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# Teachers' Perceptions of Manipulatives During Middle School Math Instruction

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COLLEGE OF EDUCATION

This is to certify that the doctoral study by

Angela Vizzi

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Abstract

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Doctoral Study Submitted in Partial Fulfillment

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Abstract

In a Colorado school district,  school personnel and parents were concerned that middle school math proficiency levels were low for 2011-2014 and math teachers were not using manipulatives in their classes to increase math performance. The district's math coordinator did not foresee providing specific professional development (PD) for math manipulative use to address these concerns. Without this PD, math teachers may be ill-quipped to teach math concepts when using manipulatives, which, in turn, could lead to further poor math performance. The purpose of this qualitative bounded collective case study was to explore middle school teachers' perceptions of PD and perceived self-efficacy regading the implementation of manipulatives. Knowles's andragogy and Piaget's cognitive development theories framed this study. A homogeneous sample of 12 voluntary participants with more than 5 years teaching middle school math, both with and without access to manipulatives, volunteered to participate in this study. Data from observations, interviews, and archival documents were analyzed using comparative and inductive analyses and were analytically coded. Participants reported a need for PD that focused on physical and virtual manipulatives (PM and VM) and a low perceived self-efficacy regarding manipulatives use during math instruction. A blended PD using face-to-face and distance learning formats was designed to increase math teachers' knowledge of and perceived self-efficacy with PM and VM for math instruction. This endeavor may contribute to positive social change by reforming PD opportunities to support teachers' practice and self-efficacy using manipulatives during math instruction, ultimately increasing student performance.

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## Dedication

This study is dedicated to my family. This could not have been accomplished without each one of them.

To Mom and Dad: Thank you for the support, patience, and guidance you provided during this entire journey.

To Theresa and Barbara (my sisters): Thank you for being supportive and patient during this journey. This is officially the end of my alphabet soup!

To Nathian and John (my nephews): I dedicate this study to you because you boys are my heart.

To Adria (my cousin): You are one of the best writers and editors I know. You have been there to assist in any way necessary from the beginning. Thank you!

To Ronnie (my husband): You have endured a lot of ups and downs during this journey. I commend you for remaining patient and accommodating. You are now a better cook because of all the nights you had to “figure it out”— you’re welcome.

To Kiyah, Ronald, Vincent, and Rain (my children): No longer will I miss a moment of your life. Thank you for your patience and willingness to accept a bribe so that I could read and write. Kiyah, you have helped me with your siblings when I needed it the most. I dedicate this study to the four of you because you are the reason my life has meaning!

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Another acknowledgement that I must make is toward my peers. When I first began my doctoral journey at Walden University, my four-year-old son, Ronald, suddenly died. My whole world stopped. If it were not for my peers and Dr. Swetnam, my life would be completely different. A few semesters later, I was enrolled in a course with Dr. D'Ann Calams, a fellow bereaved parent. To have an individual who truly understood the daily struggles and kept me focused when I just wanted to give up was invaluable. Thank you so much for helping me remained focused when I was feeling low. Thank you for thinking of me often. Thank you for being a friend that I will forever cherish.

Lastly, I would like to thank my local school district for allowing me to collect data in the middle schools. In addition, to the middle school math teachers who decided to volunteer to be a voice within this study— thank you.

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## Introduction

The integration of manipulatives into mathematics instruction necessitates that students be at ease with new mathematical representations. Manipulatives are recommended by math experts to increase academic achievement in mathematics (Boggan, Harper, & Whitemire, 2011; Kaminski, Sloutsky, & Heckler, 2008). Children better cognize mathematics when allowed to use concrete instances (Chang, 2008). Studies conducted using manipulatives revealed that students' academic achievement in mathematics increased when manipulatives are applied appropriately (Chang, 2008; Huang, 2012; Vitale, Black, & Swart, 2014). However, students are only contingent beneficiaries to academic achievement in mathematics in relation to teachers' knowledge, skills, and professional development (PD). For teachers to keep current with the changes in mathematics educational reforms and pedagogies, PD should be developed to meet math teachers' needs (McGee, Wang, & Polly, 2013).

Teacher PD is a critical factor to consider when determining whether manipulatives are applied appropriately during instruction (Patel, Franco, Miura, & Boyd, 2012). According to McGee et al. (2013), teachers' perceptions of the overall impact of PD greatly determines the degree of change a teacher is willing to make to their instructional methods or strategies within the classroom. This is important because when teachers do not believe that content demonstrated during PD will be useful, they are less likely to change their instructional methods or strategies (McGee et al., 2013). This doctoral study on teachers' perceptions of PD and self-efficacy in the implementation of manipulatives to teach math in middle school was designed in part to assist in determining the needs of teachers and ways to make them more willing to make necessary changes to instructional methods and strategies.

