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Effective Math Manipulatives To Use With The B.E.S.T. Standards In Grades K-6

Katharine E. Eby
Florida Atlantic University, keby2018@fau.edu

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Introduction

Question Description

The purpose of this research paper was to explore and investigate which of the most commonly used math manipulatives is the most effective for each of the six strands of the B.E.S.T. standards. The specific questions asked were "which of the most common math manipulatives are the most effective," and "which math manipulatives should be used for each topic of the B.E.S.T. standards?" Much of the research already conducted on math manipulatives is related to which types are effective or whether virtual manipulatives are better for learning over concrete manipulatives. Currently, there is not a lot of research conducted on math manipulatives as they relate to the B.E.S.T. standards. This is due to the fact that the B.E.S.T. standards are both newly developed and implemented. In this research paper it is important to review the literature and investigate the findings to determine which math manipulatives are the most common and effective as it applies to the B.E.S.T. standard strands.

Importance of Math Manipulatives

Over the past forty years, multiple researchers have found that the inclusion of math manipulatives in mathematics instruction has a powerful effect on student learning and understanding of math concepts. This is because math manipulatives are used to transfer abstract concepts to concrete concepts to help students build a deeper understanding of math concepts. A majority of the research gathered supports the use of math manipulatives in everyday math classes as the ability for students to apply learning in alternative situations requires conceptual understanding, which is anchored directly to experience with concrete objects.

Methodology

Research Process Description

To conduct research to investigate these questions, numerous peer-reviewed articles, educational blogs, and mathematics websites were found from the Florida Atlantic University (FAU) library database, Google Scholar, and other general Google searches. All of these resources together round out the research, so that the diverse resources are used to determine which common math manipulatives are ideal to be connected with the six B.E.S.T. standard strands. Some of the terms used when searching for peer-reviewed articles and other resources include some of the following phrases: "B.E.S.T. standards,"B.E.S.T. standard strands," "most commonly used math manipulatives," "purpose of math manipulatives," "strategies for implementing math manipulatives," "history of math manipulatives." These terms were selected as they had a connection to the topic of the research questions, which was the most effective math manipulatives to use with the B.E.S.T. standard strands. The reviewed literature was narrowed down by focusing on whether the resources provided information that could answer the research questions. Additionally, after reviewing some of the literature found using some of the initial searches, it pushed the investigation further to review the history behind the inclusion of math manipulatives, as well as their advantages and disadvantages for implementing these mathematical tools.

Historical Development

History of Math Manipulatives

Math manipulatives are not a recent or modern discovery in education as they have been present in education for at least two hundred years. Prior to the 1800s, one's fingers would be considered one of the first math manipulatives; however, other objects were not considered math

manipulatives until the complexity of math exceeded the usability of one's fingers. Therefore, it was not until the 1800s, in which objects used as math manipulatives were seen as a possible educational tool. Many educational researchers and innovators throughout history have supported the inclusion of math manipulatives as they believed in the importance of having authentic learning experiences in which concrete tools are key features of achieving that level of deep understanding. There are two educational researchers that have strongly influenced and advocated for the use of math manipulatives. One of those researchers was George Pólya who used a Chinese proverb, "I hear, and I forget. I see and I remember. I do and I understand," which explained his reasoning behind the use of math manipulatives. Another researcher was Jean Piaget in which his learning theory supported that children are active learners that master concepts once they progress through the three levels of knowledge: concrete, pictorial, and abstract.

History of Florida State Standards

In order to understand how the new B.E.S.T. Florida standards were developed, it is important that a review of previous Florida standards is conducted. In 1996, the Sunshine State Standards were implemented in Florida's educational system and were broad statements that described the general knowledge students should be able to demonstrate for grades first through twelfth. In 2005, Florida implemented the Next Generation Sunshine State Standards, which were very similar to the Sunshine State Standards, but would be more closely synonymous with Common Core standards. In 2014, the standards changed from the Next Generation Sunshine State Standards to Florida Standards. These standards modified the Common Core Standards further by incorporating more content, so that the focus of math standards was not solely on skills and strategies for solving math problems. In 2020, it was decided that the Florida standards

would once again be changed to a new program called the B.E.S.T. Standards. The B.E.S.T. standards differ from the Florida standards as these standards were specifically made for the Florida educational system by educators in Florida. By fall of 2022, all Florida public schools will have implemented the B.E.S.T. standards for mathematics in all grade levels.

