Teachers’ Perceptions on the Use of Math Manipulatives in Elementary Classrooms

By

Son Pham

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Department of Curriculum, Teaching and Learning
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Abstract
The purpose of this study is to investigate how elementary school teachers use manipulatives to help their students understand mathematics. This qualitative study examines previous literature on the use of manipulatives to teach mathematics as well as gathers data from interviewing elementary school teachers. Analysis of the literature and data collected through interviews suggests manipulatives could enrich the student’s learning experience and help teachers narrow the gap between concrete and abstract concepts in mathematics. This research paper sheds light on the benefits and drawbacks of manipulatives use and hopefully encourages teachers to integrate manipulatives to promote mathematic learning in their lessons. Finally, this research paper will suggest best practices with manipulatives and offer strategies to implement manipulatives in the elementary mathematic classroom effectively.

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Teachers’ Perceptions of the Use of Math Manipulatives in an Elementary Classroom
Chapter 1: Introduction

Statement of the problem:

Throughout my many years of tutoring, I noticed that students often struggle with mathematics and as a result lost interest in learning math. They consider themselves as simply “not good at math” and therefore did not persist. This gave me a reason to ponder: what can be done to help these students become more interested and successful in mathematics.

“Mathematics educator around the world believe students learn better when they have the opportunity of experiencing the use of manipulatives” (2) (Munger as cited in Dennis, 2011). Based on my experiences with teaching math, I believed manipulatives could help arouse enthusiasm, keep students engaged and narrow the gap between abstract and concrete math concepts (Shaw, 2002). This research paper investigated how a small of group of elementary school teachers use manipulatives to help their students understand the math concepts and it also strives to examine how effective manipulatives are to learning mathematics.

Through my own experience, teaching mathematics to elementary school children could be one of the most difficult tasks not because of the content but the instructional strategies that teachers employ. Data gathered from EQAO (Education Quality and Accountability Office) results show that mathematic performance of students in Ontario is falling in recent years as the report stated “Over the past five years, the percentage of students performing at or above the provincial standard in mathematics has declined by four percentage points” (EQAO, 2014).

Building a solid foundation in mathematics starts at a very young age and getting students engaged in the class is crucial in helping them improve their mathematics achievement. Teachers find every way they know of to make math engaging, fun and easy to learn. Teachers
often use manipulatives to help tighten the gap between abstract and concrete ideas in math. The problem is that elementary school teachers use manipulatives to help students understand math concepts taught in class but is there data to support the use of manipulative is an effective strategy? Is it possible that students become over reliant on the use of manipulatives even on tests where manipulatives are not permitted? The students become reliant on manipulatives on tests and cannot independently find the answer to math problems. This makes us question the effectiveness of manipulative and how it can be used to help students gain confidence in mathematic.

**Purpose of the Study**

This study investigated how elementary school teachers use manipulatives to help students understand mathematical concepts. Students learn math by building on to what has been previously learned. Students bridge the gap between abstract math theories to concrete concepts that are familiar to them. This research paper investigated what teachers think about the effectiveness of using manipulatives in helping students understand mathematics and can they apply what they learned or independently demonstrate understanding.

**Research Questions**

The main research question is what are elementary school teachers’ perceptions about the use of manipulatives as a tool to help students learn and engage with mathematics? What
implications do manipulatives have in the classroom? How do students fare when manipulatives are not provided?

1) How does the use of manipulatives help students understand math?

2) How important is using manipulatives to mathematic teachers?

3) Do manipulatives help or hinder the students’ conceptual understanding in mathematics?

4) What are the differences in students’ engagement that teachers noticed when manipulatives are used to teach mathematics?

5) What are some ways manipulatives can support students’ learning?

6) What are teachers’ perceived challenges of using math manipulatives?

**Significance of Study**

According to the Education Quality and Accountability Office (EQAO), the latest results from the 2014 Provincial Assessment show that 67 per cent of Grade 3 students met the standard (level 3), a drop from 71 per cent in 2010, while 54 per cent of Grade 6 students met the standard this year, down from 61 per cent in 2010. The students struggle most when asked to apply math knowledge, for example to problem solving (Jones, 2014). Ontario Education Minister Liz Sandals called the results “a problem” (Alphonso, C. & Hammer, K., 2014). This statement and results raised concerns for educators like myself and motivated me to investigate different instructional strategies to teach math more effectively. The use of manipulatives as a teaching tool is very popular in most classrooms but how effective are they?

There is more research needed on helping students understand math concepts using manipulatives as a math tool to close the gap between abstract and concrete math. Students need
to learn how to apply their knowledge to tackle problem solving questions effectively. From my experience, with more complex questions, students have to break them down using manipulatives, especially when critical thinking is required. According to Dennis (2011), using manipulatives when solving math problems may enhance a student’s ability to identify the correct operation to solve problems (p. 18). There’s a need to explore manipulatives as a mean to teach math. "Efforts must be intensified by incorporating manipulatives as a learning resource" (Thompson as cited in Dennis, 2011, p. 11).

This research is significant to the Ontario elementary mathematic education because it explores effective ways of teaching math to elementary school students using manipulatives. “An innovative approach to assisting students grasp new ideas is the use of manipulatives” (Dennis, 2011). This research could encourage many teachers to increase the incorporation of manipulatives in their math lessons. If the use of manipulatives could help increase student’s academic performance of mathematic then it could benefit many people including the students, parents, and teachers.

**Background of the Researcher**

When I was in elementary school, I struggled with learning mathematics and thought it was a very difficult subject to master. My mom kept saying that she had a hard time teaching me mathematics because I was very forgetful. Every time I hear that, I gasp in disbelief. My mom used different types of strategies to help me understand the concepts including the use of manipulatives. However, according to her, I struggled to pass every math test. It was not because I forgot easily, it was because I didn’t understand the abstract concepts in mathematics. Usually when a student understands a mathematic concept, they can demonstrate it repeatedly.
As I grew older, I was much better at math and found math enjoyable. I don’t remember exactly when it started to change for me but I could safely say that it was during my middle school years that I started to love math. I believe that the instructional strategies in Vietnam (the country I came from) are different than Canada and thus I thrived in the Canadian education system. The pressure to perform in Vietnam was intense and failing was the worst thing that could happen to a student. For most students, failing a grade (especially for high school students) meant the students could not advance to the next grade and either had to repeat it or had to leave school and start looking for a career in trades or settle for low income work. In contrast, the dynamic of the Ontario classroom was more engaging and encouraging. There were different methods of teaching math and manipulatives were readily available for every student. I felt that the learning environments in Ontario classrooms were set up to help every student succeed with different resources available to assist the students. I enjoyed math so much that I began to work as a math tutor in my second year of university.

