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THE IMPACT OF MANIPULATIVES ON LEARNING IN THE ELEMENTARY AND MIDDLE SCHOOL MATHEMATICS CLASSROOM

by

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STATEMENT BY AUTHOR

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This paper is a review of research pertaining to the use of manipulatives in the elementary and middle school mathematics classrooms. It embodies the logic behind using manipulative materials in the classroom setting and the impact their use will have on student understanding and enjoyment for learning mathematical concepts.

This research paper will identify the struggles and concerns of manipulative use along with the need of increased professional development and training for teachers to be better prepared for the daunting, yet rewarding challenges of successfully teaching mathematics.

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Chapter 1: Introduction

This study will investigate the use and learning theory of using manipulative materials in the elementary and middle school classrooms to teach mathematical concepts. A study by Moch (2001) was performed on fifth grade mathematics students where one class used manipulative material and the other class used worksheets. Students shared that they never knew mathematics could be fun and they felt like they had gained more understanding using manipulatives than by using worksheets like they had always used before.

At my school I have found that students and teachers struggle with how to effectively use manipulative materials to show or learn understanding of a skill. Manipulatives are used for introducing a new concept or for a game day. They are taken away as a punishment or when used improperly by students. Sometimes the teacher is not sure how to use them so the manipulatives are put on a shelf to collect dust and the teacher intends to find a lesson for them in the future when he or she has time. As a teacher, I know that time is difficult to find and I think a great learning opportunity for me and numerous students is lost when manipulatives are forgotten on classroom shelves. If manipulatives are beneficial to student learning then I want to gain an understanding of how to effectively use the manipulatives in my classroom to better increase the learning for my students. Also, I hope to share my new insight into the world of manipulatives with my colleagues to improve the overall mathematic concepts of all students in our school.

Statement of the Problem

Manipulatives are a tool for instruction, yet teachers tend to not use them due to lack of education and confidence of their effectiveness to increase learning (Green, Flowers, & Piel, 2008). Manipulatives are seen as toys or games and are possibly only used on special occasions or for short periods of time. It is important for the student and the teacher to understand how to

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successfully use manipulatives in learning or the results of the manipulative use maybe confusion and frustration for both the learner and the instructor.

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Research Questions

Do manipulatives increase learning in elementary and middle school mathematics?

How do manipulatives help students learn concepts?

What are the misunderstandings about the teaching use of manipulatives?

Are the effects of manipulatives beneficial to all learners?

Will attitude or enjoyment towards learning mathematics increase with the use of manipulatives?

Is added or ongoing professional development needed for teachers to effectively educated learners using manipulatives?

Significance of the Research Problem

Students in the United States are not keeping pace with other countries when it comes to mathematics (Lemke & Gonzales, 2006).Teachers are in a need of improving the way we teach our students to better prepare them for the future. Why are teachers not using the manipulatives if they have them at their disposal? Teachers may have many manipulative materials in organized containers in their classroom but they lack the training on how to implement them correctly in a lesson. Teachers tend to see them as a diversion and do not believe they are necessary for understanding (Green, Flowers, & Piel, 2008). Students should have the opportunity to learn to the best of their abilities and it seems like we are falling short when it comes to the fundamentals of the basic concepts in mathematics. Teachers need more instructional strategies in our teaching toolboxes and manipulatives may be one of those helpful tools.

Limitations and Assumptions

The research for this paper will be limited to elementary and middle school age students in mathematics. The research will include both past and present information on the use of manipulatives and the teaching theories behind them.

The assumptions of this paper are that students are able to learn mathematics. Also, using manipulatives is a teaching method that can be taught to teachers to effectively increase the learning of their students in elementary and middle school mathematics classrooms.

Definitions of Terms

Abstract stage of learning- the teacher models the mathematics concept at a symbolic level, using only numbers, notation, and mathematical symbols to represent the number of circles or groups of circles. The teacher uses operation symbols to indicate addition, subtraction, multiplication, or division.

Absorption theory – the teacher views children as passive learners who store knowledge as a result of drill, practice, memorization, and reinforcement (Cain-Caston, 1996)

Concrete stage of learning- the teacher begins instruction by modeling each mathematical concept with concrete materials.

