

Overcoming numeracy enigma through Mathematics manipulative tools

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Abstract

This study aimed to determine correlation of manipulative tool the level of acceptability of Learners from Grade I to VI pupils in Lumban Central Elementary School. This study utilized the descriptive research design through survey questionnaires. The respondents were chosen using the purposive sampling techniques. The level of mathematical manipulative tools was very highly evident. It is important for students to have access to these tools because it helps them build a concrete understanding of concepts in math. The overall level of acceptability of manipulative tools was also very highly evident. There is a significant correlation of mathematical manipulative tools and learner's level of acceptability; all the variables bear a significant relationship. Therefore, the hypothesis indicating that there is no significant correlation of using Mathematical manipulative tools to the learners' level of acceptability in Lumban Central Elementary School in Lumban Sub-Office, Division of Laguna is rejected. Using manipulative tools can be a great way to help learners understand and apply abstract concepts in math. Use questions and prompts to facilitate this exploratory learning process. By encouraging exploration, discussion, and real-world applications, teachers can help learners develop their problem-solving skills and have fun while doing it. As such, it is important to consider each student's individual needs and choose manipulative tools that are best suited for their individual learning style. To improve mathematical learning and acceptability, teachers should employ manipulatives. These tools may also help pupils visualize mathematical concepts. Manipulative tools work best when teachers know how to use them and pick the best activities for their students.

Keywords: acceptability; application; exploratory; manipulative; visualize

1. Introduction

Mathematics is usually perceived by pupils as one of the difficult subject areas to understand. If you see a child struggling with math, you might wonder why, and whether it's something to be concerned about. Why is math so hard for some kids? It's not uncommon for kids to have trouble with math. Math difficulties can show up at different ages and in lots of ways. And it's a myth that girls struggle more with math than boys do. Some challenges are clearer, like trouble adding, subtracting, multiplying, or doing long division. Others are less noticeable and may not even seem directly related to math. For example, some kids have trouble telling time or left from right. When kids struggle with math, it doesn't mean they're not smart or not trying hard enough. In fact, kids who have trouble with math are often trying their best.

Some kids just need more time and practice to learn math skills, or better instruction. Others need additional support to get there. The type of support kids need often depends on what's causing the challenge. Teachers in the Philippines continuously seek for ways on how to ease the teaching of Mathematics for easier and more efficient understanding of the subject matter. One of the techniques that is being developed and utilized by the Mathematics teachers is the use of Math Manipulative Tools. It helps make abstract ideas

concrete. A picture may be worth a thousand words, but while children learn to identify animals from picture books, they still probably don't have a sense about the animals' sizes, skin textures, or sounds. Even videos fall short. There's no substitute for firsthand experience. Along the same lines, manipulatives give students ways to construct physical models of abstract mathematical ideas.

Since ancient times, different civilizations have used physical objects to help them solve everyday Math problems. Some of these are the use of wooden board and clay trays covered by a thin layer of sand as counting boards, by the ancient civilization of the Southwest Asia. The ancient Romans created the first abacus made of beans or stones which moved in grooves in sand or on tables of wood, stone, or metal, based on counting board. The Mayans and the Aztecs both had counting devices that were made of corn kernels strung on string or wires that were stretched across a wooden frame. The Incas also had their own counting tool, which was knotted strings called quipu (National Council of Teachers of Mathematics, 2010).

Math manipulatives are physical objects that are designed to represent explicitly and concretely Mathematical ideas that are abstract (Moyer, 2011). The used of Math manipulatives have long been advocated in the Montessori Schools teachings, using concrete objects. The utilization of this learning materials is anchored on Piaget's emphasis on teaching from the concrete, to the representational, to abstract, in the hope to help young learners, make sense of their Mathematics understanding.

In line with the goals of the Basic Education K to 12 Program in the Philippines, facilitating students advance to higher levels of cognitive development, manipulatives can support students who already possess the ability to think abstractly. Modelling a Mathematical concept with manipulatives leads students to think about the mathematics in a different way and attain a higher level of understanding (Cockett, A., & Kilgour, P. W. 2015)

One of the challenges that teachers encounter in today's generation of learners is the different learning styles of the pupils and students. Teaching Mathematical concepts with manipulatives incorporates a multi-representational approach to mathematics which meets the needs of students with a variety of learning styles. Educators should also be adaptive, flexible and knowledgeable about the recent trends in their field of study. Existing researches suggests that educators should use manipulatives and appealing materials in teaching Mathematics regularly in order to give students hands-on and familiarity experiences that can help the learners construct useful meanings of the mathematical ideas.

Philippine private schools had been long integrating the use of manipulatives in their school programs, this is most evident in the Montessori and exclusive schools, wherein learners are more mindful on the use of objects in learning areas. This is what the researcher aims to incorporate in her classroom teaching in government school. Most of government schools in the country have deficiency of learning materials and instruments. The use of manipulative tools as teaching strategy created a place in the classroom where pupils understand terms related to the concepts of Mathematics in Primary. This study determined the effect of Overcoming Numeracy Enigma through Mathematics Manipulative Tools in Lumban Central Elementary School. Lumban Sub-Office, Division of Laguna, School Year 2022-2023.

1.1. Background of the Study

This study investigated how teachers use Mathematics manipulatives in their instructional lessons. Moyer (2011) states that some teachers use manipulatives in an effort to reform their teaching of mathematics without reflecting how the use of representations may change their own mathematics instruction. According to The K to 12 Basic Education Program (2012), pupils and students should learn at their own pace in their own learning style. The Department of Education asserts that teachers will be given enough number of training workshops that they can apply in the classroom. The department also provides learning instruments that can materialized their goals. Learners must operate on something concrete to construct meaning. The active thinking is the component imperative to student learning.

The use of manipulatives in teaching mathematics has a long tradition and solid research history. Manipulatives not only allow students to construct their own cognitive models for abstract mathematical ideas and processes, they also provide a common language with which to communicate these models to the teacher and other students. In addition to the ability of manipulatives to aid directly in the cognitive process, manipulatives have the additional advantage of engaging students and increasing both interest in and enjoyment of mathematics. Students who are presented with the opportunity to use manipulatives report that they are more interested in mathematics. Long-term interest in mathematics translates to increased mathematical ability (Sutton & Krueger, 2002).