I tutored math in small group settings and one-on-one settings. As I tutored different students, I noticed that students generally had difficulty working with abstract math concepts. However, when I used manipulatives, the students understood better and become more engaged in learning math. I developed a love for teaching and decided that I would pursue a career in teaching. Through my mathematics tutoring experience I realized that manipulatives could help students learn new math concepts and help them make connections between concrete and abstract ideas. However, some would say that it’s distractive and could hinder the student’s learning ability. When I tutored my students, I often used manipulatives such as pencils, rulers, counters and other objects found around them to help them understand math. From my experience, manipulatives helped students who struggle in math become interested, enthusiastic
and more confident in solving math problems. I believe that creative manipulatives can stimulate and excite the students when learning as opposed to doing math with pencil and paper. I, myself, am a visual as well a kinesthetic learner, so I find the hands-on approach to learning is much more captivating than math worksheets and drills. However, when it comes to test questions, the students asked for the manipulatives that they were familiar with to help them solve the problems which is sometimes not available. I remember using manipulatives at a very young age and thought it was extremely helpful. Throughout my practice teaching experiences, I used manipulatives to help my students understand math and they often enjoyed it.

This research will further my understanding on the use of manipulatives (by elementary teachers) to teach math. I’m interested in what elementary school teachers think about using manipulatives in the school classroom and if they find it helpful. What strategies do they use? What are the benefits and drawback of using manipulatives? Are there a specific group of students that would benefit most with the use of manipulative? Could manipulatives be used for every student throughout elementary and middle school? Are there any other types of manipulatives available in the classroom?

Overview

Chapter 1 presents the introduction and purpose of the study, the research questions and how my passion for mathematics leads me to pursue a research related to math. Chapter 2 contains a review of the literature that has been conducted on my topic. It also includes my theoretical framework and the pros and cons of manipulatives. Chapter 3 provides the methodology and procedure that will be used in this study including information about the
sample participants and data collection instruments. At the end of my MTRP are the references and a list of appendixes.

Chapter 2: Literature Review

For the purposes of this paper a manipulative is defined as “any hand on object that the student can physically move in order to discover the solution to the problem” (Rust 1999).

Theoretical Framework

According to many theorists, children were born not able to understand abstract concepts but only concrete materials. Dennis, C. (2011) stated Montessori’s theory of “learning through action and activity” (4). Montessori’s theory coincides with Piaget’s stages of cognitive development. According to Piaget, children between the ages of 7 to 11 are in the stage of concrete operational, which demonstrated through the use and manipulation of concrete objects. Children between this age range develop concrete references. Piaget explained how children become sophisticated thinkers by immersing themselves into the natural world and explore the environment. Piaget’s theory explained that “by manipulating objects and by exploring what is new and unfamiliar, they discover and adapt to the world around them”. O’donnell (2008) stated “by learning Piaget’s approach, teachers can offer students developmentally appropriate activities and classroom environments that are stimulating, interesting, and complex enough to nurture higher order thinking” (O’Donnell, A., D’amico, M., Schmid F.R., Reeve, J., & Smith, J., 2008). I believe instead of sitting throughout to learn and receive information, students should be allowed to go about and discover by manipulating objects. That is very much in line
with Piaget’s cognitive development theory and his discovery-based learning theory. Piaget believed that teachers should “avoid instructional strategies that place students in passive mode of thinking” and adopt the strategy that “encourage students to explore the objects and activities around them (as cited in O’Donnell et al., 2008). I could explore how teachers use manipulatives to help their students understand abstract content.

When students are enthusiastic about the math topic, they are more open to learning than when they are uninterested. Manipulatives have always been a tool teachers use to capture student’s curiosity and explain abstract concepts using concrete materials. In my experience as a teacher, I often use manipulatives to help students understand math concepts. I find that students are more engaged in learning when manipulatives were on the table rather than just paper work. Rust (1999) argues that students seemed to enjoy the manipulatives and hands on learning more than the workbook (p.25). However, Rust (1999) also demonstrated through statistical evidence which showed that there was more learning using the work book than there was with manipulative (p.25). That statistical evidence was gathered through a math skill test called Knox County Math Skill Test. The researcher suggested that the students scored better possibly because they were accustomed to paper and pencil test rather than with actual manipulative (p.25).

**Support for Manipulative Use**

There’s a growing body of evidence that suggests manipulatives use is an effective tool to help students understand mathematical concepts. For example, Traver Holder (1993) stated that
the use of manipulative has been proven by researcher to be a highly effective means of teaching math. I believe that manipulatives are valuable tools to help students of any academic level understand math. It is not just for students of low academic ability but also suitable for students of high academic ability as well. McIntosh (2012) validated the notion of manipulatives use explicitly in her research when she states that “It is clear that even with minimal exposure, students of all intelligence levels can benefit greatly from the use of manipulatives” (p.6). To further discuss this idea of manipulatives exposure, I think manipulatives are interactive and adaptable in which the teachers could use to help any students of various academic abilities. The students build on what they already know using the manipulatives. Student’s strengths and weaknesses develop at a very young age and once that initial foundation has been established new math concepts build on top of previous ones. Manipulatives can help weak students rebuild their foundational knowledge by exploring the abstract math theories in concrete and straightforward ideas. Whereas, students who have advanced mathematical skills could benefit from manipulatives by enriching what they have already learned and take the math concepts to the next level. However, manipulatives could be very challenging to incorporate especially when the teachers are not confident in using them. This notion is further elaborated by McIntosh (2012) when she stated “Without further information on teachers beliefs towards their training and their confidence levels, teachers may unknowingly be teaching their students mathematical misconceptions through manipulative use” (p.19). It is very crucial that the teacher steer the students in the right direction to assist them in understanding the concepts correctly.

Olkun & Toluk (2004) believed that using manipulatives is not just for learning new concepts but also be used to identify student’s current conception of mathematical objects (p. 1). I also believe that it gives students a chance to redefine the mathematical definitions or clear up
misunderstanding that they have from the past. During my first practicum in the Master of Teaching program, I was teaching grade 4 students a square-based prism as a rectangular-based prism. I have always interchanged the names and it was especially confusing when the grade 4 Math Nelson book called the square-based prism as a “rectangular based prism”. I took the manipulatives containing different prisms and compared the square-based prism with rectangular base prism in front of the class. I also consulted different books to see what they say about the matter. After some research and consultations with several resources, it was evident that they called square-based prisms as rectangular-prisms in many elementary school text-books. Thus Olkun & Toluk (2004) were correct about using manipulatives not just to learn new concepts but to clear up misconceptions as well. He also argued that teachers could help students understand math concepts using manipulatives with the conjunction of guiding questions.

I believe that it is important to ask probing questions to guide students into the right direction. Most students would not know how to think critically about the math concepts represented by manipulatives such as pattern blocks until the teachers ask them inquiry based questions. When the math concepts are questioned and challenged, by both the teachers and students, they become more meaningful. As cited in Olkun & Toluk (2004), students should be encouraged to actively involve in arguing about mathematical concepts (p.2). Olkun & Toluk (2004) supports my level of thinking when he states that “The reason for using manipulatives, questioning and argumentation at the same time in mathematics class is to create a “hands-on, minds-on math” environment”. I believe we can introduce manipulatives to students but if they don’t actively work with the manipulatives to understand the concepts, they wouldn’t benefit as much. It is not just the hands on aspect but also actively seeking and making sense of mathematical theories that will take the students to the next level. Also, it is important to
question and discuss the ideas behind the concepts portrayed through the manipulatives. Students will become more involved and engaged when they question and explain their mathematical thinking. Through proper use of manipulatives, I believe students’ level of engagement, participation and performance will improve.

