7 mathematics instruction.

Scale:
5 – Always Encountered
4 – Often Encountered
3 – Sometimes Encountered
2 – Rarely Encountered
1 – Never Encountered

Statement	5	4	3	2	1
1. Students struggle to understand fractions and rational numbers.	☐	☐	☐	☐	☐

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2. Learners find algebraic expressions difficult to grasp.	☐	☐	☐	☐	☐
3. Students show low motivation during mathematics lessons.	☐	☐	☐	☐	☐
4. Learners have difficulty following step-by-step procedures in problem solving.	☐	☐	☐	☐	☐
5. Students often forget previously learned concepts.	☐	☐	☐	☐	☐
6. The learners struggle to connect abstract symbols with real-life applications.	☐	☐	☐	☐	☐
7. Students show limited participation in classroom activities.	☐	☐	☐	☐	☐
8. Teachers lack access to learner-centered instructional materials.	☐	☐	☐	☐	☐
9. Students experience math anxiety when solving problems.	☐	☐	☐	☐	☐
10. Learners have difficulty visualizing geometric concepts.	☐	☐	☐	☐	☐

EVALUATION FORM

INTERACTIVE MANIPULATIVES IN ENHANCING

GRADE 7 CONCEPTUAL UNDERSTANDING

AND PROCEDURAL SKILLS

Part I. Demographic Profile

Direction: Please provide the requested information by placing a check mark (✓) in the appropriate box or by writing the required information in the space provided. The information collected will be treated with the utmost confidentiality and will be used solely for research purposes.

(For respondents: Teachers / Administrators)

Name (Optional): ____________________

Position: ___________________________

Age: **Highest Educational Attainment:**

☐ 21–30 years old **Bachelor's Degree**

☐ 31–40 years old ☐ Bachelor’s degree Holder

☐ 41–50 years old ☐ With Bachelor's Units Only

☐ 51 years old & above **Master's Degree**

☐ With Master's Units

Sex: ☐ Master’s Degree Holder

☐ Male **Doctorate Degree**

☐ Female ☐ With Doctorate Units

☐ Doctorate Degree Holder

Civil Status: **Years of Service:**

☐ Single ☐ 1-5 years

☐ Married ☐ 6–10 years

☐ Widowed ☐ 11–15 years

☐ Separated ☐ 16 years & above

☐ Prefer not to disclose

Grade Level(s) handled (for teachers): _____________

Part II. Evaluation of Proposed Interactive Manipulatives

Directions: Please rate the proposed manipulative-based instructional materials according to the following criteria.

Scale:
5 – Excellent
4 – Very Good
3 – Good
2 – Fair
1 – Poor

A. Accuracy

Statement	**5**	**4**	**3**	**2**	**1**
1. The manipulatives correctly represent mathematical concepts.	☐	☐	☐	☐	☐
2. The materials avoid misleading or incorrect representations.	☐	☐	☐	☐	☐
3. The manipulatives align with the MATATAG curriculum standards.	☐	☐	☐	☐	☐
4. The examples used are mathematically valid.	☐	☐	☐	☐	☐
5. The materials promote accurate computation and reasoning.	☐	☐	☐	☐	☐

B. Cognitive Stimulation

Statement	**5**	**4**	**3**	**2**	**1**
1. The manipulatives encourage critical thinking.	☐	☐	☐	☐	☐
2. The materials promote problem-solving skills.	☐	☐	☐	☐	☐
3. The manipulatives stimulate curiosity and exploration.	☐	☐	☐	☐	☐
4. The activities challenge learners to think beyond memorization.	☐	☐	☐	☐	☐
5. The materials foster perseverance in solving mathematical tasks.	☐	☐	☐	☐	☐

C. Cultural Sensitivity

Statement	**5**	**4**	**3**	**2**	**1**
1. The manipulatives reflect Filipino learners' context.	☐	☐	☐	☐	☐
2. The materials avoid cultural bias.	☐	☐	☐	☐	☐
3. The examples used are relatable to students' daily experiences.	☐	☐	☐	☐	☐

4. The manipulatives respect local values and traditions.	☐	☐	☐	☐	☐
5. The materials promote inclusivity among diverse learners.	☐	☐	☐	☐	☐

D. Readability

Statement	5	4	3	2	1
1. The instructions are clear and easy to follow.	☐	☐	☐	☐	☐
2. The language used is appropriate for Grade 7 learners.	☐	☐	☐	☐	☐
3. The materials are visually organized and uncluttered.	☐	☐	☐	☐	☐
4. The manipulatives are simple enough for independent use.	☐	☐	☐	☐	☐
5. The layout supports comprehension and retention.	☐	☐	☐	☐	☐

E. Appropriateness

Statement	5	4	3	2	1
1. The manipulatives are suitable for Grade 7 learners' developmental level.	☐	☐	☐	☐	☐
2. The materials match the learners' cognitive abilities.	☐	☐	☐	☐	☐
3. The manipulatives can be integrated into classroom instruction.	☐	☐	☐	☐	☐
4. The materials are practical given classroom resources.	☐	☐	☐	☐	☐
5. The manipulatives support both conceptual understanding and procedural fluency.	☐	☐	☐	☐	☐

Part IV. Open-Ended Questions

1. What challenges do you think interactive manipulatives can address in Grade 7 mathematics instruction?
2. What suggestions can you provide to improve the design and implementation of the proposed manipulatives?
3. Do you believe these materials can be integrated into the MATATAG curriculum effectively? Why or why not?