In 2013, the National Council of Supervisors of Mathematics (NCSM) issued a position statement on the use of manipulatives in classroom instruction to improve student achievement. In order to develop every student's mathematical proficiency, leaders and teachers must systematically integrate the use of concrete and virtual manipulatives into classroom instruction at all grade levels." (NCSM, 2013). This position is based on research supporting the use of manipulatives in classroom instruction. For example, Ruzic & O'Connell (2001) found that long-term use of manipulatives has a positive effect on student achievement by allowing students to use concrete objects to observe, model, and internalize abstract concepts.

The Philippine K to 12 Curriculum framework focuses on the totality of the learners, how they learn and develop. It is a challenge for teachers to create a conducive atmosphere where the learner enjoys learning and takes part in meaningful learning experiences. But the implementation of the Republic Act 10533 of the Enhanced Basic Education Act of 2013, had introduced some problems. The manipulative usage is widely accepted as an effective way to teach mathematics, although, there is little effort given toward helping teachers ensure their students make the correct connections between the materials and the underlying mathematical concepts. The value of manipulatives has been recognized for many years, but some teachers are reluctant to use them in their lessons due to lack of numbers and cost of learning materials.

The performance of students in mathematics was also a problem in government schools. It should be highlighted that the pupils may not perform well in the tests for various reasons. One of such reason is the likelihood that they never learn the material to the level of conceptual understanding which manifests in low performance. Lumban Central Elementary School had noticed that one of the areas that the school needs to enhance is the area of Mathematics. The researchers aimed to explain the importance and benefits of Math manipulatives and to alleviate the poor retention and lack of mastery of the Primary Grade I to III pupils in Mathematics, specifically in the basic Fundamental Operations. The main purpose of the study was to determine the effect of Overcoming Numeracy Enigma through Mathematics Manipulative Tools in Lumban Central Elementary School. Lumban Sub-Office , Division of Laguna, School Year 2022-2023.

1.2. Theoretical Framework

This study was anchored on several learning theories.

Bruner's constructivist theory suggests that it is effective when faced with new material to follow a progression from enactive to iconic to symbolic representation. Bruner's work also suggests that a learner even of a very young age is capable of learning any material so long as the instruction is organized appropriately. Another theory where the study is anchored is Piaget's Theory of cognitive development. A solid history of research supports the regular use of manipulatives in classroom mathematics instruction. While children can remember, for short periods of time, information taught through books and lectures, deep understanding and the ability to apply learning to new situations requires conceptual understanding that is grounded in direct experience with concrete objects. It is also important to note the critical role of the teacher in helping students connect their manipulative experiences, through a variety of representations, to essential abstract mathematics.

Another theory is Lev Vygotsky's Social Development Theory which states that social interaction precedes development; consciousness and cognition are the end product of socialization and social behavior. He also introduced the concept of Zone of Proximal Development. The ZPD is the distance between a

student's ability to perform a task under adult guidance and/or with peer collaboration and the student's ability solving the problem independently. The theory also states that scaffolding, or supportive activities provided by the educator, or more competent peer, to support the student as he or she is led through the ZPD. The last one is Gardner's Theory of Multiple intelligences. Howard Gardner's Theory of Multiple Intelligences honors and promotes the development of all seven avenues of intelligence in young children. This approach provides a framework to identify how children learn; to build on their strongest assets; to help them become more intelligent by exposing them to a variety of ways of learning; and to use teaching strategies that make learning more efficient, successful, and enjoyable for all children.

Excellent teachers and regular experiences with hands-on learning can provide students with powerful learning in mathematics. The above theories helped the researcher to gather the necessary information needed in determining the effectiveness of Overcoming Numeracy Enigma through Mathematics Manipulative Tools in Lumban Central Elementary School. Lumban Sub-Office , Division of Laguna, School Year 2022-2023.

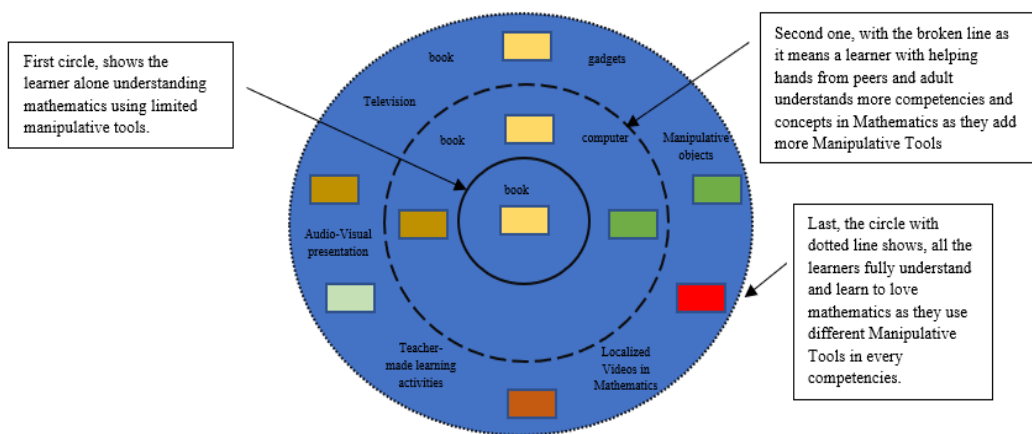


Fig. 1. This figure shows the several theories in one concept in relation to applying different manipulative tools in Mathematics. Circle shaped represents the learner /s. Rectangular shaped represents the skills and manipulative tools they used.

1.3. Conceptual Framework

The figure on the next page shows the independent and dependent variables for this study. The input shows the manipulative tools in Mathematics as well as the selected topic, specifically, addition with regrouping.

The framework presents the independent variables on mathematical manipulative tools as to of objective, content, development and evaluation whereas the dependent variable includes the academic achievement of Lumban Central Elementary School learners.