Physical manipulative - an object that appeals to several senses and that can be touched, rearranged, and otherwise handled by children (Kennedy, 1986)

Representational stage of learning- the teacher transforms the concrete model into a semi-concrete level which may involve drawing pictures, using circles, dots, and tallies, or using stamps to imprint pictures for counting.

Virtual manipulative - interactive, Web-based, or computer-mediated visual representations of dynamic objects that present opportunities for building mathematical knowledge.

Summary Statement

How teachers design their classroom learning activities using manipulatives will ultimately affect the success of their use in developing students' understanding. Mathematical understanding is fundamental for students, and manipulative materials are tools that teachers can use to help students construct their understanding (Uribe-Flórez & Wilkins, 2010).

Manipulatives are learning instruments that can benefit learners in the elementary and middle school levels. When manipulatives are used in the correct manner they become a strong tool to help the understanding of mathematics concepts for all students. Manipulative can help students move from the concrete to the abstract stage with understanding and confidence.

Chapter 2: Summary of Research Sampling

Why Use Manipulatives?

Many teachers are looking for ways to improve their students understanding of mathematical concepts. Over the years the students in the United States have not kept pace with other countries when it comes to learning mathematics (Lemke & Gonzales, 2006). The need for a change in the way we teach mathematics is upon us. The appropriate use of manipulatives may be the change we are seeking.

When given a choice, children like to model a situation to demonstrate understanding. Manipulatives provide that concrete freedom to solve problems (Ambrose, 2002). Many students have difficulty understanding mathematics because they are unable to make the connection between the physical world and the abstract world (Heddens, 1986) and the use of manipulatives in mathematics classroom is the concrete modeling of abstract mathematical ideas (Olkun & Toluk, 2004).

Some learning theorists have a belief that in order to make understanding permanent, children must understand the underlying concepts. They believe manipulatives help create clear mental images which help the transition to abstract ideas in the future. Connections are also made on how the use of manipulatives help bridge the gap between mathematical ideas and real-world situations. Support is given to the use of manipulatives at all grade levels which can be beneficial to encouraging the move to abstract thinking (Kennedy, 1986). This idea adds support to the belief that although there is no proof that manipulatives are needed to guarantee understanding, there is enough support in studies to say manipulatives are worthwhile.

The use of manipulatives may help in that many teachers are frustrated with students in secondary mathematics courses who have relied only on algorithms and struggle with basic concepts (Jones, 2000). Teachers at all levels easily become frustrated with students because

they do not show the understanding of the basic fundamentals of mathematical concepts. They are able to perform the algorithms but lack the understanding of why they are going through the steps and end up not understanding the relevance of the answer they have found. Berman and Friederwitzer (1989) shared an opinion that I believe is important:

> Effective mathematics requires more than the use of symbols or numerals. All students, and even many adults, need concrete models to understand mathematical concepts. Elementary and middle school children can understand and master basic concepts of mathematics, including algebra, when concrete materials are used to model these concepts (p.21).

Using manipulatives is a way to have students gain understanding and confidence in their mathematical skills.

The goal of using manipulatives is to help students' understanding of mathematics, rather than increasing efficiency in calculations (Jones 2000), versus the sole use of the absorption theory, which views children as passive learners who store knowledge as a result of drill, practice, memorization, and reinforcement, which was used in the past (Cain-Caston, 1996). Using this method, students were not encouraged to think 'outside the box' to become better problem solvers. Children should not just be told about mathematics but actively participate in thinking mathematically (Heddens, 1986).

Elementary mathematics is not elementary and the way teachers learned mathematics may not be the way they need to learn to teach mathematics to students (Philipp, 2008). One of the most challenging misconceptions about teaching elementary and intermediate mathematics is that the concepts are simple. The use of manipulatives may just give us the chance to instill the understanding of problem solving in children which has been lacking in the past.