In Section 1 of this study, I discuss the problem, rationale of the problem, and significance of the problem, from both a local and national perspective. In addition, I define special terms, present research questions, review current literature, and explore conceptual frameworks associated with the problem. I also discuss implications for possible projects based on the likely findings from the data collection and analysis. Finally, I discuss a summary of the key points in Section 1.

## Background of the Problem

Manipulatives are virtual or physical objects and help students increase understanding of mathematical concepts (Boggan et al., 2011). The use of manipulatives further supports the student in making a mental translation from an abstract, mental concept to a concrete representation of that abstract concept being taught (Boggan et al., 2011). The Enhancing Education through Technology Act of 2001 was passed in an effort "to improve student academic achievement through the use of technology in elementary schools and secondary schools" (No Child Left Behind [NCLB], 2002, sec. 2401-2404). Despite federal initiatives such as the No Child Left Behind Act of 2001, many United States math teachers have remained reluctant to use any type of virtual or physical manipulatives within their classroom instructional methods (McNeil & Jarvin, 2007; Pelfrey, 2005).

This reluctance is problematic in light of research suggesting that math education should focus more on the skills and knowledge teachers would like their students to understand versus the skills and knowledge teachers would like their students to compute (Goldsby, 2009). For instance, teachers should have a clear vision prior to instruction and identifiable set of objectives for the learning outcomes and targeted objectives (Peklaj, Kalin, Pečjak, Valenčič Zuljan, & Puklek Levpušček, 2012). When teachers have a clear vision of objectives and learning outcomes, their lesson planning is focused more on activities that tell the students to do things rather than what they should master in terms of the identified objectives (Peklaj et al., 2012). Teachers' perceived sense of self-efficacy of manipulatives is contingent upon PD and what the teachers are trying to achieve as it relates to students' math achievement and progress (Van de Walle, Williams, Lovin, & Karp, 2014). Teachers' confidence levels or teachers' perceived sense of self-efficacy assist in attaining the clear vision necessary to determine the set of objectives and learning outcomes.

Most United States math teachers possess a procedural knowledge of mathematics instruction that is referred to as a more traditional instructional method (Bartell, Webel, Bowen, & Dyson, 2013; Sutton & Krueger, 2002). However, the National Council of Teachers of Mathematics (NCTM) has recommended that math teachers possess more than just procedural knowledge (Bartell et al., 2013; Sutton & Krueger, 2002). Due to the significant weight that is placed on students' understanding of procedural knowledge, teachers are likely to be more inclined to think of mathematics as having separate sets of procedures and rules for solving and manipulating expressions instead of how those procedures and rules overlap to solve math problems. In order for teachers to display efficacious behaviors that will motivate students throughout the instruction of math concepts and skills, they need to understand the objectives and relate the learning using manipulatives(Tschannen-Moran & Barr, 2004). Efficacious behaviors of math teachers include task analyzing the lesson content so the student masters the specific skills using manipulatives to internalize the larger mathematical concepts being taught (Tschannen-Moran & Barr, 2004).

When teachers self-assess their decisions to use manipulatives during math instruction, the teachers become aware of how to positively affect student achievement and learning outcomes (Bruce, Esmonde, Ross, Dookie, & Beatty, 2010). This suggests that students will positively respond toward learning more difficult mathematical concepts and skills from teachers who feel comfortable and confident using manipulatives during instruction. In my local school district, hereafter referred to as Colorado School District 1 (CSD1), potential outcomes of implementing manipulatives during classroom instruction are positive gains in students' assessment scores in math and an increase in teachers' perceived sense of self-efficacy in using manipulatives during math instruction.

According to the Colorado Department of Education (CDE, 2013), there were a total of 9,597 middle school students enrolled within CSD1 in the 2011-2012 school year. CSD1's 2011-2012 mathematics local Transitional Colorado Assessment Program (TCAP) scores indicate that only 53.97% of the middle school students performed at proficient levels. The TCAP state average for middle school students for the same year was insignificantly higher, 58.80% (CDE, 2013). CDE (2013) reported that CSD1's middle school enrollment increased to a total of 10,704 in the 2012-2013 school year, but that there was no statistical difference in TCAP math scores among middle school students. The 2012-2013 school year mathematics TCAP scores indicated that only 54.07% of middle school students performed at proficient levels, which continued to be below the state percentage of 56.68% (CDE, 2013). CSD1's middle school enrollment decreased during the 2013-2014 school year to 10,536, but the mathematics TCAP scores within CSD1 remained statistically similar at 55% (CDE, 2013). The 2013-2014 school year TCAP scores within CSD1 continued to be below the state percentage of 56.39% (CDE, 2013). The instructional methods, and whether or not manipulatives were used during preparation for the assessment, were not listed.

