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The Importance of Using Manipulatives in Math Class

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A Literature Review Presented

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Abstract

This literature review synthesizes research on how the use of manipulatives in math class benefit the learner. The problem is that the students are not always given the opportunity to explore and learn through the use of math manipulatives in order to gain a strong foundation and understanding of mathematical concepts. The purpose of this literature review is to explore the benefits of using manipulatives in the classroom and the impact it has on student achievement levels. The literature review is made up of research studies published within the last 10 years and explore the different types of manipulatives, levels of student engagement while using manipulatives, the impact of manipulatives on student achievement, and the cost of the manipulatives. Published research findings included in this study revealed strong evidence that manipulatives are beneficial for the classroom when the learner uses them for the standards that are being taught.

The Importance of Using Manipulatives in Math Class

Introduction

The use of math manipulatives to explore and learn number concepts is an important strategy in the early childhood field. Frequently, teachers do not see the benefit of using manipulatives, nor do they want to take the time to let the students explore. Research shows that manipulatives are important to implement in the classroom because it helps with students learning in the mathematics content area (Liggett, 2017). Furman (2017) emphasizes the importance of “contextual application in learning math concepts, which is often referred to as “hands-on learning” through the use of manipulatives, realistic word problems, and enticing and authentic challenges such as determining how many cubes it takes to measure a room” (p. 4). The problem is that the students are not always given the opportunity to explore and learn through the use of math manipulatives in order to gain a strong foundation and understanding of number concepts.

Manipulatives are important to use in the classroom to help students learn and explore using a variety of hands-on learning methods. Liggett (2017) defines manipulatives as, “objects used for instruction that vary in shape, size, and color” (pg. 1). Research has shown that if students are able to explore with manipulatives they have a higher percentage of mastering number sense and will gain more knowledge from utilizing the materials (Jung, Brown, Karp, 2014). The purpose of this literature review is to explore the benefits of using manipulatives in the classroom and the impact it has on student achievement levels.

This literature review includes peer reviewed articles from the Northwestern College database and from ERIC.gov dated between 2011-2020. Keywords used in the search included:

benefits of manipulatives, types of manipulatives, student engagement using manipulatives, and student achievement. A gap in literature exists in how manipulatives do not benefit students or the lack of benefits when using manipulatives. The literature review is divided into subtopics including the different types of manipulatives, staying engaged while using manipulatives, the impact of manipulatives on student achievement, and the cost of the manipulatives.

Review of the Literature

The Different Types of Manipulatives

Researchers Pouw, VanGog, & Paas (2014), state that when students interact with manipulatives their reasoning resources are focused on those objects. Students use the interaction with manipulatives to learn more and to gain a better understanding of mathematical concepts. According to Hurrell (2018), using manipulatives is a prerequisite for students learning and being able to physically manipulate the materials is beneficial to the learner. Hurrell (2018) conducted a quantitative research study examining how Kindergarten students utilized manipulatives. Hurrell (2018) investigated how the Kindergarten students physically handled the materials and had discussions with the students to gain a better understanding of how using the manipulatives in mathematics helped with concept development. The students used popsicle sticks and were given the individual popsicle sticks, once they had ten of them, they traded it in for a bundle, which had ten sticks. The students gained a better understanding of place value by using manipulatives.

Thirey & Wooster (2014) conducted a quantitative research study in a freshman calculus course that took place at West Point Military Base exploring the effects of using construction paper as a manipulative while learning calculus math skills. Of the 18 students in the calculus math class, all of the students reported that the use of construction paper as a manipulative gave them a better understanding when learning the properties of calculus. The findings of this research study encouraged further use of manipulatives in teaching calculus. Similarly, a study by Hurst and Linsell (2020) agreed with Thirey and Wooster's (2014) findings that manipulatives increase student's learning. Hurst and Linsell (2020) conducted a quantitative research study where they required 32 students to use bundling sticks as manipulatives to

demonstrate their understanding and reasoning skills in multiplication, division, and place value math skills. From this study, Hurst and Linsell (2020) found that when the students used the manipulatives their math assessment scores and conceptual understanding of math skills improved. In this study, it was noted the importance of teachers physically modeling the use of the manipulatives so students grasped a better understanding of the concrete material use (manipulative) in terms of math skill development. Much like Thirey & Wooster (2014) findings that construction paper used as manipulatives gave the calculus students a better approach to the properties in learning math skills, Hurst & Linsell (2020) findings showed increase in math understanding and reasoning skills by the use of manipulatives. The research shown in Thirey & Wooster (2014) and Hurst & Linsell (2020) showed that manipulatives are beneficial to a learner at any age with a variety of concepts.