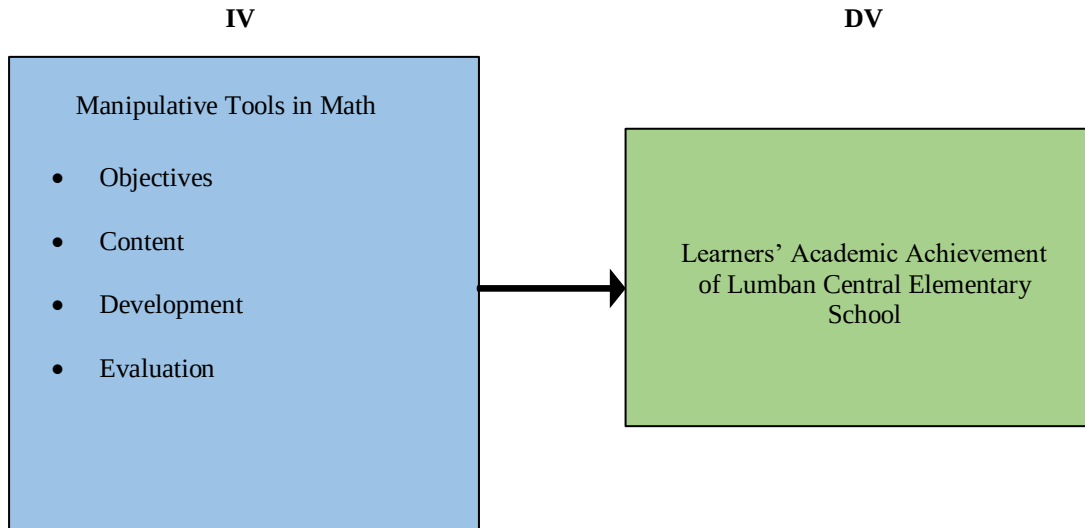


Fig. 1. The research paradigm

1.4. Hypothesis

There is no significant difference between of the learners using Mathematical manipulative tools to the learners' academic achievement of Lumban Central Elementary School, Lumban Sub-office, Division of Laguna

1.5. Statement of the Problem

This study seeks to determine the effect of using Mathematical manipulative tools to the learners' academic achievement of Lumban Central Elementary School

Specifically, it sought to determine the answer to the following questions:

- 1.) What is mean level of Mathematics manipulative tools as to:
 - a.) Objectives
 - b.) Content
 - c.) Development
 - d.) Evaluation;
- 2.) What is the mean level of the academic achievement of the learners using Mathematics manipulative tools? and
- 3.) Is there a significant difference between the academic achievements of the learners using Mathematics manipulative tools?

1.6. Significance of the Study

The researcher believed that the results of this study will benefit the following:

Curriculum Specialists. They could also benefit from this study in identifying the parameters that may contribute to better teaching-learning outcomes. The findings may also provide an alternative learning strategy in line with the educational goals of K to 12.

Learners. The study can help the pupils to increase their understanding of mathematical concepts

especially in the topic of four fundamental operations. Manipulative is suggested to be used in most of Math – Primary level topics to ease the teaching learning process.

Mathematics Teachers. This research will give teachers new idea on how to improve the critical thinking skills and performance of Primary Pupils. It can highlight the resourcefulness of the teachers that can provide alternative teaching materials that can discover the pupil's learning capacity and capabilities in solving mathematical problems.

Researchers. The study can help future researchers to identify the do's and don'ts in making supplementary teaching materials. The study made a realization of the importance of the interaction with the manipulative tools can increase the learners' mathematical performance by improving retention and understanding concepts in Mathematics.

Parents. This Math manipulative tool will help them train and monitor their children's learning progress at home. The manipulatives can make their child learn in a more practical and efficient way. Principals. This Math manipulative tool will help them to impart their knowledge on how this tool is made and what is the efficiency of this materials to the pupils specially in elementary level.

1.7. Scope and Limitation

This study will make use of the learners of Lumban Central Elementary School as the respondents in questionnaire. Then the construction of the instructional materials or the manipulative tools for Mathematics. Taking into considerations the pieces of information, notes and discussions, the researcher started to create and develop the manipulative tools in teaching the learners. The results will be based from the mps of spot tests given to the learners. Since the study was about the use of manipulative tools, the validity of it was tested by the expert in the field of Mathematics. The status of the developed instructional materials were reviewed by those 2 master teachers in Lumban Central Elementary School, Lumban Sub-office.

2. Related Readings

This section presents literature and studies both from foreign and local sources which are relevant to this investigation. They are reviewed to support the problems being studied.

The National Council of Teachers of Mathematics (N C T M) Principles and Standards for School Mathematics emphasizes the importance of using manipulatives and visual representations, as well as mathematical modelling, in each of its standards at all grade levels. This paper discusses some of the ways manipulatives can be used to enhance and deepen mathematical understanding for all students.

Van de Walle et al., (2018) define a mathematical tool as, “any object, picture, or drawing that represents a concept or onto which the relationship for that concept can be imposed. Manipulatives are physical objects that students and teachers can use to illustrate and discover mathematical concepts, whether made specifically for mathematics (e.g., connecting cubes) or for other purposes (e.g., buttons)”. More recently, virtual manipulative tools are available for use in the classroom as well; these are treated in this document as a tool for teacher modelling and demonstration.

The use of manipulatives in teaching mathematics has developed over time. Golfashani (2018) noted that teaching mathematics have moved from using beans or counters to linking cubes, fractions circles and other technologies. With the increased use of manipulatives, a new attitude is evolving towards mathematics. Mathematics is no longer a set of concrete rules to follow but rather a way of thinking. There are now reasons behind the rules.

The word “manipulate” originates from the Old French word “manipûle”, meaning “handle”. In English it means “to move or control, to operate, to manage with one's hands”. Manipulatives are concrete learning materials that allow students to comprehend abstract concepts through concretizing them thus help

them to establish a relation between the manipulatives and abstract mathematical concepts by offering concrete experiences (Holmes, 2018). Mathematical tools are essential to understanding the world around people. They give them the ability to quantify, analyse, and predict complex systems in a way that words alone could not. Mathematical tools are tools that mathematicians use to solve problems and make connections. They can be as simple as a pen and paper, or as complex as a computer program.

According to Shaw (2017), manipulatives take many forms in elementary and middle grades classrooms where students are learning mathematics by doing mathematics. Base-ten blocks, two-colored counters, fraction strips, beans, and geometric solids are a few of the many manufactured and teacher-made manipulatives that students might use during their K–6 mathematics experience. Manipulatives have been used over the long term for many years at the primary and early elementary grades. Through many studies manipulatives have shown to be beneficial in mathematics. Wenglinsky (2019) found that teachers, reporting use of a variety of instructional aids, covered more content, and the use of these aids was found to strongly relate to student achievement in topics such as geometry, ratio, proportion, and percent

Manipulatives are concrete objects that can be viewed and physically handled by students in order to demonstrate or model abstract concepts. They represent a category of mathematical tools that are referenced in mathematics standards such as the Mathematics Process Standards included in Principles and Standards for School Mathematics (NCTM, 2016) or the Standards for Mathematical Practice included in the Common Core State Standards for Mathematics (National Governor's Association et al, 2018). Manipulatives enable students to integrate their knowledge and associate them with their thoughts in order to understand mathematical concepts thoroughly (Boggan, 2016); they contribute to students' communication with their own mathematical thinking and to bringing their mathematical ideas to a higher cognitive level. They also evoke amusement in the teaching process by providing active participation of both students and teachers and in this way, lead to permanent learning through creating equality of opportunity among students.