Results

Math Manipulatives

Math manipulatives are physical or concrete objects that are used by students and teachers to illustrate or demonstrate abstract mathematical concepts in a more concrete form. Math manipulatives can be any object(s), even if their intended purpose is not related to mathematics but are being used specifically to build a deeper understanding of mathematic concepts. These educational tools are used for three reasons: to introduce, practice, and remediate mathematic concepts in a hands-on approach. In order for math manipulatives to be effective in bridging the gap between informal math and formal math, the manipulatives used must match the development level of the children. For instance, young children in kindergarten or first grade, are typically very concrete learners, such that they require hands-on objects such as base-ten blocks to connect with more abstract concepts, instead of a place value chart which is considered a pictorial-based manipulative. Overall, the purpose of using math manipulatives is to help students explore and experiment with math topics in order to understand and develop meaning of more difficult or challenging math concepts.

B.E.S.T. Standards

B.E.S.T. standards were approved for implementation in Florida schools as of February 2020. They are considered to be more rigorous than the previously implemented Florida

standards and Common Core standards. This new system is being introduced to schools throughout Florida in order to measure student development and to prepare students beyond their K-12 education. These standards were not only developed as a way to completely remove the Common Core standards, but also to develop standards that have student-centered expectations in which the curriculum, instruction, and assessments are based on. By implementing these standards, the Florida Department of Education is optimistic that they will meet some of their goals outlined when the standards were in development. Some of their goals included creating a roadmap to the number one standard in the United States; increasing the quality of Florida's curriculum; and streamlining the standardized testing for the state. Additionally, there are many benefits associated with these new standards. For instance, the experts intentionally made sure there was a balance between conceptual understanding and procedural fluency, so that not one type of knowledge was favored. Also, there is an emphasis placed on real-world application in which these realistic scenarios are connected to math concepts, so that students can make the connection of why these math concepts are relevant to their education. Though these are some intriguing benefits for implementing this new standards system, one of the main reasons the B.E.S.T. standards have gained so much traction is because this is the first set of standards that were developed by Florida expert educators for students in Florida and are understandable by teachers and parents.

Six Strands of the B.E.S.T. Standards

There are six strands or overarching topics of the B.E.S.T. standards for grade levels Kindergarten through sixth grade. The six strands include: Number Sense and Operations, Fractions, Algebraic Reasoning, Measurement, Geometric Reasoning, and Data Analysis and Probability. The first strand, Number Sense and Operations, encompasses multiple benchmarks

or subtopics for each grade level including the following: counting; place value of whole numbers and decimals; addition and subtraction problems; multiplication and division problems; and integers. The second strand, Fractions, covers the following benchmark topics: partitioning shapes into halves, thirds, fourths; understanding fractions as numbers; comparing fractions with the same and different denominators; relationship between fractions and decimals; and solving math problems using the four operations with fractions. The third strand, Algebraic Reasoning, concentrates on the following benchmarks: fact families for addition and subtraction; writing and solving problems using the four operations; using the order of operations; solving equations and inequalities with one variable; and understanding numerical patterns, inputs, and outputs. The fourth strand, Measurement, centers around the following math topics: measure attributes of objects; tell time and identify elapsed time; understand the value of coins; combining coins and dollar bills; units of measurement; and converting measurement units. The fifth strand, Geometric Reasoning, focuses on the following math subtopics: two- and three- dimensional figures; defining attributes; lines of symmetry; classification of quadrilaterals; perimeter and area; and coordinate planes. Lastly, the sixth strand, Data Analysis and Probability, connects to the following math concepts: collecting, representing, and comparing data; pictographs; numerical and categorical data; mean, median, mode, and range; and statistical distributions. This indicates that there are multiple abstract math concepts within the six strands of the B.E.S.T. standards that would benefit student understanding with the inclusion of math manipulatives.

Math Manipulatives Connected to the Six Strands

For Numbers and Operations there are three concrete math manipulatives that would be most effective for students understanding these math concepts on counting, place value, addition,

and subtraction. The most effective manipulative for understanding place value would be base-ten blocks because they represent ones, tens, hundreds, and thousands. Counters are the most effective manipulative for teaching addition and subtraction problems as students are able to represent two numbers with the two colors on the counter chips. For the math concept of counting, the most effective tool would be unifix cubes as the initial counting math concepts are focused on counting from zero to twenty. This is because the unifix would be the most ideal math manipulative because it is a great way to connect counting ones and turning them into tens.