Concerns about Using Manipulatives

Some concerns when it comes to the use of manipulatives are that children may tend to form an over-reliance on manipulatives which restrains them from using inventive strategies in solving a problem. A few added possible limitations of using concrete methods are for some girls, the use of manipulatives hold them back from moving onto abstract thinking skills. Girls tend to want to please their teachers and the wording of the questions might limit their desire to take risks to solve problems. Girls have found a way that works and they do not see the need to try anything new. Boys tend to move onto and use invented strategies to solve problems and girls tend to fall back on what they know will work and feel comfortable with-the uses of manipulatives. Educators must exercise caution in using manipulatives all the time. Teachers can use intervention and questioning strategies that help girls to become more adventurous and confident in taking risks to solve problems (Ambrose, 2002).

Puncher, Taylor, O'Donnell and Fick (2008) shared the similar finding from a study of a sixth grade classroom:

> Student understanding through manipulatives occurs when students are motivated to use a manipulative as a tool to obtain the answer to a challenging problem. Manipulatives are a much more useful tool for testing our ides that are slowly emerging within the student rather than understanding a concept after a procedure has been taught, hence the time for using manipulatives as a problem solving tool for multiplications had likely passed for most of these 6th graders (p. 321).

Manipulatives should be used to help in student understanding and applying mathematical principles, not an efficient means of computation for the future (Jones, 2000).

There are concerns that sometimes the transition between the manipulatives and the

abstract use of symbols may create confusion for students in understanding the concepts being taught. When manipulatives are brought in and quickly replaced with the use of symbols, it results in student confusion because they are not ready to relate the algorithms to the concrete experience (Jones, 2000). The misuse of manipulatives may create a misconception of two mathematical worlds-manipulatives vs. symbols. Students may miss the connection between the concrete and the abstract (Bright, 1986). Bright (1986) continues to comment how students do not automatically grasp the connection and it is up to the teacher to communicate it to them, which is hard if the teacher does not fully understand the connection themselves. Manipulatives are not needed to teach every concept and teachers should not force the use of manipulatives when there is not a need.

Other concerns about manipulative use is the increase in lesson length, increase in money needed to purchase the material, lack of motor skills for all students to manipulate hands-on material, and increases in classroom management or behavior problems that arise due to students having to wait for, or share, materials. This use of virtual manipulatives may help with many of these concerns (Steen, Brooks, & Lyon, 2006).

Virtual manipulatives can save time. The teacher does not have to distribute and clean up hands-on materials. Money is also saved when hands-on materials do not need to be purchased. Additional benefits are the equal access to the same lesson and activities. Students do not have to wait to take turns and this increases the time-on-task practice. The students also receive instant feedback from the computer programs, therefore students can better self-regulate understanding. Students can also manipulate the computer to view different angles of three-dimensional shapes, which is much more difficult to do manually. This allows for a more in-depth lesson. Lastly, students who have difficulty with motor skills may more easily use virtual manipulatives (Steen,

Brooks, & Lyon, 2006).

Simply using manipulatives to teach mathematics is not a guarantee of student understanding. Teachers must guide children to develop skills in thinking. Teachers should also be asking leading questions placing greater emphasis on the "why" and "how" with less emphasis on the "what." These questioning strategies can help children begin to develop their own thought processes and techniques to solve problems. Teachers asking the right kind of questions can help children bridge the gap from the concrete world to the abstract world with less confusion and increased confidence. This is especially important at the primary level (Heddens, 1986).

It must be remembered that the use of manipulatives is not the end-all be-all in teaching mathematics. Manipulative use does not always succeed and when it does not, it is usually because either the child is not developmentally ready for the concept, the child has not mastered the prerequisite concepts, the model is too abstract for the student, the instruction shifts to symbolic before the child has developed the cognitive concrete model to embrace the concept, or the gap between the model and its symbolic representation is too large. We do not want to try and force the use of manipulatives in every lesson and sometimes they can be a waste of time and effort (Jones, 2000).

Will Attitude Toward Learning Math Improve with Using Manipulatives?

Mathematic classes are starting to change from boring pencil and paper chores to fun and exciting activities to which children look forward. The same concepts are being taught, but students are now finding learning mathematics to be pleasurable and not a chore (Cain-Caston, 1996).