Carbonneau (2013) suggested that according to “both Piaget’s and Bruner’s theories of cognitive development, the idea as students gain abstract reasoning the cognitive benefits of using manipulative should attenuate” (p. 12).

Piaget’s four stages of cognitive development are sensorimotor, pre-operational, concrete operational and formal operational. I believe that when students are able to work with concrete objects, we introduce abstract ideas and bridge it with their pre-existing knowledge of concrete objects using manipulatives. According to Carbonneau (2013), students who physically join blocks to make a larger blocks are expected to have a better conceptual understanding than those that use written and verbal learning (p. 10). “The process of moving systematically through the four stages of cognitive development is aided by the manipulation of concrete objects” (as cited in Carbonneau, 2013, p. 10).

Selecting the proper manipulatives for the particular math lesson can be challenging and requires much consideration. Marzola (1987) states that [giving] concrete [objects] doesn’t automatically equate to good [teaching]. She believes that manipulatives should be chosen carefully with a “critical eye toward clarity and utility” (Marzola, 1987, p. 12). The article outlined the manipulative selection process as followed:

- Clear connections between meaning and symbol
- Mathematically honest (not phony or contrived) representations
A grade 4 math teacher, Katie Couture, did a research on 29 grade 4 students to see if manipulatives could help students increase their math achievement. Her data was collected through teacher surveys, parent surveys, student surveys and various pre and post math tests. She questioned how manipulatives are used in grade 4 classrooms to teach addition, subtraction, multiplication, division, place value and fractions. Couture concluded that manipulatives “allow students to construct deeper meanings of math concepts”, “make learning more fun for the students”, and “help struggling students visually see a math process while allowing advanced learners question themselves and dig deeper into a math concept they have mastered” (Couture, 2012, p. 27). I find this research very interesting because it is very much in line with what I believe in. According to my experience, students often enjoy manipulatives and become intrigued when they master difficult math concepts unfolding in front of them.

Another amazing elementary school teacher, Crystal Allen, conducted a research on manipulatives and found that “Manipulatives were proven to assist in helping students eliminate their frustrations and create enjoyment in learning mathematics” (Allen, 2007, p. 7). According to Allen (2007), most research states that when manipulatives are used properly they can increase student’s academic performance. She conducted a research with a group of fifth grade students on learning geometry using pattern blocks to find the internal angles of geometrical shapes.
Dennis (2011) conducted a quantitative study on the effect of the use of manipulatives and comprehension of math concepts and he found evidence that the use of manipulatives can improve learning (p. 1).

“The utilization of manipulative material provides a tool for problem solving, increases mathematics understanding, enhances thinking flexibility, and reduces mathematics anxiety” (as cited in Dennis, 2011).

He further elaborated that manipulatives help relieve boredom through exploration and the use of their imagination (Dennis, 2011, p. 20). This is consistent with what Allen (2007) stated “…the group increased their skills and showed more interest and enjoyment when learning was done through the use of manipulatives” (p. 14). Both articles found that there is a reduction in boredom and an increase in enjoyment. Both of these articles echo the same message as the previous articles that support the use of manipulatives in mathematic lessons. I also believe that the use of manipulatives requires a rich imagination and with imagination, the students become engaged. Through engagement and participation, the student’s math anxiety may be reduced. I believe boredom cannot co-exist with engagement and enjoyment.

Against Manipulative Use

There is mounting evidence from research that shows manipulative may not work especially when it comes to young children because young children do not comprehend the simultaneous representation of math concepts in 2 different ways (concrete and abstract). (as cited in McNeil, N. M., & Jarvin, L., 2007) “Manipulatives are the source of the problem
because they require dual representation” (McNeil, N. M., & Jarvin, L., 2007). They elaborated
further by identifying 3 obstacles to dual representation: “nontransparency between the
manipulatives and the concepts”, “children’s limited cognitive resources”, and “children’s
tendency to resist change” (p. 313). Non-transparency means children take the manipulative as a
tool in itself and not able to see the math concepts that it is used to illustrate. This non-
transparency idea goes in line with Moyer, P. S. (2001) who conducted a study to investigate
how middle school teachers use math manipulatives, and she concluded that ```manipulatives are
not necessary transparent``` (p. 177). “Limited cognitive resource” is due to being children they
require a lot cognitive resource to comprehend both the manipulative and the mathematical
concepts at the same time. “Resistance to Change” states that dual representation requires the
student to see “familiar objects in new lights” which proves to be difficult for children especially
when they are used to see it in one particular way (McNeil, N. M., & Jarvin, L., 2007, p. 314).

McIntosh (2012) suggested in her article that using manipulatives doesn’t necessarily
give the user an answer. As quoted from her article:

““One of the reasons that we as adults may overstate the power of concrete
representations to deliver accurate mathematical messages is that we are “seeing” concepts that
we already understand. That is, we who already have the conventional mathematical
understandings can “see” correct ideas in the mathematical representations. But for children who
do not have the same mathematical understandings that we have, other things can reasonably be
“seen”” (McInstosh, 2012).

In McIntosh (2012), a math lesson taught to the students, many didn’t use manipulatives
to help them solve the problem but came to a solution through traditional algorithm method and
then used manipulatives to show their thinking. “The students were not interested in exploring the manipulatives in order to develop deeper mathematical thinking, they were more concerned with getting the answer and solving it the quickest way they knew. The researchers were convinced that the manipulatives were more of a hindrance to the students than support” (McIntosh, 2012, p. 8).

McNeil, N. M., & Jarvin, L. (2007) suggested that manipulatives do not help (and may even hinder) students’ learning and performance (p. 312). The first source of error comes from the teachers because if teachers do not use manipulatives properly the students could misunderstand the concepts. “Teachers consider manipulatives to be fun and rewarding but fail to recognize the value of manipulative as tools for learning math” (McNeil, N. M., & Jarvin, L., 2007). I can relate to this because when teachers don’t have the proper understanding of the use of manipulatives they could potentially transfer that misunderstanding to their students. Especially when the teachers don’t believe that manipulatives can help and don’t take these learning tools seriously. As McNeil, N. M., & Jarvin, L. (2007) explained how teachers’ attitudes toward manipulatives rub off on students because teachers think of manipulatives as play time (p. 312). Some teachers were interviewed about the effectiveness of manipulatives and one of them said “Sometimes I think they are just having fun but eventually we will get to the real math part” (312) (McNeil, N. M., & Jarvin, L. (2007).)

Virtual Manipulative
“Virtual Manipulative” is an interactive, web based visual representation of a dynamic object that provides opportunity for constructing mathematical knowledge (Moyer, P. S., Bolyard, J. J., & Spikell as cited in Moyer, P. S., Bolyard, J. J., & Spikell, M. A., 2001, p. 3). Virtual manipulatives are sometimes called “computer manipulative”, they are manipulatives that can be used on the computer or on websites. “Computer manipulatives are computer programs that allow the user to manipulate representations of concrete objects, such as base-ten blocks or geoboards, on a computer screen” (Moyer, P. S., Bolyard, J. J., & Spikell, M. A., 2001).