For Fractions, there is one concrete math manipulative that would be most effective when working on understanding fractions which would be fraction tiles. Fraction tiles come in different variations: the original fraction tiles, fraction circles, and fraction squares. The original fraction tiles are proportionally sized tiles to help students compare fractional values. Fraction circles are circles partitioned to represent a whole, halves, thirds, fourths, fifths, sixths, eighths, tenths, and twelfths. Fraction squares are similar to fraction circles except they are shaped as squares instead of circles. This means, that with any variation of these fraction tiles, students are able to use a hands-on approach to compare fractions and determine whether they are equivalent.

For Algebraic Reasoning, there is one concrete math manipulative that students would benefit from utilizing when learning about algebraic concepts. A X-Y coordinate pegboard can be used to graph coordinates in the four quadrants, as well as display data and display transformations of geometric figures. This means that the XY coordinate pegboard should be paired with algebraic concepts that focus on transformations of geometric shapes for students in grades kindergarten through sixth grade. Once students exceed sixth grade, this manipulative can be used to graph lines on a coordinate plane based on equations with two variables.

For Measurement, there are five concrete math manipulatives that would be beneficial for students when learning about the different concepts of measurement. When learning about mass, a bucket balance would be the most effective tool to help students explore the measurement of mass with accuracy to 1 gram. For the concept of length, width, or height, there are two manipulatives that should be utilized: rulers and unifix cubes. Rulers are used to determine the exact measurement of length, width, and height using inches or centimeters. Unifix cubes allow students to measure the attributes of objects and two-dimensional figures using nonstandard units. When learning about time, geared clocks or Judy Clocks allow students to explore telling time and calculating elapsed time using analog clocks instead of digital clocks. For the concept of money, the math manipulative of play money is ideal to help students with learning to identify the value of coins and count coins and dollar bills. Additionally, all of these math manipulatives for measurement enable students to become familiar with their uses in real-world applications.

For Geometric Reasoning, there are three commonly used concrete math manipulatives that would be most effective for students understanding which are geoboards, pattern blocks, and relational geosolids. Geoboards are used to explore geometric concepts of symmetry, congruency, area, and perimeter. Not only are students able to learn about symmetry or area and perimeter, but geoboards can be used to create two-dimensional figures based on defining attributes. Pattern blocks are ideal for determining which two-dimensional figures can be combined to compose other two-dimensional figures. Additionally, these blocks are important for learning about the attributes for two-dimensional figures. Relational geosolids are three-dimensional shapes that can be used to learn about prisms, pyramids, spheres, cylinders, cones, and hemispheres. This manipulative is beneficial for students to understand the relationship

between two-dimensional figures and three-dimensional figures such that three-dimensional figures are composed of nets which are two-dimensional figures connected together.

For Data Analysis and Probability, there are three concrete math manipulatives that students would benefit from utilizing when learning about probability: playing cards, dice, and spinners. Playing cards are an ideal tool for students to explore probability concepts and understand how these concepts can be applied to real-world situations. Dice are not only used for students to understand probability, but also to predict numerical outcomes with repeated or multiple rolls. Spinners are beneficial for students to explore making predictions about probability and recording the data to draw conclusions. Spinners are different from dive in that they are not limited to numerical outcomes. Instead, spinners can be based on a variety of topics such as colors, animals, or fruits.

Conclusion

In conclusion, math manipulatives are effective educational tools for learning and understanding abstract math concepts. This was evident as math manipulatives have been present in education for over two hundred years. Multiple researchers advocated for the implementation of math manipulatives to become the norm or standard. Since Florida has developed and adopted a new system of math standards, known as the B.E.S.T. standards, it was important to explore how to connect the new math standards with the already commonly used math manipulatives that most teachers have in their classroom. By connecting the individual math manipulatives to their coordinating strands, it helps identify which math manipulatives are the most effective for each strand. Based on the literature reviewed and investigated, it is clear not all math manipulatives are beneficial to be used for all strands of the B.E.S.T. standards for students in grades

kindergarten through sixth grade. Though some of these math manipulatives analyzed in this research can be used for more than one strand, it is important to remember that the use of a variety of math manipulatives is important to expand student understanding of abstract concepts by not relying on a single type of manipulative for multiple concepts.

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