In a study performed in a fifth grade classroom for eighteen hours over a seven-week trial

period, children that previously did not care for mathematics were eager and enthusiastic about participating in and learning mathematics. The children enjoyed the task of having to uncover and think through problems using manipulatives. Students were excited for the opportunity to touch and feel mathematics not just to see and hear it (Moch, 2001).

Even though learning enjoyment and excitement for a lesson using manipulatives may increase student interest in math, there are teaching challenges, which may present themselves. Some of these include: behavior problems that may arise, lack of sufficient teacher planning time, and effective implementation of manipulatives in the lesson to increase student understanding (Quinn, 1998).

Research was performed on granting students free access to manipulative materials in their classroom. The students could spontaneously choose manipulatives to solve problems. The first week of the free access was chaotic with students spending much of the time showing inappropriate behavior with the materials. However, after the novelty of the new materials wore off, the free access to the materials did not seem to be problematic or distracting in the learning environment. Students began to use the materials freely to solve many different types of problems. This also generated additional ways to use the materials and did not limit their ideas to the manner in which the teacher presented the problem. Furthermore, if there was extra time at the end of class, many students would return to previously discussed challenging problems and continue to work on solutions or return to former activities or even make up their own activities to practice skills. Even if the teacher did not foresee the need for manipulatives in solving problems in a lesson, students usually found a way, or invented and searched for a way, to extend the problems so manipulatives could be used. The students themselves became empowered to take control of their own learning (Moyer & Jones, 2004).

Professional Development for Teachers

In the days of standardized testing and the continued importance placed on student achievement, the need to cover a large amount of curriculum quickly is a challenge for teachers. Some teachers believe that manipulatives will take too much time. For others, the increased need for classroom management during the use of manipulatives in the classroom ends up being a restraint. Some of these teachers argue the benefit to student learning is minimal compared to the headache the manipulative materials will create in their classrooms (Moch, 2001).

A major limiting factor why manipulatives are not being used in the mathemathics classroom daily is that teachers tend to teach the same way they were taught in elementary school rather than what they learned in their undergraduate teaching methods classes. Misconceptions can be re-taught using manipulatives and students understand the concepts more fully. A surprising finding is that this was not limited to children's learning but also included adult learning (Green, Flowers, & Piel, 2008).

A researcher conducted a study on 47 pre-service teachers enrolled in university classes. The participants were given a before and after survey on their beliefs and understandings of manipulatives in teaching mathematics. Most of the members stated that they did not have much experience with manipulatives growing up, but would now, after the class, use them in their classroom. Many stated that manipulative use increased the understanding of fundamental concepts they never fully understood before the concrete representation of the manipulatives in class. Some strong concerns about the use of manipulatives were time constraints, behavior problems, and durability of the manipulatives being used (Quinn, 1998).

A study done by Puchner, Taylor, O'Donnell and Fick (2008) found similar results in a two week grant-funded mathematics institute:

> In their lesson study reports teachers indicated that the grant project had increased their understanding of the importance of using manipulatives. What particularly caught our attention as professional developers, however, was from our analysis of the research lesson taught, where we found a pattern of ineffective manipulative use and misuse, and we further explored this topic in order to strengthen our own understanding of the difficulties teachers experience in effectively using reform strategies and goals. (p.313)

In another study, researchers had teachers use three different strategies to teach average to students in grades four through six. The strategies used to present the lessons were traditional, concrete with manipulatives, and visual spreadsheets. Researchers concluded there was no clear advantage to any one method of teaching; however, the classroom teachers commented on how they personally benefited by learning and trying new hands-on activities they had never performed in the past. The teachers felt their personal understanding of average was increased because of the hands-on methods of learning and they felt better-prepared to help young learners in future classes understand mean (Baker and Beisel, 2001).

Uribe-Flórez and Wilkins (2010) found teachers who tend to believe it is important for students to participate in hands-on activities to effectively learn mathematics instruct students using manipulatives more often. Furthermore, teachers who tend to believe that manipulative use with older students is less effective or necessary use manipulatives in mathematic instruction less often. They also discovered teachers' background was not found to be a strong consistent predictor of the amount of manipulative use in their mathematic instruction.