Manipulatives are physical teaching tools which engage students not just visually, but also physically. These learning tools include anything from coins to puzzles and blocks. The use of manipulatives is becoming more popular because students are actively involved in the learning process. By touching and exploring hands-on materials, children use their senses, which allows more cognitive connections to be made with a concept. Although there are dozens of manipulatives that are used to facilitate students of all ages, the pedagogical basis to use each one of them remains the same. Today's teachers can use these manipulatives to teach math in such a way that students can easily understand abstract mathematical concepts. Manipulatives assist students as visual models develop children's understanding. Students are often lost in a muddle of symbols and numbers. For that reason, they need something concrete to understand difficult and complex math concepts (Yero, 2019).

Manipulatives are concrete objects that can be viewed and handled by students. Students have the opportunity to explore and manipulate these objects in order to gain an understanding of mathematical concepts. They are often used to help students learn a new concept or to reinforce an existing one. They can be used in many subjects, including math, science, and social studies. They are used to demonstrate, reinforce, and help students retain material. Manipulatives can include physical objects like coins, beads, blocks, etc., as well as non-physical objects like graphs or charts. Manipulatives can be used in many ways: they can help students visualize concepts and make them more memorable; they can help students understand the relationships between numbers; they can emphasize the importance of certain numbers or values; they can help students develop motor skills; they can assist in understanding abstract concepts; they can be used to help solve problems.

Math manipulatives are small objects that help with teaching math. They are useful tools for teachers and students. They provide a hands-on way in which to explore and learn. When children are using these materials in natural ways, they are learning differently than they are when they are only listening or

watching a lesson. This tactile learning builds a more profound, personal understanding of math concepts. Math manipulatives make math FUN! Children of all ages enjoy using these concrete tools to make sense of the problems they are given. They mainly help younger learners who are learning new math concepts for the first time. A relationship is built when children see how to solve problems and given opportunities to “try” something using math manipulatives. With repeated practice and “play” with manipulatives, math fluency develops.

Math manipulatives are small objects that help with teaching math. They are useful tools for teachers and students. They provide a hands-on way in which to explore and learn. When children are using these materials in natural ways, they are learning differently than they are when they are only listening or watching a lesson. This tactile learning builds a more profound, personal understanding of math concepts. Playing cards make useful math tools because they have numbers on them. They can be used to teach addition and subtraction through games like addition “war” and subtraction “war.” Playing cards, like these, come in traditional decks that you can find at most stores or dollar stores. Buying them in bulk playing card sets and having a pack for each student is helpful. Teachers would benefit from a set of jumbo playing cards to use for lessons and demonstrations as they provide a significant visual for kids.

Another must-have manipulative is the two-color (red and yellow) counters. They have many uses and help little learners learn to count, make patterns, add, and subtract. They are an essential tool for teaching addition that I use frequently. Students use them for independent practice and help in solving addition and subtraction problems. Number lines are important for many number concepts, such as counting, sequencing, and number recognition. Students can be taught how to solve addition and subtraction problems by jumping up or down the number line. Provide students with a number line, such as these personal number lines. Use a large number line to display on a bulletin board for class demonstrations (Proud to be Primary, 2016).

Manipulatives are concrete objects that can be viewed and physically handled by students. They can be used to help learners understand concepts and improve their skills, but they can also be used in the process of teaching them. In a traditional grade-level mathematics classroom, the use of manipulatives has become essential in providing students with the knowledge to conceptualize basic math operation skills. This approach to instruction involves using physical tools to enhance student understanding of the mathematical content. Teachers are finding the need for using manipulatives to create effective, active, and engaging math lessons. Using manipulatives, or “tangible objects,” can provide for a variety of learning styles and abilities within classrooms (Horan & Carr, 2018).

Horan and Carr (2018) define manipulatives as concrete objects that allow students hands-on experience while being actively engaged in the learning. There are multiple ways to use manipulatives. In the classroom, teachers are using manipulatives in a lesson as they introduce, practice or remediate a mathematical concept (Hidayah et al., 2021). These physical tools may include a variety of concrete objects that might be used at the elementary level such as counters, fraction strips, pattern blocks, cubes, geoboards, etc., for all kinds of math instruction. Using manipulatives as an approach provides a foundation which will encourage critical thinking and students' ownership of their work. Teachers are able to have a vivid picture of student understanding in which they can determine the next appropriate steps (McDonough, 2016).

Teachers were starting to use manipulatives to enhance their lessons and saw positive outcomes in their students' mathematical skills. In the 1900s, Italian physician and educator Maria Montessori developed the use of manipulatives with the goal in mind to enable children to learn through personal investigation and exploration (Hurst & Linsell, 2020). Today, using manipulatives stresses the importance of concrete operations in the primary stages of knowledge formation in young children. In a traditional mathematics class today, using manipulatives is well-established in the classroom.

Based on psychologist Jean Piaget's research, children learn concepts through three levels of knowledge: concrete, pictorial, and abstract (Hurst & Linsell, 2020). As students manipulate objects, they

take the necessary first steps toward building understanding and internalizing math processes and procedures.

Students need to understand the concept at the two levels of concrete and pictorial first before they can handle an abstract or symbolic level (Hurst & Linsell, 2020). To create mental images and models, it is necessary to use concrete manipulatives. Students who show an understanding of the concept at this physical or concrete level are well-positioned to move to the next level where they will be able to use representations of the objects in place of the real objects (Tirosh et al., 2018).

Understanding the interconnections of mathematical ideas can be improved by utilizing manipulatives. Using manipulatives to solve a problem can assist students in keeping track of what they did and explaining their ideas (Hurst & Linsell, 2020). Student-centered learning has a variety of meanings in education. Students are encouraged to engage with their own ideas, experiment with new materials, and explore. A common description of student-centered learning is that students are at the center of their learning where the teacher is there to support and guide students' progress and learning (Keiler, 2018).

Using math manipulatives fosters student engagement in a way that allows for students to explore different math concepts with hands-on learning materials (Hidayah et al., 2021). Math manipulatives are tools that allow students to explore concepts in a way that is engaging and educational. They can help students to understand complex math concepts on a deeper level, without being too abstract or confusing. Using math manipulatives fosters student engagement in a way that allows for students to explore different math concepts and apply what they have learned. This can be done by creating a problem, then having students use the manipulatives to solve it. Using this method allows students to take control of their learning, which is more likely to lead to them being successful when they are given more difficult problems to solve. The use of manipulatives allows students to see the properties of numbers and shapes in a concrete way that has been shown to help increase retention and comprehension.