According to Moyer, P. S., Bolyard, J. J., & Spikell, M. A. (2001), “computer manipulatives” are primarily computer programs that must be purchased and “virtual manipulatives are available to all internet users (184).

They discussed two types of virtual manipulatives: static (pictures or visual images) and dynamic (objects that can be manipulated) (p. 184).

Virtual manipulatives are very useful because they are always readily available for teachers and students to use. They are freely available on the web and students can have access of these rich learning tools anywhere. This research is similar to Young (2006) as he stated that one of the benefits of virtual manipulatives is ease of accessibility as expressed in his article “A key aspect of these benefits is their availability online“(p. 2).

“Teachers who may be reluctant to send concrete manipulatives home for student use may be more likely to give assignments to students who have access to the virtual manipulatives through their home computers” (Moyer, P. S., Bolyard, J. J., & Spikell, M. A., 2001). This
statement is reflected in Young (2006) article as he discussed “This ease of access is also seen as an ease of management” (p. 2).

Young (2006) stated in his article “Furthermore, virtual manipulatives are capable of doing things that are simply not possible with physical manipulatives, pencil and paper, or other tools” (p. 2). In addition, virtual manipulatives have the benefit of “providing students with instantaneous corrective feedback” (Young, 2006, p. 2). I have used manipulatives online several times with the students and most applications allow users to try and test out objects unlimited opportunities to get them right. As described in Young (2006), “The guided format features of the applets allowed guessing and trial-and-error, and at the same time, would not accept and incorrect response” (p. 2).

Virtual manipulatives allow users to see countless representations of the same object in many different ways. As stated in Young (2006), “Another pedagogical benefit of virtual manipulatives is that they have the ability to provide multiple representations of a single concept at the same time” (p. 2). Furthermore, “virtual manipulatives may be helpful for students with disabilities” (Young, 2006, p. 2). In my previous teaching experience, I saw students with exceptionalities and special needs enjoy working on the computer more than on conventional learning material like paper and books. These students show great interest in the virtual setting especially images in high definition. As Young (2006) asserted in his article, “Several authors have contended that virtual manipulatives increase motivation and attention in students as well as teachers” (p. 2).

Young (2006) concluded in his study that
“Virtual Manipulatives provide a compelling and promising tool for teaching and learning mathematics. The existing literature on virtual manipulatives has effectively pointed out the many benefits that they may hold, while recognizing that their effectiveness is primarily reliant on teachers and instructional design” (p. 8)

Chapter 3: Methodology

Participants

This research study examined the use of manipulatives in elementary classrooms. The study was conducted by reviewing the literature and then conducting interviews with the selected teachers. There were two participants interviewed working in elementary school settings. The teachers were elementary school teachers with at least 5 years of experience who are certified to teach kindergarten to grade 6. Both teachers have taught and currently teaching elementary mathematic classes in the past with the Toronto District School Board (TDSB).

The goal of this research was to determine how teachers use manipulatives to help their students understand abstract concepts in math. The teachers were carefully selected based on their teaching experience and their use of manipulatives. In order to collect data regarding the use of manipulatives, exemplary teachers were interviewed. These teachers were selected on the following criteria:

1) They have experience teaching using manipulatives in an elementary classroom setting
2) They have at least 5 years of teaching experience.
3) They are willing to participate and be open to sharing their knowledge
Teachers were identified and found from my network of teachers. The selected participants were provided with Letters of Consent (see Appendix#).

**Data Collection and Analysis**

The primary means of data collections was face-to-face interviews. The interviews were recorded and transcribed onto papers. I made sure the participants were aware of the research topic and understood the significance of the research. All questions were asked in the same chronological order to maintain consistency within the interview process. Responses were recorded in writing and body language and facial expressions were observed and recorded as part of the notes. Body language and tone contributed to the findings in a way that responses alone could not.

**Ethical Review Procedure**

The Master of Teaching program Ethical Procedure was followed. Informed consents were read to each participant and the consent forms were signed before the interviews began. Each participant kept a copy of the consent form. I made sure the participants understood that the information they provided during the interview are kept confidential. If they want to revise their answers to the interview questions, they could do that at any time. Participants were also informed that they could suspend the interview at any time.

**Limitations of the Study**

The limitations of this study include: low number of participants; shortened time frame to conduct research as well as a lack of experience in qualitative research method. Some bias may
appear because I have a passion for teaching mathematics. That may show up without me noticing even though I tried my best to stay neutral. I tried to go into an interview with an open mind and not word my questions in a leading manner such as “Don’t you agree…”.

Chapter 4: Results

My research participants agreed that using manipulatives in the mathematics classroom has significant positive impact on how students understand mathematics. Results and finding are organized according to themes (and what I found from the interview that relates to the themes).

For the purpose of protecting the identity of the participants in this research, pseudonyms are used for both the teachers: Mary a grade 6 teacher and Kim, also a grade 6 teacher.

Kim has 8 years of experience working as a teacher in the Toronto District School Board. As a current grade 6 teacher, Kim promotes the use of mathematic manipulatives on a regular basis. Kim attended many math workshops and seminars both inside and outside of the school to further her knowledge in teaching mathematics. Kim did her AQ in math and became a math specialist. Kim enjoyed learning mathematics during her undergraduate education where she majored in Geography. She described herself as a teacher with a strong foundation in mathematics and a passion for teaching mathematics.

Mary is currently a grade 6 teacher and is also a Math Lead of the model school in the inner city of the Toronto District School Board. She has 9 years of teaching experience and has taught various grade levels from Kindergarten to grade 6. She has extensive manipulatives available to use in her classroom and often other math teachers would come to her to borrow
manipulatives. She aims to work toward balanced math in the classroom and adopts a variety of assessment strategies that include multiple intelligences and differentiated instructions. She incorporates manipulatives often in her classroom especially for students of kinesthetic and visual learners. She is also a Technology Lead in the school and that role allows her to work with technology on a regular basis. She introduced various websites to her class such as “math-whizz.com” to encourage students to take math beyond the traditional classroom setting. As well as technology provided by the ministry such as SmartBoards and soon, Ipads.

**Theme 1: Benefits of Manipulatives in a Mathematic Classroom**

The participants believed that manipulatives are very useful and should be implemented in math classrooms to help students bridge the gap between concrete and abstract concepts. Their use is largely determined on three aspects of teaching: Content Knowledge, Pedagogical Knowledge and Manipulative or Technological knowledge.

Kim stated that using manipulatives is important to her as a teacher:

“Well, using manipulatives, as the word implies, it creates the ability for students to visualize what they are doing and to have hands on. Even at the high school level, it is difficult to move the children straight to the abstract level. They must see the concrete and build them to the abstract.”
Content Knowledge

Content knowledge is the knowledge about that particular mathematics topic that will be taught in the class. The participants interviewed in this study have extensive knowledge in mathematics. They both have a passion for math and it is reflected through their many years of teaching experience in the mathematics classroom. When asked about her educational background, Kim answered:

“In Teacher College, I did math as my major [teachable] and I have been teaching math for a while. I teach middle school. I've been teaching math for the last 8 plus years.”