Manipulatives are not magic. Simply using them does not necessarily result in students' mastered understanding of a concept. However, through manipulative experiences, the students have an opportunity to gain insight into their understanding of mathematics. In a study by Moyer

(2001), teachers recorded their manipulative use for one year in classes at the middle school level. Researchers found that the teachers felt manipulatives were fun, but not necessary for teaching and learning mathematics. The teachers seemed to separate class instructions into "real mathematics" and "fun mathematics." The "real mathematics" was learning in the traditional manner with textbooks and increased lecturing for instruction. "Fun mathematics" was the use of manipulatives as a supplement or in an activity or a game after the concept had been taught, or if there was extra time. Teachers' lack of professional training on the benefits and uses of manipulatives makes it difficult for them to assimilate manipulatives into regular, daily use in the mathematics classroom.

Hatfield's (1994) research connects the importance of cooperating teachers and how their instructional practices play an important role in the development of mathematics attitudes and teaching practices for student teachers. If student teachers lack confidence using manipulatives, the cooperating teachers should serve as mentors to their mathematical understanding and growth. However, if cooperating teachers do not feel confident using manipulatives as an instructional approach, the movement toward increased hands-on teaching and learning of mathematics is hindered.

The classroom teacher must be provided with constant and on-going in-service to ensure they are using the most productive strategies for student achievement of mathematical concepts (Cain-Caston, 1996). Without ongoing training for teachers, it is easy for a classroom full of great potential to become stagnant and tedious for both the teachers and the students.

Chapter 3: Analysis of Research

How Manipulatives Help Students Learn

Is Improper Manipulative Use Harmful to Learners?

Learners Attitude Towards Math Using Manipulatives

Is Professional Development Necessary for Manipulative Usage?

Chapter 4: Conclusion

My Classroom

Using Manipulatives to Teach Standards in My Classrooms

Concerns About Using Manipulatives in the Classroom

How to Promote Manipulative Use at My School

Call for More Research

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Ambrose, R. C. (2002). Are we overemphasizing manipulatives in the primary grades to the detriment of girls? *Teaching Children Mathematics, 9*(1), 16-21. Retrieved from Education Full Text database.

This article reviews the possible limitations of using concrete methods. For some girls, the use of manipulatives holds them back from moving onto abstract thinking skills. Girls tend to want to please their teachers and the wording of the questions might limit their desire to take risks by thinking outside the box to solve problems. Basically they have found a way that works and they don't see the need to try anything new. Boys tend to move onto and use invented strategies to solve problems and girl tend to fall back on what they know will work and felt comfortable with-the uses of manipulatives. This article will be very helpful in my paper because it states that manipulatives are not the answer for all learners. Also, it states caution in using maniplatives all the time. The article also lists interventions and questions that help with girls to become more adventurous and confident in taking risks to solve problems.

Baker, J., & Beisel, R. (2001). An experiment in three approaches to teaching average to elementary school children. *School Science and Mathematics, 101*(1), 23-31. Retrieved from Education Full Text database.

This article is about using three different teaching strategies to teach 4-6 grade students average in mathematics. The three teaching strategies covered include: concrete manipulatives, traditional method, and visual spreadsheets. The results indicate there is not a clear advantage to any one method over the other. The researchers did learn the grades 4-5 were not at the learning readiness state to fully understand the algorithm of average. A teacher involved in the study stated that he benefited from using hands-on manipulative activities to improve his understanding of the concept. He felt better prepared to help his students learn in the future. I found this helpful for my paper to support the idea that using manipulatives as a teaching tool is a strategy for learning but not necessary for understanding concept.

Berman, B., & Friederwitzer, F. (1989). Algebra can be elementary . . . when it's concrete. *Arithmetic Teacher, 36*, 21-4. Retrieved from Education Full Text database.

This article is about using concrete manipulatives to teach algebra to elementary students. It states that effective mathematics requires more than symbols. It talks about how all students and even adults can benefit from the use of concrete materials to better understand math concepts. This article will be useful in reinforcing the importance for why we should use manipulatives in elementary and middle school.

Bright, G. (1986). Using manipulatives. *Arithmetic Teacher, 33*, 4. Retrieved from Education Full Text database.