Research shows that when manipulatives in mathematics are used effectively, student understanding and engagement increases because manipulatives aid in the understanding of visual concepts through the use of visuals, scaffolding learning, and engaging students in learning (Cockett, 2015). Students are able to link representations based on manipulatives with written, symbolic representations. Authors Cockett and Kilgour (2015) did a quantitative study on the impact of using manipulatives in mathematics on student understanding, efficiency, engagement and enjoyment. During this study, several types of manipulatives were used with students participating in various mathematical activities. Observations were also part of collecting qualitative data. The results concluded that students were more engaged when using manipulatives, and that their perception of their learning environment improved in each of the three areas: enjoyment, understanding, and efficiency.

In addition to enjoyment, concrete things that imitate daily objects help youngsters learn concepts by allowing them to draw on their practical expertise. Students are building up their problem solving skills and making connections. Planning instructional engagement activities is a huge part of students' motivation. Manipulatives give that extra boost in creativity and an increase in skills in students. A Yale University study (Hurst & Linsell, 2020) found that simple objects kept elementary students involved and entertained with very high levels of attention and concentration. The use of concrete models can facilitate the development of number sense as well as develop the meaning of written symbols and help students develop a sense of place value (Hurst & Linsell, 2020). By using this method, teachers can get a better understanding of what students know, as well as identify misconceptions, so they can design interventions accordingly.

Hidayah et al., (2021) stated, "the use of manipulatives is still limited to the use of classical and group learning. The students, therefore, could not repeat the math manipulatives instruction by themselves after class" (p. 539). The manipulatives' nature allows students to manipulate them in order to learn certain ideas. It is necessary to have manipulatives, but it is also important to know how to utilize them appropriately in a well-designed learning experience. When teaching mathematics, educators who are aware of their

students' competency levels can effectively scaffold content. To do so, teachers must first comprehend how their students think and why they think that way. Mathematical knowledge acquisition in early learners is dependent on student-centered mathematics education; consequently, educators should endeavor to provide a mathematically rich atmosphere in which children critically explore concepts, solve problems, and openly discuss their thoughts.

Teachers who use tangible manipulatives effectively in their classrooms can have a favorable impact on their students' arithmetic skills. When it comes to employing manipulatives in the classroom, the advantages are infinite. The use of these tools enhances students' learning experiences, bridges the gap between the physical and abstract, and, ultimately, fosters life-long learning in curious young learners. Using manipulatives is of value in the mathematics classroom, especially when students are making their own connections to problem-solving in relation to mathematical concepts. Another connection is how the role of manipulatives and metacognition go hand in hand with young children's cognitive development. Metacognition is when one observes, tries, and reasons with various mathematical concepts. It is thinking about thinking; a way for student learning to be enhanced and for them to understand their own learning processes (Dinsmoor et.al., 2022).

Math manipulatives are objects that students can use to better understand a math concept or skill. They can take many different forms, but they are all tools that students can use to help them represent and solve a math problem. Math manipulative empower students to learn foundational and complex concepts and skills through developmentally appropriate hands-on learning experiences. Elementary math manipulative are often given to classroom teachers by their school district; however, this is not always the case. Sometimes teachers need to find, buy, make, or print their own math manipulatives to supplement what they are given. No matter the case, every elementary classroom must have an abundance of math manipulatives to support student learning. Some examples of math manipulatives are base-ten blocks, unifix cubes, and coins. There are a lot of different kinds of elementary math manipulatives and they even come in many different forms. Virtual math manipulatives are online and can be accessed using a desktop computer, laptop, iPad, or interactive white board. These are sometimes offered through curriculum programs or for free online. These are a great option, but should be accompanied with ones students can manipulate and hold in their hands. When students can physically touch manipulatives, it helps their brain make important connections (Durgin, 2021).

Math manipulatives are objects that help students understand mathematical concepts by allowing them to work with the numbers and symbols of mathematics. The ability to manipulate objects is an important part of learning any subject, but it is especially important when trying to learn math. Math requires students to make connections between abstract ideas like multiplication and division and the real world around them. Manipulatives allow young minds to explore these connections by giving them something tangible on which they can model those concepts. Using simple physical objects that students can visualize, touch and move to express their thinking is an inexpensive and effective classroom resource to explore mathematical concepts and encourage learning. No one strategy or tool will improve a student's proficiency in mathematics in isolation. However, using manipulatives – where purposeful and in line with other evidence-informed strategies, such as developing metacognition or structured interventions – is likely to improve student outcomes.

Manipulatives are physical objects that students can visualize, touch and move. Increasingly, there are virtual alternatives to physical manipulatives, however, the evidence base draws primarily from research conducted using physical tools. Ensure that there is a clear rationale for using a particular manipulative or representation to teach a specific mathematical concept. Manipulatives should be used to provide insights into increasingly sophisticated math. Enable students to understand the links between the manipulatives and the mathematical ideas they represent. This requires teachers to encourage students to link the materials (and

the actions performed on or with them) to the math of the situation, to appreciate the limitations of concrete materials, and to develop related mathematical images, representations, and symbols. Try to avoid students becoming reliant on manipulatives to do a type of task or question.

A manipulative should enable a student to understand math by illuminating the underlying general relationships, not just 'getting them to the right answer' to a specific problem. Manipulatives should act as a 'scaffold', which can be removed once independence is achieved. Before using a manipulative, it is important to consider how it can enable students to eventually do the math without it. When moving away from manipulatives, students may find it helpful to draw diagrams or imagine using the manipulatives. Manipulatives can be used to support students of all ages, depending on where they are in their learning journey. The decision to remove a manipulative should be made in response to the students' improved knowledge and understanding, not their age (Susannah, 2020).

Math manipulatives allow students to work with math in the way that's best for them. By working independently with math manipulatives, a student is better able to work at their own pace and spend more time on concepts or problems that are particularly difficult for them. Many math concepts are conceptual and hard for students to visualize on paper. By practicing math processes with math manipulatives, learners can see exactly how the process affects the numbers and how problems are solved. Dominoes are much more than just a fun game. They're also one of the best foundational math manipulatives. Dominoes can be used to teach a variety of math skills — like addition, multiplication, division, and subtraction. And they're particularly helpful in younger grade levels. They're easy for even the youngest students to grasp and move, and they can help math learning feel like a game. Pattern blocks are a math manipulative perfect for geometry lessons. These blocks are made of either plastic or wood and come in a variety of shapes — like triangles, squares, rectangles, and trapezoids. Online math games can even support student learning over the summer months or during school breaks. The fun nature of online games keeps students excited and learning at home — because they don't feel like homework (Prodigy, 2022).