I followed up with a question about additional qualification after teacher’s college and she said “I've done the AQ courses in math up to the specialist level.” Kim elaborated on her university experience where she did Geography (mapping) as one of her majors. She said “You have to see math in a different light. In post grad, I did geography as my major. Map work involves mathematical concept and that is transferable knowledge. I was able to utilize and see math in different aspect of life and how important it is.”

Mary is one of the math leads in the school and has been teaching math for 9 years and explained “I taught math in grades 1, 2, 3, 4, 5, 6”.

“I loved math and so that is why I am so passionate about it because I know a lot of females [teachers] who did not like math; they were turned off of math for different reasons.”

I followed up with a question regarding her training in math, Mary explained

“In my Bachelor of Education (B.Ed.), I took math but my undergrad, I didn’t. I was in the specialized program, so it wouldn't fit. It was more language based psychology background.
But in my B.Ed., I took heavy math courses and that allows me to understand better how students learn math through primary/junior grades.”

Similar to Kim, Mary also took extensive additional qualification and workshops to further her knowledge in mathematics. She is an active organizer and leader of math workshops in her school. She said “I’ve gone to [math] training by Marian Small, who's like a math guru. I've gone to Google Camp where we talked about STEM (Science, Technology, Engineering and Math) in Math. We integrate Google gadget into STEM tasks and then I have gone to training for STEM because I'm also a science lead.”

Overall both Kim and Mary demonstrated a good understanding of mathematic knowledge as they both have extensive background in math and experience in teaching math.

**Pedagogical Knowledge**

Pedagogical knowledge is the “teachers’ deep knowledge about the processes and practices or methods of teaching and learning.” Koehler & Mishra (2009) further explained that it is “an awareness of common misconceptions and ways of looking at them, the importance of forging connections among different content-based ideas, students’ prior knowledge, alternative teaching strategies, and the flexibility that comes from exploring alternative ways of looking at the same idea or problem are all essential for effective teaching.”

Different teachers have different ways to teach a math lesson and in Kim’s case, she has practical and creative ways to teach the students that can be quite engaging. She explained how she uses different strategies to help students understand math and one of them was using benchmarks.
“I used benchmarks in geometry a lot so for example, that 90 degrees, 180 degrees, it’s their benchmark, cause kids can go higher in angle or lower in angle, but they use that as a benchmark.” - Kim

Kim also believes in applying mathematical knowledge to everyday life experiences. She discussed mathematical teaching approach that is simple, relevant and connects theory to real life lessons. She explained that if “They’re [students] doing it and they can apply what they are doing to real life experiences. So they understand that math is not just in the classroom, it is real life, even when they are putting on their clothing or go to the barber.”

Kim further elaborated that she often incorporates manipulatives anywhere she sees fits. To her manipulatives are available everywhere, inside and outside of the classroom. She explained:

“For example you are talking about geometry and they are learning about angles. They’re learning right angles, why not use your elbow, the right angle is created right there. Why not use things that they see around their classroom. Oh here is the right angle, they are learning tiles in the room, they putting down this, and they are doing that.”

When asked how manipulatives make a difference in her student’s engagement. Kim answered that “They experience a greater degree of success and they are motivated. When we are doing 3D shapes they actually have those 3D solids. When we have to find surface area of triangular prism or rectangular prism, they can see the faces. Through engagement, there is success.”
Another way that she uses to engage the students is what she calls “Math Talk”. Kim recalled one of her lessons when a school consultant came in to observe her lesson:

“We have a consultant who is working with the school currently and last week they were in my classroom observing. He said think, task, talk. And that’s what he saw evident in my class. Think (Minds On), then they have the task [activity] and then they talk about it [discussion].”

Mary also believed that using manipulatives is very important in helping students understand mathematics. She asserted “It definitely helps. Regardless of the research, what the research said, it definitely helps”. She explained further “It’s just the way students learn and I understand that their attention span is limited. You can’t stand up and teach directive learning the whole time, so I think the best way to really understand the material is to have something in front of them to manipulate it, to play with it, make it tangible.”

Mary believed that pedagogy is an important element in using manipulatives. She valued the process and not the outcome. She believed in giving students ample opportunities to communicate their understanding. She suggested “communication in math is huge. So they could talk about what’s in front of them. They are able to talk about what they see, what they’ve done and how they can change it or why they think like that.”

She added “The communication and understanding are definitely much easier because they are manipulating it; they are not watching you do it.”

I followed up with a question about her students’ engagement during the lesson. Mary exclaimed “I think engagement goes up!” As she put it,
“We made it [geometry angles] with random materials, with the popsicle sticks. I had a large clock hand that we used but we used it for angles. We also made angles just with papers and clips. They were able to understand it themselves as opposed to just using protractors and they were able to create their own protractors.”

**Manipulative or Technological Knowledge**

The results show that having a deep understanding and knowledge of using manipulatives is critical in a math lesson. During lesson planning, teachers who take the time to study the manipulatives and put it to the test will find it much more effective when they teach it to the class. Teachers should be selective with the types of manipulatives that they use and how to use it. There are many manipulatives that can be chosen from a variety available in the classroom but the ones that will be most effective in your lesson should be carefully chosen by working with them during lesson planning.

According to Kim:

“The teachers should use the manipulatives before showing to the kids. I should experience it, I should try it. I should go through it, make my mistakes; I should discover “Aha” moments before I bring them to the classroom. At least I am knowledgeable of some of the pitfalls. What are some of the questions students should have and what are some of the challenges students may have when they use manipulatives.”

Manipulatives should be chosen very critically with an objective lens to its relevance, clarity and flexibility. Kim also believes that having good knowledge of the manipulatives is very helpful when choosing what to use in the lesson.
“One of the things I would suggest is that any one desire to use manipulatives should first take time to be selective of manipulatives that will be used and should have a great mathematical knowledge of how to use the manipulatives.” Kim added that “Understanding the protractor, I use the strategy where they see the whole 360 rather than 180 because most protractors we see are 180 but how do we get to see that it’s only half. I try to see the whole and then branch off to a half.” She explained even when it comes to technology such as a protractor, we must be mindful of its pros and cons.

Kim further discussed: “And when you use the manipulatives, we need to think that we create opportunity for students to scaffold their thinking and to make the connection they can investigate using manipulatives. The concepts can be much clearer and they can consolidate thinking using manipulatives. It’s not just for the children who are challenged in math. Manipulatives should be used by everyone.”

**Theme 2: Challenges of Manipulatives Use**

Despite many benefits and advantages of manipulatives use in the mathematic classroom, there are also challenges that come with it. The lack of mathematical content knowledge, pedagogical knowledge, and technological/manipulative knowledge including the time requirement and availability of manipulatives are discussed in this section.