This article portrays caution when using manipulatives. The author states that misuse of manipulatives may create a misconception of two math worlds-manipulatives vs. symbols. Students may miss the connection between the concrete and the abstract. He further states that students don't automatically grasp that connection and it is up to the teacher to education them, which is hard if the teacher doesn't fully understand the connection themselves. The author also comments that manipulatives are not needed to teach every concept and teachers should not force the use of manipulatives when they are not needed. I find this article very useful to show the negative aspects of using manipulatives and how the misuse of them can potentially create a larger misunderstanding of concepts than by not using them at all.

Cain-Caston, M. (1996). Manipulative queen. *Journal of Instructional Psychology, 23*, 270-4. Retrieved from Education Full Text database.

This article focuses on two conflicting theories of best practices. Absorption theory, which views children as passive learners who store knowledge as a result of drill, practice, memorization, and reinforcement vs. concrete usage of manipultives. The author completes a study comparing test results of classrooms which used manipultives vs. those which used worksheets. Results show students using manipulatives out-performed those using worksheets. This article is similar to another article I will be using (Moch, 2001). I will also be using Cain-Caston's article because it talks about what absorption theory is and how the way we taught math in the past is no longer

successful and is in need of change.

Green, M., Flowers, C., & Piel, J. (2008). Reversing education majors' arithmetic misconceptions with short-term instruction using manipulatives. *The Journal of Educational Research (Washington, D.C.)*, *101*(4), 234-42. Retrieved from Education Full Text database.

This article focuses on a study dealing with the misconceptions of arithmetic. It states that teachers teach the same way that they were taught rather than what they learned in their undergraduate teaching method classes. It states that misconceptions can be retaught using manipulatives and the subjects understand the concepts more fully. A surprising find is that this study was not limited to children's learning but also included adult learning. This article will be useful in my research. The article supports that it is never too late to use manipulatives to increase understanding. I also have found myself falling back on how I was taught or the comfort of using the book in my classroom. This article gives me confidence and states the need to step up to the challenge and try something new.

Hatfield, M. (1994). Use of manipulative devices: elementary school cooperating teachers self-report. *School Science and Mathematics*, *94*, 303-9. doi: 10.1111/j.1949-8594.1994.tb15680.x

This article explores the importance of cooperating teachers and how their instructional practices play an important role in the development of mathematics attitudes and teaching practices for student teachers. The article continues to state if student teachers lack confidence using manipulatives, the cooperating teachers should serve as a mentor to their mathematical understanding and growth. However, if cooperating teachers do not feel confident using manipulatives as an instructional approach, the movement toward increased hands-on teaching and learning of mathematics is hindered. This article will be useful supporting the need for professional development of student teachers along with continuing education of experienced teachers.

Heddens, J. (1986). Bridging the gap between the concrete and the abstract. *Arithmetic Teacher, 33*, 14-17. Retrieved from Education Full Text database.

This article discusses the importance of questioning when using manipulatives in the

classroom. Asking students to explain and understand the "how" and "why" they are manipulating problems to better improve their critical thinking skills. This article will be useful in showing the importance of using appropriate and relative questions to help increase the learning of the students along with the manipulatives.

Jones, S (2000). *The role of manipulatives in introducing and developing mathematical concepts in elementary and middle grades.* Retrieved on August 2, 2010, from http://www.resourceroom.net/math/Jones_mathmanip.asp

This article states a working definition of manipulatives and it states five reasons why manipulative use may fail. The reasons are 1) the child is not developmentally ready for the concept, 2) the child has not mastered prerequisite concepts, 3) the model is to abstract for the child, 4) the concept shifts from concrete to abstract before the child grasps the concept, and 5) the gap between the model and it symbolic representation is too large. This article supports the need for manipulatives but also states caution and some limiting factors of their use. I will use this article in my research review of the concerns of manipulative use.

Kennedy, L. (1986). A rationale. *Arithmetic Teacher, 33*, 6-7. Retrieved from Education Full Text database.