According to D'angelo and Iliev (2012), using manipulatives aids in furthering student comprehension of mathematical knowledge. As students are given the chance to explore on their own with the chosen manipulatives they are able to critically think and make connections in understanding the math concept. Data have shown that concrete objects can help children gain access to concepts and processes that might otherwise be inaccessible. Looking at a specific group of students, English language learners' (ELLs) comprehension increases immensely. Data have shown that ELLs, "improve in vocabulary development, oral proficiency, comprehension, and display enthusiasm to continue using the manipulatives" (Stapleton, 2014). ELL students' comprehension increased because they had to interpret a directive with an action in solving the problem. Therefore, the use of hands-on, multi-sensory manipulatives to help students increase comprehension is encouraged.

Another connection is how the role of manipulatives and metacognition go hand in hand with young children's cognitive development. Metacognition is when one observes, tries, and reasons with various mathematical concepts. It is thinking about thinking; a way for student learning to be enhanced and for them to understand their own learning processes. (Belenky et al., 2009) state, "metacognitive prompts are questions that ask students to reflect on various aspects of the learning materials and problem-solving process and have been hypothesized to facilitate abstraction and learning". Students given concrete manipulatives with metacognitive prompts have shown a better transfer of procedural skills than students given abstract manipulatives with problem focused prompts. As a result, the manipulatives utilized in mastering sophisticated cognitive skills taught in mathematics are critical to increasing comprehension.

The use of multi-sensory manipulatives as tools has been said to increase involvement and interaction in teaching ESL students. In a journal article, Stapleton (2014) stated the following: Students enjoy working with hands-on manipulatives which increase the opportunity for student involvement and

interaction. Students who use the materials do not sit passively while the instructor attempts to verbally explain a concept. Students are encouraged to participate with other students, make connections with new concepts, and draw conclusions based on their understanding. This brings us to the next point: visualization. Where some students learn best with visuals, math manipulatives also aid with being able to conceptualize a math problem (Carbonneau, 2013). While students can recall material from books and lectures for short periods of time, deep understanding and the ability to apply what they've learned to new contexts necessitate conceptual understanding anchored in actual interactions with concrete objects (D'angelo & Iliev, 2012).

In order to implement formative assessment well, shares five key strategies. Three are particularly well-supported by manipulative-based instruction: classroom activities and learning tasks which elicit evidence of learning, activating learners as instructional resources for one another, and activating learners as owners of their own learning. In all three cases, by actively engaging students in the doing of mathematics, manipulatives provide a foundation which encourages discussion and student ownership of their work. This provides teachers with a vivid current picture of student understanding and guides teachers in determining appropriate next steps.

The foreign literature mentioned above can be more useful and effective in the conduct of this research.

The Philippines is one of the many countries preparing its citizens to address the critical problems in the economy, society and even that of the environmental. As reported by the Department of Education (DepEd), the 2005-2010 National achievement tests show that many students who finished basic education do not possess sufficient mastery of basic competencies. This apprehension led the Philippine government to implement the K- 12 program. Methods, such as the use of material sources or instructional aids supplement the major methods where children learn both content and processes of science (Cruz, 2016).

Maligalig as cited by Galleto (2017) asserted that quality in education is mirrored in the performance of students in achievement test and is an old time problem confronting Mathematics education across educational level. According to Oladejo (2018) a manipulative teaching material is defined as any object from the real world that children can move around, play with or even build model of, to show a scientific concept. They are concrete, hands-on models that appeal to all the senses and can be touched by students. These manipulative teaching materials should relate to a student's real world. Low-cost manipulative materials produced through inventiveness are not an attempt to provide a weak science education, but purchase highly creative and productive system of education that can readily use available.

Ingram (2017) supported that poor teaching strategies such as skill and drill, copying from the board, and memorizing formulae create low motivation in students which in turn leads to low academic performance. He strongly suggested that teachers need to avoid these monotonous traditional strategies in order to provide a more positive view of Mathematics in their students. Technology has become an important – if not a necessary – part of the mathematics classroom not only because it enhances learning, but also because the ability to use technological tools is a necessary skill in today's world. The Philippine K to 12 mathematics curriculum framework recognizes that "the use of appropriate tools is needed in teaching mathematics (de las Peñas, 2019). In recent years we have seen the rise in the use of MT (e.g., smartphones, tablets) in mathematical learning. Accompanying the rising popularity of MT is the growth in the number of mobile apps in mathematics (Larkin 2015) and studies have been carried out to measure their impact on mathematics education (Calder et al. 2018, Fabian et al. 2018, Larkin and Calder 2016). MT also has the potential to transform the learning experience and enhance mathematics learning opportunities. It is portable, easy to boot up, and can easily fit in one's hand.

Due to the increasing demands of the twenty-first century work environment, education system must reflect those skills essential for success. Through the development of the 21st-century standards for teachers and students, the Philippines education system has begun the reform process to initiate change towards

addressing these new skills. It is through the introduction of various strategies and innovative materials in the teaching-learning process aligned with the development of the 21st-century skills (Campilla, 2021).

Poor numeracy among students has been an alarming problem not only in the Philippines but also throughout the world. It incapacitates a person in dealing with daily activities especially with complex mathematical demands of life. The learning of fraction concepts and basic operations has been especially problematic. Strategies that ensure students do benefit from the mathematics curriculum must be in place. One way of teaching mathematics that increases learning opportunities is through the use of materials with which students are familiar (Faustino, 2021). Teaching in today's mixed-ability classroom can be a challenge. These days, it's not uncommon to find a wide range of abilities in the one classroom—from students struggling to grasp new concepts, to those who are way ahead of their peers from day one. This factor has contributed to a range of problems for early math learners, including a large achievement gap between students. While individual students do benefit from different learning styles, there are a range of effective strategies which can help all students to succeed.

Additionally, the highly engaging, self-paced Math seeds program offers a research-based solution for mixed-ability K–2 math classrooms, making math fun, interactive, and personalized for young learners. Elementary math can be difficult because it involves learning new, abstract concepts that can be tricky for children to visualize. Try to imagine what it's like for a five-year-old to see an addition problem for the very first time. Since it's a totally new concept to them, it can be hard for them to visualize a scenario where one quantity is added to another. Manipulatives are hands-on tools that make math a lot easier for young children to understand. Tools like Lego, clay, and wooden blocks can all be used in the classroom to demonstrate how math ideas work. It's important that students feel comfortable and are given the opportunity to learn new math ideas at their own pace, without feeling rushed. But while the idea that 'given enough time, every student will learn' is nothing new, it's easier said than done. Mastery learning is about giving students as much time as they need to grasp a specific skill or concept. It involves varying the time you give each student to succeed. Technology-based classroom tools offer a powerful way to differentiate learning while teaching elementary math, which is an effective way to help students in mixed-ability classrooms to succeed.