**Lack of Pedagogical Knowledge**

When asked about the challenges of using manipulatives, Kim answered:
“Some teachers have the thinking that manipulatives are only for children who are struggling or challenged. That is perpetuated over the years. Oh go use the manipulatives. Let the students all use the manipulatives to investigate. Let us all use it. So it is a class using it not individual student only. Students should be free to get up and use the manipulatives they choose.” She strongly believed that manipulatives should be readily available for any student at any time whether they are mathematically challenged or mathematically gifted.

Kim explained that sometimes challenges arise in the methodology of manipulatives use. Complications arise as clarity starts to blur because the overlapping use of one type of manipulative. She recalled the challenge of pedagogy from one of her past lessons,

“In number sense the base 10 blocks can cause confusion because we use them for whole number and we also use them for decimal. When you use them as whole number we use the cubes and the rods. When you are using it as a decimal, depending on what the whole is, the decimal representation changes, and kids are still in their zone of whole number rather than decimal. If we go to the nearest hundredth, the whole become the large cube, the flat become the tenth, the rod becomes our hundredths, and it is disconnected.”

Mary pointed out that “As a teacher if you overuse the manipulatives, to the point where students do not understand number value of things, that is going to hinder their learning”. The challenge that she saw in any manipulative is using the manipulatives incorrectly or unclearly. In her words, “I think anything can hinder someone's learning if it is done incorrectly right? Not using it [manipulatives] properly would hinder it [student’s learning of mathematics]”

Mary was especially passionate when she spoke about the method and practice of teaching using manipulatives. In her words:
“I think we have to, we are using it to scaffold their learning. We teach the use of manipulative but we also work on mental math strategies so eventually they are not using manipulatives to add 2+8 in primary grade. They can do that with mental math. There has to be some sort of scaffolding so they are able to do things without manipulatives.”

**Lack of Technological Knowledge**

Mary’s statement is very similar to Kim’s. They both believe that teachers don’t have the required training to facilitate the effective use of manipulatives. She elaborated further:

“Your room may pile up with manipulative but how are we using cube link, pattern blocks, how are we using the way they are meant to be used or are we using them as counting tools? Counting is great to some extend but that's not the full purpose on how we could use it.”

With much passion Mary continued:

“In geometry for example, right? I think it's important that teachers know how to use manipulatives. I really think that's the biggest challenge, is the lack of knowledge and how to incorporate it.”

Mary explained that when she first started teaching, the greatest challenge for her was the knowledge of using mathematic technology and manipulatives. She added that there was a lack of support to obtain that knowledge. In her words,

“It’s when I started reading more of Marian Small’s books that I was able to really gain that knowledge [manipulative knowledge] for myself or looking at Khan Academy and understanding the material.”
Time Consuming

When asked "What are the greatest challenges to teachers when using manipulatives?" Kim answered “It is time consuming”. Both Mary and Kim mentioned that one of the greatest challenges of using manipulatives is “time”. They both believe that it is very time consuming both planning and implementing. Mary asserted “That’s always a challenge in school but if our focus is math then we have to put in the time in order to plan it and teach it.” Both teachers expressed their thoughts about the time demand for planning the lesson, selecting the appropriate manipulatives, making activities that use the manipulatives, asking questions to promote student discourse and assessments that reflect students’ understanding. In Mary’s opinion, “I think the challenge is not to overwhelm ourselves because I think we are already overwhelmed as teachers but to start small.” Kim also expressed the fact that we have to try the manipulatives first before we attempt to teach it and by doing that we can implement them in our lessons efficiently and effectively. The teacher has to experience it beforehand to see any problems that may arise and prepare possible solutions to the problems. Kim believed that the teacher has to be proactive and take necessary steps to deliver an excellent lesson.

Availability of Manipulatives

According to Mary, manipulatives are abundant in her school but there are schools that have a lot less resources and finding the appropriate resources for what you need could be challenging. As Mary expressed:

“I think in our school we are lucky that we have manipulatives, so that's not a challenge in our school, however for some schools, yes it is a challenge where there isn't enough manipulatives to go around but I say overall, in working with our family of school, 15 schools in
the area, the biggest complaint is teachers not being trained on how to effectively use manipulative.”

**Theme 3: Strategies and Suggestions**

Kim uses manipulatives very often in her classroom when she teaches mathematics to her students. She asserted that the use of manipulatives “creates opportunities for students to visualize that they are doing and to have hands on experience”. She believed that even for older students, it is very difficult to move right into the abstract content without exploring concrete concepts.

Kim suggested for new teachers who look to incorporate manipulatives in their classroom, they can look up different resources available to them for help. Kim explained

“There are a number of research, binders, websites, and video clips of how to use manipulatives. So, it is important that the teachers have that rich background. I encourage every teacher to use manipulatives because the kids learn best through that means. Students are not in abstract level, they are very concrete level. That is most of our students. Even abstract ones, it help them to be even more successful using concrete material.”

Kim also elaborated that “In school, there are professional development sessions and workshops, particularly on how to use manipulatives. There’s also Ontario Association of Math Educators (OAME). “

Kim mentioned that in her school, “teachers can also visit other teachers’ classes so they can see how manipulatives are used.” and learn from it. She advised teacher candidates to take
advantage of the available resources and sources of knowledge such as workshops and conferences both in and out of school. She added that “We have a numeracy committee [in the school], where we met at least once a month and we share. We run workshops with teachers and teachers candidates and showing them how we use manipulatives.”

“When we use manipulatives, we need to think that we create opportunities for students to scaffold their thinking and make the connection where they can investigate using manipulatives. The concepts can be much clearer. It is not just for the children who are challenged in mathematics. Manipulatives should be used by everyone.”

Mary believes that there’s more to manipulatives than the tangible objects. As a Technology Lead in her school, she was aware of a variety of different technology that is available to teachers. In Mary’s own words,

“I know there's a software that has a 3D solid and you can actually manipulate it to move it so, it's 360 degree so you can actually count the sides.”

Mary also offered an advice for young teachers in term of strategies for using manipulatives:

“I think if you look in the guide of effective instructions, you'll definitely get some strategies in there and how to use manipulatives. If you don't know where to start, there is a specific list on the guide to effective as well as on the EQAO.”
Chapter 5: Discussion

In this chapter, I will analyze and interpret my findings based on the results derived from the interviews. Then I will make a connection to the literature review from Chapter 2 and consider the implications of the study, limitations and recommendations for future studies. I will also relate it to my research question to see the disadvantages and/or benefits of using manipulatives in teaching mathematics.

Overview

The purpose of this study was to investigate how teachers incorporate manipulatives in their mathematic lessons and explore how they use manipulatives to help students understand mathematics. The findings from the Chapter 4 indicated that teachers facilitate manipulative use in their classroom on a regular basis. They believe that manipulatives are an important element in their lessons and crucial to helping students make a connection between concrete and abstract content. However, there seem to be a lack of training in the effective use of manipulatives. Very often, participants indicated that they had to do their own research and discover how to use the manipulatives on their own personal time. Overall, manipulatives were stressed throughout the interviews as being an important element in every math lesson as well as students of different learning needs.