This article supports a learning theory based on a belief that in order to make understanding permanent, children must understand the underlying concepts. The article goes on to discuss the importance of manipulatives in all four of Jean Piaget's learning stages. It states that manipulatives help create clear mental images which help the transition to abstract ideas in the future. Connections are also made on how the use of manipulatives help bridge the gap between mathematical ideas and real-world situations. Support is given to the use of manipulatives at all grade levels which can be beneficial to encouraging the move to abstract thinking. The ideas presented in this article are helpful in that it states although there is no proof that manipulatives are needed to guarantee understanding, there is enough support in studies to say manipulatives are worthwhile.

Lemke, M & Gonzales, P. (2006). *Findings from the conditions of education 2006: U.S. student*

and adult performance on international assessments of educational achievement. Retrieved July 29, 2010 from http://nces.ed.gov/pubsearch/pubinfo.asp?pubid=2006073

This post compared the United States performance on an international assessment to that of other countries involved in the study. The United was out performed in many of the areas. This article will be beneficial in my paper in that it shows a need for improvement and changes in the ways we are currently teaching mathematics in the United States.

Moch, P. (2001). Manipulatives work! *The Educational Forum*, *66*(1), 81-7. Retrieved from Education Full Text database.

This article reviews a study comparing test scores of a classroom which used manipulatives to a classroom that used worksheets for lessons. The results show an improvement in test scores and an enjoyment for math class in the classroom that was using manipulatives compared to the students that used worksheets. This article states how manipulatives help to increase understanding and enjoyment of learning mathematics. This will help reinforce my hypothesis that manipulatives help increase student learning in mathematics. This article is similar and reinforces the findings of Cain-Caston, another article I will be using, on how manipulatives help support problem-solving and understandings of math.

Moyer, P. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics, 47*(2), 175-97. Retrieved from Education Full Text database.

This article states that manipulatives are not magic. Simply using them does not necessarily result in students' mastered understanding of a concept. But through manipulative material, the students have an opportunity to gain insight into their experience with them. In this study teachers recorded their manipulative use for one year in classes at the middle school level. Researchers found that teachers concluded that manipulatives were fun but not necessary for teaching and learning mathematics. The teachers seemed to separate class instructions into "real math" and "fun math".

The real math was learning in the traditional manners with textbooks and increased lecturing for instruction. Fun math was the use of manipulatives as a supplement or in an activity or a game after the concept had been taught or if there was extra time. The article states that the lack of professional training for teachers on the benefits and uses of manipulatives makes it difficult for teachers to assimilate manipulatives into regular daily use in the mathematics classroom. This article strengthens the need for increased professional training for educators in the classroom.

Moyer, P., & Jones, M. (2004). Controlling choice: teachers, students, and manipulatives in mathematics classrooms. *School Science and Mathematics, 104*(1), 16-31. Retrieved from Education Full Text database.

This article explores the free access of manipulative material for students in their classroom. The students could spontaneously choose manipulatives to solve problems. The first week of the free access was chaotic with students spending much of the time showing inappropriate behavior with the material. However, after the novelty of the new materials wore off the free access to the material did not seem to be problematic or distracting in the learning environment. Students began to use the material freely to solve many different types of problems; along with generating additional ways to use the material and not limiting their ideas to only the manner in which the teacher presented the problem. If there was extra time at the end of class, many students would return to previously discussed changeling problems and continue to work on solutions or return to former activities or make up their own activities to practice skills. Even if the teacher didn't foresee the need for manipulatives in solving problems in a lesson, students usually found a way, or invented and searched for ways to extend the problems so manipulatives could be used. This article will demonstrate another strategy for using manipulatives as a tool in a classroom.

Olkun, S., & Toluk, Z. (2004). Teacher questioning with an appropriate manipulative may make a big difference. *Issues in the Undergraduate Mathematics Preparation of School Teachers, 2*. Retrieved from ERIC database.

This article examines the appropriate use of questions in a geometry class while using manipulatives to demonstrate examples of what is being represented. The instructor is using a combination of questions and demonstration to show the change in the shapes which are being discussed. Student understanding of the definitions being presented of the shapes using the visual of the manipulative material is increased. This article also states that the purpose of using manipulatives in mathematics classroom is the concrete modeling of abstract mathematical ideas. This article strengthens the benefits of using manipulatives in the mathematic classroom.