Meta-cognition is the process of thinking about your options, choices, and results, and it has a big impact on the way students learn. Before assigning a math problem, ask students to brainstorm problem-solving strategies they can use. Encourage students to work together to suggest different strategies in a respectful way. This process can be carried out at every stage of problem solving when teaching elementary math. Once students have offered an answer, ask them to verbalize step-by-step how they got that answer (Math Seeds, 2018). The basic education landscape in the Philippines changed upon the implementation of the Enhanced Basic Education Act of 2013, the law that implemented the K-12 educational system. Accompanying the change is the challenge on the change of perspective of effective teaching of mathematics. The framework of the K-12 mathematics curriculum also focuses on two goals: the development of critical thinking and problem solving skills among the Filipino learners. Hence, transitioning from the conventional teaching of mathematics towards a more student-centered approach in delivering mathematics, efforts have been made to capacitate sizeable force of teachers and administrators to institute change in the field of teaching mathematics (Buan & Liwanag, 2021).

Math can be challenging for many students. At the same time, integrating research-based teaching strategies can significantly improve their understanding of the material throughout their primary and secondary education. A simple strategy teachers can use to improve math skills is repetition. By repeating and reviewing previous formulas, lessons, and information, students are better able to comprehend concepts at a faster rate. When teachers are moving beyond the simple concepts of numbers into addition, subtraction, multiplication and division, it is important to incorporate timed tests that review the previous class or several classes. Taking a short test and then grading the test in class will help teachers assess student understanding.

When the test shows that students are answering more questions correctly within the time period, teachers are able to determine that students have mastered the basic skills.

Mathematics is not limited to learning from a textbook, lessons, or testing strategy. Students have different learning styles and need to have lessons that help improve all styles of learning to get the best results. Group work is a simple strategy that allows students to work and problem-solve with a buddy. When a teacher has provided the basic instruction, it's helpful to split the class into pairs or groups to work on problems. Manipulation tools make it easier for students to learn and understand basic skills. These are ideal when students learn best through hands-on experience and building, rather than traditional lessons and repetition.

Reinforcing the information learned in class is not always the easiest task for teachers, but math games provide the opportunity to make the lesson interesting and encourage students to remember the concepts. Depending on the class size, computer availability, and the lesson being taught, games can vary. Teachers can use computer games for the particular skills or can opt to use class games to make the lesson more fun. Teachers should be sure to incorporate a strategy into games to help students learn the material. The youngest students are at the onset of their math literacy, and teaching strategies for kindergarten math must be developmentally appropriate. Start with imparting basic ideas such as counting and number recognition before moving on to more advanced concepts. It is well established that younger students are concrete learners and can more easily grasp mathematical concepts through hands-on and visual approaches. The use of manipulatives, such as counting bears of different colors, can be used to teach basic counting and sorting concepts (Nonesuch, 2023).

Math manipulatives are a great way to teach math in the classroom. They allow students to get hands-on with their learning, and they help them visualize concepts that might otherwise be hard to grasp. Math manipulatives are tools that can be used to help students learn math. For example, a number line is a visual representation of numbers, which can be used to help students understand where different numbers fall on the number line. Math manipulatives can also include physical representations of mathematical concepts. This could include things like gears or blocks with different shapes and sizes that can be used to model an algebraic expression or equation. Math manipulatives are great tools for teaching math. They allow students to see, touch, and feel the concepts they are learning. The best part is that there are so many different types of math manipulatives available to use in the classroom. Math manipulatives can be used with all ages and grade levels. They can be used for individualized instruction or in large group settings.

Mathematics is considered the mother of all learnings in both Arts and Sciences. It is a tool for understanding structures, relationships and patterns to produce solutions for complex real life problems. But many students possessed of negative perception on mathematics as an academic discipline. This feeling effectively hindered their potential to learn and understand mathematical problem. Consequently, for them to cope with the negative perception, modern day teachers and scholars employed innovations in teaching mathematics to help students overcome fears and improve their performance on the subject. Cooperative learning is defined and conceptualized by many related literature as a teaching method whereby students support each other by working in a team. Each student contributes their own effort to promote the group performance. Learners elaborate concepts that promote deep understanding while teachers act as facilitators by providing instructional materials. In cooperative learning, they are actively involved in the process of learning and understanding very much different from conventional learning where teacher is viewed at the core of the learning process (Gamit et. al., 2017).

The practical math apparatus that is used in classrooms such as multilink cubes, Dienes, counters and bead strings. They are equipment that children can pick up and manipulate and which can help children to understand the relationship between numbers and the number system. Manipulatives can be made from almost any material. The most commonly used manipulatives are blocks, shapes, counters, clock dials,

spinners, and pieces of paper. Not every child learns math easily. Too often, it is seen as a difficult subject and this is a predisposition, we'd like to get rid of. Adding manipulative to a math session is one way to overcome this. By giving children different ways to learn math, you're offering more opportunities for them to be involved in the lesson.

Hands-on activities are known to engage kinesthetic learners. Teaching a class that suits everyone's educational needs is a challenge. By varying the types of activities, you're bound to cover different types of learners. Having a session with manipulatives can also be used to identify areas that children struggle with. You're transitioning a lot of the theoretical concepts into a practical format. This is great for supporting their learning. In Mathematics, the use of manipulatives is a highly effective method for teaching mathematical concepts. Manipulatives are objects that students can manipulate to demonstrate and practice concepts such as addition, subtraction, multiplication, division and fractions. Examples of manipulatives include blocks, dice and counters. The goal of using manipulatives in math class is to give students an immersive experience where they can visualize the process of solving a problem and be able to apply what they have learned outside of the classroom setting. For example, when learning how to add numbers together using a set of blocks, students may need help from their teacher or parent while they practice making groups of three blocks.

The Local literature mentioned above can be of most help in the conduct and development of this research.

3. Research Design and Methodology

3.1. Research Design

This study employed a descriptive research design, to test causal hypotheses. It also used the quasi experimental design in order to test the difference between the control and experimental group of respondents. So for this study cluster sampling was used. With cluster sampling, the researcher divides the population into separate groups, called clusters. Then, a simple random sample of clusters is selected from the population. The sample were chosen specifically based on their grade level. The idea behind this technique is that the researcher can concentrate on the respondents' specific characteristics which better assist the researcher with relevant information.