Correlation between Findings and the Literature Review

McIntosh (2012) stated that “It is clear that even with minimal exposure, students of all intelligence levels can benefit greatly from the use of manipulatives.” This statement is
consistent with Kim’s suggestion that every student can benefit from using manipulatives. According to Kim, teachers should not regard manipulatives as tools for students who are mathematically challenged but they should be available for every student and encouraged to be used by everyone.

When asked if manipulatives can help or hinder students’ mathematical understanding, both teachers agreed that they help when used properly. As, Mary exclaimed: “It definitely helps”. That is similar to the article by Couture (2012) who stated “The results of this project confirmed my original thought that math manipulatives will help increase student achievement” (p. 18). This was also reinforced in Allen (2007) as she stated “...using manipulatives gives students a better understanding of basic math skills and seems to hold their interest and help them to enjoy learning” (p. 15).

The results indicated much similarity to what the literature has highlighted. One of the aspects that were similar between the literature and the result is the manipulatives selection. “There are countless ways to use a variety of manipulatives but it is important to know which manipulatives are appropriate for teaching the desired math concepts and how to properly use the manipulatives in teaching that concept” (McIntosh, 2012, p.6). This statement correlates with what Kim and Mary suggested when selecting manipulatives. Teachers should dedicate time to select the appropriate manipulatives and try them out before teaching them to the students. As Mary mentioned, there may be a lot of manipulatives available in the classroom but selecting the most relevant manipulatives is very important and understanding their proper use should be a priority when incorporating manipulatives in the lessons. This is also apparent in Marzola
(1987) when she mentioned that choosing manipulatives require “critical eye toward clarity and utility” (p. 12).

Marzola (1987) emphasized that manipulatives should be chosen very carefully and critically. Likewise, Kim stated that manipulatives should be tested and selected carefully before introducing them to the students.

Selecting the appropriate manipulatives is important because if they are not carefully chosen, problems may arise during the lesson. At that point manipulatives are no longer useful but could have a negative effect on student’s learning. Especially, teachers have a large selection of manipulatives that may overlap in functionality. Marzola (1987) stated in her article that “As the number of manipulatives available to teachers increases, the need for careful, thoughtful selection becomes even more critical.”

Furthermore, the research participants discussed that improper use of manipulatives can cause problems and confuse the students. This relates to the research by McIntosh (2012) when she stated “…nevertheless some researchers feel that improper use is more of a hindrance than no use at all” (p.6).

The teachers interviewed in this study are aficionados of using manipulatives in the classroom and they suggested two possible reasons why teachers don’t use manipulatives in the math lessons. They are the “availability” of manipulatives and “time” and both these reasons are consistent in the literature review as one McIntosh (2012) stated “…yet listed availability as one of the biggest hindrances to more frequent manipulative use in their classroom (the second largest hindrance was time)” (p.8).
The teachers also stated how important it is to elicit math talk and discussions in their lesson using manipulatives. Mary explained in her math lessons she used “Think (Minds on), Task, Talk”. Both Mary and Kim believed that through teacher questioning and student discussion, they can check students’ understanding and promote critical thinking at a greater level. It is consistent with Olkun & Toluk (2004) when they asserted:

“Through teacher questioning, students are invited to express their thinking in an inquiry-based classroom environment. Teachers, then make informed decisions about students’ mathematical thinking to lead subsequent discussions. Individuals are challenged to consider their solutions through questions asked by the teacher and their classmates (p. 2).

It is important to precede and accompany demonstrations with verbal explanation of the concept being illustrated (Garnett and Fleischner, 1987)

Both Kim and Mary emphasized math talk in the mathematic lessons where teacher and students can discuss and communicate their ideas and thoughts. They believed that it is an important step in creating student discourse. This idea goes hand in hand with the literature review. It is especially in line with Marzola (1987) as she quoted in her article “The mere presentation of representational models is obviously not sufficient to improve concept development in mathematics. It is important to precede and accompany demonstration with verbal explanation of the concept being illustrated”
Implications for My Future Teaching

The implication for me as a teacher is that through research and interviews with these teachers, I’ve learned more about the significance of using manipulatives in math lessons. I’ve learned about the theories behind using manipulatives by reading various articles on math manipulatives use in the classroom. Through reading the research literature, I learned the pros and cons of using manipulatives. I learned that there are many resources available to help teachers incorporate the use of manipulatives in their classroom. By doing this research paper, I’ve gained much knowledge on the use of manipulatives and its importance in any math lesson. I will share what I learned with my future colleagues and students. The information that I learned through this research project will strengthen my existing teaching philosophy.

Through research I learned about different types of manipulatives that can be used in the classroom. Manipulatives come in all forms and sizes but each has their own purpose. In addition, virtual manipulatives are just as effective and are easily accessible to students and teachers.

Through interviewing the participants, I learned different strategies that I could implement in my future classrooms. I also appreciated the sharing of knowledge from experience teachers because for some new teachers, learning how to use manipulatives properly could be challenging. I also enjoyed the process of going through interviews with these teachers because sitting down with them allowed me to discover new teaching tips that I could use in the future. Manipulatives don’t teach the students mathematics, it is the teachers that teach the students with the manipulatives as a teaching tool. The teachers are the catalysts to make learning happen. I feel that it is important to understand that and not rely solely on
manipulatives. Through questioning, thinking and discussions, teachers can help students solve problems using these visual and kinesthetic aids.

I also learned that as mathematic teachers, we have to help students make a connection with real life scenarios. That is one of the possible ways to help students make learning math personal. They have to see how it connects to their daily life. They have to see that the manipulatives that they use to solve mathematic questions are all around them. As Mary pointed out that manipulatives such as angles in geometry can be found on the human body. Just by manipulating her elbow, she could demonstrate acute, obtuse and right angles.

**Implications for the Broader Community**

This study has implications for the education community in three ways:

Firstly this research will encourage teachers to incorporate manipulatives use in their mathematic classroom with confidence. It is especially beneficial for new teachers like me who hesitate to use manipulatives due to reasons such as availability and time constraints. They can be creative and use manipulatives of different shapes and forms. Teachers can feel confident that manipulatives are beneficial to their math lessons as asserted by the interview participants and the researchers.

Secondly, this research informs teachers that pedagogy of using manipulatives is just as important as knowledge of mathematics. Selecting the appropriate manipulatives that has a clear purpose and clarity is the key to helping students bridge the gap between concrete and abstract concepts.
Lastly, this research carries a message to teachers and educators that students of all learning abilities can benefit from using manipulatives. As Mary mentioned in her interview, we should not automatically associate manipulatives use with students who are weak in math but we have to allow all students to have access to manipulatives at all time.

**Recommendations**

Base on my research, I have the following recommendations for using manipulatives in the classroom:

1) **Having manipulatives as a component of mathematic lesson for all types of learners.** It is most beneficial for visual learners and kinesthetic learners but it is encouraged for all students of varying abilities and learning levels. Even though, the use of manipulatives may be time consuming in term of planning and conducting the lesson, they are worth it as students will understand the material better.