In a qualitative research study by Presser, Vahey & Dominguez (2015), the use of manipulatives and online games were used in a preschool classroom to examine the effect on skill development. Sixteen teachers with 8-10 students in each class were given the use of manipulatives and online games. The students were given a pre and post standardized assessment to assess the impact of the manipulatives and online game use. During the study, the findings revealed that the preschool students struggled with having time in the day to use manipulatives or online games for skill development. The teachers in this study found the manipulatives and online games useful and convenient to use with their students and curriculum. In a similar study, Tucker and Shumway (2021) conducted a qualitative research study with 33 students in second grade who were given virtual manipulatives (VM) when learning about how a number line works in math. The virtual number line had animals that faced left if they were negative and faced right for positive numbers. Student interviews and observations were

collected for data. The findings of this study concluded that the students loved using virtual manipulatives and gained a better understanding of the positive and negative number line concepts. A quantitative research study completed by Loong (2014) confirmed the findings in both Tucker and Shumway (2021) and Presser, Vahey, & Dominguez (2015) research about the positive effects of using virtual manipulatives in the classroom. Loong (2014) completed a quantitative research where students used virtual base-10 blocks and placed them on a computer mat where they were able to manipulate the blocks to work through multiplication and division of fraction math problems. The students in the study had more of an understanding of place value and fractions than before. In comparison, Gecu-Parmaksiz & Delialioglu (2019) conducted a quantitative study with 72 participants at 1 school. The study was conducted over 4 weeks and looked at the influence of the virtual manipulatives with the first graders geometry over concrete manipulatives. Gecu-Paramaksiz & Delialioglu (2019) found virtual manipulatives to be more impactful for the students than the concrete manipulatives that they used. Students struggled identifying the difference between a square and a rectangle, but still showed improvements on identifying the shapes that were taught.

Staying Engaged While Using Manipulatives

According to Petersen and McNeil (2021), not only do teachers use manipulatives to help students gain a better understanding of math concepts, but manipulatives aid in keeping students engaged in their learning and in the content of the curriculum. Petersen and McNeil (2021) conducted a quantitative research study on two types of manipulatives used at a childcare center. This study included 79 participants who meet with the researchers once a week for a two-week time period. During this time the researchers used manipulatives that were high perceptual richness and low perceptual richness. High perceptual richness were items that looked appealing

to the students. They were colorful objects that the students have either used before or are drawn to because of their color. The low perceptual richness manipulatives were items that were not as colorful, and did not appeal to the students when they saw them. The findings from this research study showed that the high perceptual richness hindered the counting of the students and the low perceptual richness did not affect the students counting. The use of the high perceptual richness distracted the learners more, while the low perceptual richness was found to be more engaging for the students. However, in a study conducted by Golafshani (2013) concluded that the use of manipulatives keeps students engaged in the learning process. Golafshani (2013) conducted a 21-week quantitative study in four, 9th grade classrooms where he examined the engagement of students when using manipulatives. Golafshani (2013) found that teachers who viewed manipulatives as distracting toys did not use or like the use of manipulatives whereas teachers who viewed manipulatives as a learning tool used manipulatives and experienced positive learning results from their students. In this research study, it was noted that the teachers preferred virtual manipulatives better and found them to be more useful for students than concrete manipulatives. It was noted in this study that teachers did a better job of utilizing the manipulatives when they were confident using the manipulatives themselves.

Actively engaging students in math concepts is a difficult task for teachers. Althausser (2017) conducted a qualitative study with 347 elementary teachers who recently graduated from Eastern Kentucky University. The study used the data collection of questionnaires and observations of the teachers and students in the classroom. The information gathered from the teacher questionnaire showed that the teachers saw an importance in using hands-on activities and manipulatives as a way of keeping students engaged in learning. The teachers reported that they felt nervous about using manipulatives out of fear of the students not using the

manipulatives in a meaningful way. The teachers also reported that they felt confident in modeling the use of the manipulatives before giving the manipulatives to the students. The conclusion of the study found that students were more engaged in learning, more self-confident in their understanding of the learning content after the use of manipulatives. In comparison, Sanderson (2017) concluded in her research that manipulatives improve student's reasoning skills through hands-on learning. Sanderson (2017) conducted a qualitative research study that took place at West Chester University involving 51 participants. Each participant was given a Cap Kit as a manipulative to use while demonstrating their counting and skip counting math skills. A Cap Kit is bottle caps that are utilized as manipulatives. In conclusion, even though there were challenges such as distractions, time constraints, and cost of manipulative, the benefits outweighed the challenges as students had a more concrete understanding of the concepts taught.