3.2. Respondents

The respondents of this study are the learners of Lumban Central Elementary School. It comprises of learners from grade one to grade six. This study was conducted school year 2022-2023.

3.3. Data Gathering Procedure

The gathered data will be tabulated, and interpreted using the following tools. Mean and standard deviation have been used to determine the mean level of the use of manipulative tools in teaching Mathematics. The responses was tabulated and used as the basis for the statistical treatment of data. Mean was used to convert the responses into scores as basis for determining the verbal interpretation as scaled into five optional answers.

Mean of Grouped Data:

$$\bar{x} = \frac{\sum fx}{n}$$

where: $\bar{x}$ = mean
 f = frequency of each class
 x = mid-interval value of each class
 n = total frequency
 $\sum fx$ = sum of the product of mid - interval values and their corresponding frequency

Standard deviation was used to have a better idea on how the data entries differ from the mean.

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

$\bar{x}_1$: Mean value of the first group

$\bar{x}_2$: Mean value of the second group

n_1 : Size of the first group

n_2 : Size of the second group

s_1 : Standard deviation of the first group

s_2 : Standard deviation of the second group

3.4 Research Procedure

The researcher submitted the proposed title of the study to her research professor for approval. Upon receiving the consent, information were gathered through reading books in the library, magazines, unpublished theses and various online articles and also sought advices from the people who are expert in the formulation/adoption of the possible questionnaire for validation.

Then the construction of the instructional materials or the manipulative tools for Mathematics. Taking into considerations the pieces of information, notes and discussions, the researcher started to create and develop the manipulative tools in teaching learners..

Since the study was about the use of manipulative tools, the validity of it was tested by the expert in the field of Mathematics. The status of the developed instructional materials were reviewed by those 2 master teachers in Lumban Central Elementary School.

3.5. Statistical Tools

The statistical treatments will be used for this study: For statement of the problem number 1 and 2, mean and standard deviation were used to measure students level of achievement in utilization of the Mathematics manipulative tools.

For statement of the problem number 3, t-test for two sample means was used. The formula is given below:

4. Presentation, Analysis and Interpretation of Data

This section lay out the result of the study in tabular forms. All questions in the statement of the problem are carefully answered through the presentation, analysis and interpretation of the results.

Table 1 . Mean level of learners' academic performance in terms of MPS before utilization of Mathematics manipulative tools

Grade Level	Math MPS
Grade One	71.88
Grade Two	70.54
Grade Three	70.03
Grade Four	64.08
Grade Five	67.46
Grade Six	68.21
Mean	68.70
SD	4.12

The table above shows the mean level of Math academic performance of learners in terms of mean percentage score (MPS) from learners Grade one to six in Lumban Central Elementary Schoos in Lumban Sub-Office, during the school year when learners' Mathematics Manipulative tool was not yet being utilize. The average MPS of the nine schools is 68.70, signifying moving to mastery level. The standard deviation of 4.12 signifies heterogeneity and can be attributed to different factors such us school culture, teacher factors, student factors, and even family support.

Table 2. Mean level of learners' academic performance in terms of MPS after utilization of Mathematics manipulative tools

Grade Level	Math MPS
Grade One	76.48
Grade Two	75.14
Grade Three	74.63
Grade Four	68.68
Grade Five	72.06
Grade Six	72.81
Mean	73.30
SD	4.67

The table above shows the mean level of Math academic performance of learners in terms of mean percentage score (MPS) from learners Grade one to six in Lumban Central Elementary Schools in Lumban Sub-Office, during the school year when learners' Mathematics Manipulative tool was being utilized. Appreciation is already being considered. The average MPS from the nine schools is 73.30, interpreted as moving to mastery level, and noticeably 4.60 points higher than the previous school year. The standard deviation which is 4.67 still connotes heterogeneity but 0.70 points lower than the previous school year, signifying better performance because of lower variability.

5. Summary, Conclusion and Recommendation

This section recaps the important parts of the study by giving the summary, discusses the conclusion, and leaves recommendation to target person or group of persons.

5.1. Conclusion

Based from the findings of the study presented, the following conclusions were drawn:

1. In addition to aiding comprehension, manipulative have also been effective in helping students increase their problem solving skills. In particular, students who used tangible objects to learn about mathematics showed an increase in their ability to apply problem solving skills to real-life problems. This suggests that manipulative can be used to not only help students understand mathematics but to also prepare them for real world challenges.

2. Conclusively, manipulative tools greatly benefit learners in their ability to understand difficult concepts. It has consistently shown that the use of manipulative tools facilitates the development of deeper understandings, as well as improved problem-solving skills. Moreover, learners often feel more positive about their education when manipulative tools are used, finding it more engaging and stimulating. As a result, it's clear that manipulative tools are an effective means of enhancing learning outcomes, and can be a great way to help learners understand difficult concepts.

3. Mathematical manipulative tools help students learn math better and increase their acceptance of the subject. This can be attributed to the fact that these tools provide students with a physical understanding of the concepts taught, allowing them to visualize and make connections between the problems they are trying to solve. Additionally, the use of manipulative helps to reduce the cognitive load of learners, allowing them to better comprehend the material

5.2. Recommendation

Based on the findings and conclusion of the study, the following are recommended:

1. Using manipulative tools can be a great way to help learners understand and apply abstract concepts in math. Use questions and prompts to facilitate this exploratory learning process. By encouraging exploration, discussion, and real-world applications, teachers can help learners develop their problem-solving skills and have fun while doing it.

Teachers should be encouraged to discuss their observations and the process used to come to a conclusion with the learners. This helps to build problem-solving skills and promote logical thinking.

2. There is a great deal of evidence to suggest that manipulative tools can be very beneficial for student learning, but it is also important to keep in mind that not all students may feel comfortable with their use. As such, it is important to consider each student's individual needs and choose manipulative tools that are best suited for their individual learning style.

3. It is recommended that teachers use manipulative tools in the classroom in order to help students learn math effectively and increase their acceptance of the subject. These tools can also be used to

demonstrate math principles in a concrete way, so students are able to better understand the material. Additionally, it is important to note that the success of the use of manipulative tools is dependent on the teacher's ability to effectively utilize the tools and choose the most effective manipulative activities for their students.

4. More research with a broader scope should be carried out, taking into account the many different factors that were not taken into account in the previously mentioned investigation.

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