2) **Be selective with the types of manipulatives chosen for the lesson.** Manipulatives selected should be based on relevance and clarity. Teachers should use manipulatives that are purposeful and not just for the sake of using manipulatives. Teachers should also try using the manipulatives themselves to find out the most efficient and effective way to work with them before teaching them to the class. This allows teachers to be comfortable with the manipulatives and ample time to conquer the challenges before implementing the manipulatives.

3) **Be open to learning about different and new manipulatives as well as the most effective ways of using them in the classroom.** Continue to incorporate manipulatives in your teaching pedagogy and also sharpen your math content knowledge by taking AQ courses,
university mathematic courses or attend school workshops, seminars and conferences. Teachers who find unique and creative ways of using manipulatives in their math lessons are encouraged to share their knowledge and resources to teachers and teacher candidates. Through sharing, we can discover more and better ways of using manipulatives.

**Limitations of the Study**

Due to various constraints of my program, this research has some limitations. The limit of the study time frame impacted on the number of participants I was able to interview. I sought out the best and most recent literature on the topic but I am aware that more literature is available. The practicality of conducting research while engaged in full time study was also a constraint on my time.

Lastly, as a teacher candidate who enjoys teaching mathematics and has some mathematic teaching experience, I believe this research may be slanted in that direction. I tried my best to keep a neutral perspective throughout the interviews and tried to balance the literature review selected for review but I acknowledge that I may have shown bias one way or another.

**Further Questions**

Further questions for future investigation include: Do students improve on tests and quizzes when mathematic manipulatives are used? Is there a significant improvement in
mathematic performance when students use manipulatives? Do students experience math anxiety when manipulatives are taken away?

**Future Directions**

Future studies should investigate students’ performance when they are allowed to use manipulatives versus students’ performance when manipulatives are not permitted. Future research may also investigate the effectiveness of specific manipulatives and how they impact students’ learning. In addition, researchers should also investigate the potential reason for as to why teachers often use manipulatives in primary grades and then gradually decreases as the grade level increases. Throughout my research, I’ve learned that manipulatives can benefit students of all grades and all ability levels. Is it because students in higher grade levels cannot find the appropriate manipulatives that they require or is it because they have grasp the abstract concepts so well that concrete objects are no longer needed?

**Conclusion**

According to my research, elementary school teachers find that using manipulatives is an important part in their math lessons. Both teachers believe that manipulatives give students opportunities to explore tangible and non-tangible objects to make connections between concrete and abstract concepts in mathematics. The literatures show that there are benefits to using math manipulatives in math lessons. They allow students to see math in different lights and arrive to their own personal understanding. Manipulatives create opportunities for students to discuss, reason, and communicate their mathematical ideas. The use of manipulatives deepens students’ understanding of abstract concepts and their relationship with concrete concepts. Manipulatives make math learning more meaningful and enjoyable. This research paper hopes to encourage
teachers to use manipulatives more often in their mathematic lessons. When teachers use
manipulatives to teach mathematics, students show more engagement and through engagement,
learning happens. Let the manipulatives come out. Let learning takes place in every mathematic
classroom. Let learning happens in every student.
References


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


Appendix: Letter of Consent (Adapted from OISE)

Date: ___________________

Dear ____________________,

I am a graduate student at OISE, University of Toronto, and am currently enrolled as a Master of Teaching candidate. I am studying _________________ for the purposes of investigating an educational topic as a major assignment for our program. I think that your knowledge and experience will provide insights into this topic.

I am writing a report on this study as a requirement of the Master of Teaching Program. My course instructor who is providing support for the process this year is Dr.__________________. My research supervisor is ____________________. The purpose of this requirement is to allow us to become familiar with a variety of ways to do research. My data collection consists of a 40 minute interview that will be tape-recorded. I would be grateful if you would allow me to interview you at a place and time convenient to you. I can conduct the interview at your office or workplace, in a public place, or anywhere else that you might prefer.

The contents of this interview will be used for my assignment, which will include a final paper, as well as informal presentations to my classmates and/or potentially at a conference or publication. I will not use your name or anything else that might identify you in my written work, oral presentations, or publications. This information remains confidential. The only people who will have access to my assignment work will be my research supervisor and my course instructor. You are free to change your mind at any time, and to withdraw even after you have consented to participate. You may decline to answer any specific questions. I will destroy the tape recording after the paper has been presented and/or published which may take up to five years after the data has been collected. There are no known risks or benefits to you for assisting in the project, and I will share with you a copy of my notes to ensure accuracy.

Please sign the attached form, if you agree to be interviewed. The second copy is for your records. Thank you very much for your help.

Yours sincerely,

Researcher name: _______________________________

Phone number, email: ______________________________
Instructor’s Name: ____________________________________________
Phone number: _________________ Email: _______________________

Research Supervisor’s Name: ___________________________________
Phone #: ________________ Email: _______________________

Consent Form

I acknowledge that the topic of this interview has been explained to me and that any questions that I have asked have been answered to my satisfaction. I understand that I can withdraw at any time without penalty.

I have read the letter provided to me by _______________________(name of researcher) and agree to participate in an interview for the purposes described.

Signature: ________________________________________

Name (printed): _________________________________

Date: __________________________
Interview Questions:

Section 1: Background information of interviewee

1) Tell me about yourself and your current philosophy of teaching elementary math.
   - How long have you been teaching mathematics?
   - What grade do you currently teach?
   - Could you talk about your experience in teaching mathematics? Grades you taught in the past.

2) Describe yourself as a K-12 mathematics student. Did you enjoy your experience?

3) Describe any post-secondary (undergraduate) training you had in math.
   - In what ways, if any, did it inform your current professional practice as a math teacher?

4) What Professional Development (PD) courses or Additional Qualifications in mathematics did you complete after graduating from teachers' college?
   - If not, are you planning to take any in the future and why?

Section 2: Interviewee's perception on the benefits of using manipulative to teach geometry

1) How important is using manipulative to you as a mathematics teacher?
2) Do you think providing manipulative will help or hinder the development of deep, conceptual understanding in mathematics? Please explain.

3) What are some of the differences that you noticed, if any, in students engagement when you provide manipulative in their geometry activities?

4) Base on your experiences, what are some of the ways that the use of manipulatives supports student learning? In what ways might manipulative hinder student learning?

Section 3: Interviewee's challenges with using manipulative

1) In your opinion, what are the biggest challenges, if any, that may prevent teachers from using math manipulative as part of their geometry unit?

2) What was most difficult for you when implementing manipulative in geometry? Explain why.

3) Have you seen any complications that manipulative have caused in affecting students understanding of geometry?

Section 4: Suggested strategies to use in mathematics classroom

1) What techniques or strategies do you use in your classroom to help students understand geometry using manipulative? Please provide one example.

2) Do you facilitate and encourage group discussions during the use of manipulative?

3) Do you pose specific questions to elicit student discussions when they use manipulatives?

4) What suggestions do you have for teachers that will assist them in facilitating the use of manipulative in their mathematics classrooms?
5) What training or professional development, if any, do you feel teachers need in order to support and/or build the skills necessary to affectively facilitate the use of manipulative in their mathematics classroom?