Impact of Manipulatives on Student Achievement

Student achievement is important to consider when using manipulatives. The impact the manipulatives have while solving math questions improve a student's understanding. This is a main reason to utilize the manipulatives. Bouck, Satsangi, Doughty & Courtney (2013) conducted a quantitative study with three students ages 6-10 who have all been diagnosed with Autism Spectrum Disorder. In this study, the students were taught how to use virtual manipulatives as well as concrete manipulatives to solve two digit subtraction problems. Bouck, Satsangi, Doughty & Courtney (2013) found that virtual manipulatives helped the students in solving the two-digit subtraction problems faster than they would on their own without the manipulatives. Similarly, Burte, Gardony, Hutton, & Taylor (2017) conducted a quantitative study with 92 students in grades 3-6 in New England. Of the 92 students who started the study,

only 86 students finished. This study examined at how visual impact of the manipulatives helped student achievement. The students were given a pre-test and a post-test for data collection. The questions on the pre and post-test included pictures to help with visual impact had higher grades than those questions that did not. In comparison, Kurz & Kocic (2011) directed a research with 50 preservice teachers at three different elementary schools. Each preservice teacher had to organize a math night with the families that attended the school. The preservice teachers took notes on how the families played the different games and utilized the manipulatives that they were given. The preservice teachers observed by asking questions to the participants at the math nights as well as taking comprehensive notes while the students played the math games with the manipulatives with their families. According to Kurz & Kocic (2011) the manipulatives played a strong presence in helping the students understanding of the different concepts that were taught. Kurz & Kocic (2011) noted that many times the manipulatives were used to make the math games more fun, but they were more beneficial in helping the students solve the problems at hand.

Cost of Manipulatives

The types of manipulatives utilized in the classroom can be affected by the by the cost of the manipulatives. Larkin (2016) conducted a qualitative research study where some students physically used balancing beams as manipulatives while learning addition and subtraction math concepts and other students were given online manipulatives to learn the same concept. The students using the physical manipulative reported a better understanding of the math concept compared to the students using the online manipulatives. Although the students loved the physical manipulative the best, the cost of the balancing beams was a huge factor. When students are able to explore with manipulatives, learning is occurring without students realizing it

(Petersen & McNeil, 2014) but cost could be a factor affecting the use of manipulatives in the classroom. Researcher West (2018) was concerned about the cost of manipulatives in the classroom, so he conducted a qualitative research study to explore the quality and affordability of manipulative use in the school classroom. West (2018) surveyed teachers from Australia and found that teachers were spending on average around \$500 of their own money on classroom items such as manipulatives and 10% of teachers reported that they spent around \$2,000. This finding was very disturbing, so West (2018) compiled a list of the different manipulatives that the teacher's mentioned in the survey results. From that list, West (2018) created a table that outlined the different types of manipulatives, concrete and online items. For example, magnetic rods were used to help with geometric shapes. This could be used in the classroom for students of all ages. West (2018) found this list of manipulatives helpful for stakeholders and teachers to use when ordering school supplies. This list also encouraged teachers to use manipulatives in the classrooms. Although research has shown that cost is factor in using manipulatives in the classroom, there are creative ways to keep the cost of manipulatives low.

Conclusion

Research has shown that the implementation of manipulatives in learning math concepts offer students a different way of learning and being engaged in the content area. Evidence suggests if manipulatives are utilized constructively they have a significant outcome on a student's math skills. This is shown in the different types of manipulatives that can be used, as Hurrell (2018) researched and how important it is for students to explore and discuss when using these items. According to Golafshani (2013) when teachers viewed the manipulatives as a learning tool, the students stayed more engaged with the lesson. Students who were more engaged were able to have better discussions with their peers as well as having a firmer

understanding of concepts taught in the classroom. Kurz & Kokic (2011) found that the use of manipulatives as a way to improve math conceptual understanding impacted student achievement as was determined by the informative and formative assessment. The students showed that using the manipulatives made a difference in how they felt with the different math games. Students overall felt more positive and successful as they better understood math concepts with visual assistance from the manipulatives. The increase costs for the manipulatives play a role on how they are used in the classroom. If the manipulatives are affordable, the teacher is able to utilize the manipulatives for the benefits of students and because of the help of West (2018), teachers have a better understanding of what they can and cannot afford for their students because of his list of manipulatives and cost for each item. Knowing all of this information, it is important to utilize manipulatives in math class for the benefit of the students and their understanding of math.

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