Philipp, R. A. (2008). Motivating prospective elementary school teachers to learn mathematics by focusing upon children's mathematical thinking. *Issues in Teacher Education*, *17*(2), 7-26. Retrieved from ERIC database.

This article focuses on prospective elementary school teachers (PSTs) and the importance of using the understanding of how students learn, to teach the students the concepts and understanding in mathematics. It states that importance has to be taken away from how the PSTs were taught math in school and a focus on what is the best way their future students will learn math in their classroom must be made. The article continues to describe and show examples of the four principles of mathematics and mathematics teaching and learning. The abridged principles are: (1) the way most students are learning math is problematic (2) learning concepts are more powerful than learning procedures (3) students' reasoning is different from adult reasoning (4) elementary math is not elementary. The article will be useful in my research to address the importance of understanding *how* students learn mathematics. Strength is also added to the notation that elementary math concepts should be easy for all children to understand.

Puchner, L., Taylor, A., O'Donnell, B., & Fick, K. (2008). Teacher learning and mathematics manipulatives: a collective case study about teacher use of manipulatives in elementary and middle school mathematics lessons. *School Science and* Mathematics, *108*(7), 313-25. Retrieved from Education Full Text database.

This article will be very useful in that it states that professional develop is necessary for growth. But teachers have a lot to learn about the appropriate manipulative use and

some unlearning for manipulative use also. The article also states that many teachers revert back to the way they were taught even though they are trying to use the training they received. I found this article helpful to reinforce the need for ongoing professional development along with concerns of possible mis-teaching and the misuse of manipulatives.

Quinn, R. (1998). The influence of mathematics methods courses on preservice teachers' pedagogical beliefs concerning manipulatives. *The Clearing House*, *71*, 236-8. Retrieved from Education Full Text database.

This article is about potential teachers in a mathematics methods classroom. The teachers were given a before and after survey on their belief and understanding of manipulatives in teaching math. Most of the members stated that they didn't have much experience with manipulatives growing up, but would now, after the class, use them in their classroom. Many stated that manipulative used increased the understanding of fundamental concepts they never fully understood before the concrete representation of the manipulatives in class. Some strong concerns about the use of manipulatives were time constraints, behavior problems, and durability of the manipulaives being used. I found this article very useful because it backs up many of the concerns and feels I have about manipulative use. This article really emphasizes the need to use manipulatives to increase student understanding but there are many challenging and limiting factors to overcome to make it possible.

Steen, K., Brooks, D., & Lyon, T. (2006). The impact of virtual manipulatives on first grade geometry instruction and learning. *The Journal of Computers in Mathematics and Science Teaching, 25*(4), 373-91. Retrieved from Education Full Text database.

This article discusses the benefit of virtual manipulatives. It states numerous benefits of virtual manipulatives versus hands-on manipulatives. One of the first benefits is the increased time saved by not having to pass out and clean up hands-on material and money saved not having to buy hands-on material. Additional benefits are the equal access to the same lesson and activities. Students don't have to wait to take turns therefore increasing the time-on-task practice. The students also receive instant feedback from the computer, therefore students can better self-regulate understanding.

Students can also manipulate the computer to view different angles of three-dimensional shapes, which is much more difficult to do manually, which allows a more in depth lesson. Lastly, students who have difficulty with motor skills could easily use virtual manipulatives. I will use this article to counter possible concerns about manipulative use.

Uribe-Flórez, L., & Wilkins, J. (2010). Elementary school teachers' manipulative use. *School Science and Mathematics*, *110*(7), 363-71. Retrieved from Education Full Text database

This article investigates the connection of teachers who believe the use of manipulatives is important for children's learning tend to teach in the lower grade levels. Teachers who tend to believe it is important for students to participate in hands-on activities to effectively learn mathematics instruct students using manipulatives more often. Furthermore, teachers who tend to believe that manipulative use with older students is less effective or necessary use manipulatives in mathematic instruction less often. Teachers' background was not found to be a consistent predictor of the amount of manipulative use in their mathematic instruction. This article will be helpful in sharing why some teachers use manipulatives more often than other teachers in mathematic instruction.