CSD1's repeated low math proficiency levels at the middle school level are a cause for concern for administrators, teachers, and parents. When students do not fully understand mathematical concepts and skills, this problem is most commonly attributed connected to the teachers' knowledge, understanding, and use of instructional methods (Peklaj et al., 2012). Teachers in all 50 states are required to take and pass state proficiency exams that are considered to validate certain knowledge and understanding of the desired instructional subject prior to entering the classroom (Reagan, Schram, McCurdy, Te-Hsin, & Evans, 2016). The rationale for this requirement is that qualified teachers will better teach students the expected core skills in each of the four content areas (DeAngelis, White, & Presley, 2010).

Teachers who teach core academic subjects (reading, writing, science, social studies, and math) are classified as highly qualified by meeting three basic criteria specified by NCLB: possess a bachelor's degree, hold a full teaching certificate, and demonstrate competency in the subject that will be taught (NCLB, 2002, sec. 1901). The rationale for including an expectation of highly qualified teachers in the law was that it is necessary for teachers to understand area content, pedagogy, and learning for students at higher risks of encountering developmental issues related to abstract learning (Douglas, Burton, & Reese-Durham, 2008). In turn, school districts must employ teachers who are highly qualified in the content area they teach.

Teachers within the local school district used for this study are considered highly qualified to teach when the three criteria listed within the NCLB Act are met. The Human Resources specialist in CSD1 also maintained that 100% of the teachers, including middle school teachers, are considered highly qualified because it is a condition of their employment (H. Resource, personal communication, August 5, 2014). In CSD1, during the 2010-2011 school year 100% of the teachers were considered highly qualified (CDE, n.d.). The percentage of highly qualified teachers decreased slightly in the 2011-2012, 2012-2013, and 2013-2014 school years (99.80%, 99.87%, 99.86% respectively) (CDE, n.d.). A human resource specialist in CSD1 informed me that this slight decrease is attributed to the affiliation of charter schools within the district (H. Resource, personal communication, August 5, 2014).

Although there does not appear to be an issue of teachers being highly qualified within CSD1, teachers still need to possess the knowledge and skills to use manipulatives and other tools which support the scaffolding of math skills and concepts (Douglas, Burton, & Reese-Durham, 2008). One avenue in which teachers are able to continuously perfect their skills and learn new tools to implement with the students is through continuous PD. However, continuous PD was not available at the time of the study. CSD1's K-12 math coordinator stated that there were no specific dates for continuous PD for math teachers throughout the school year and no district-wide PD specifically related to manipulatives offered to math teachers (M. Coordinator, personal communication, July 31, 2014). Therefore, it was necessary to explore middle school math teachers' perceptions and beliefs in CSD1 regarding the use of, or lack of use of, and proficiency of manipulatives to support instruction of middle school math concepts and skills.

Several studies have recommeneded the use of manipulatives at all grade levels in teaching a plethora of mathematics concepts and skills (Burns, & Hamm, 2011; Carbonneau, Marley, & Selig, 2013; Yuan, 2009). This research suggests that it is vital to explore varying views and beliefs on the use of manipulatives among middle school teachers. However, this study specifically focused on middle school math teachers' perspectives related to manipulatives because considering teachers' views is paramount when instructing students (Chamberlin, Farmer, & Novak, 2008). Teachers' perspectives about manipulatives are critical because teachers are ultimately the individuals responsible for the implementation and student use of virtual manipulatives (VM) and physical manipulatives (PM). Therefore, teachers must perceive the value of manipulatives in order for the implementation of manipulatives to be effective and noticeably increase students' mathematical understanding of concepts.

The importance of teachers in implementing manipulatives in the classroom was supported by Puchner, Taylor, O'Donnell, and Fick (2008), who maintained that many United States teachers do not use manipulatives during math instruction because of the "necessary time investment and poor results" (p. 314). An international study showed that the use of VM or PM during math instruction was significantly low, 14% (VM) and 22% (PM) respectively (Akkan, 2012). Stewart (2003) further supported Akkan's findings by maintaining that as students graduate to higher-grade levels, "fewer and fewer manipulatives are used in math education" (para. 4). Unsuccessful efforts have been made to increase VM and PM usage during mathematics instruction throughout the United States.

In No Child Left Behind, there has been a refocus on increasing the use of VM and PM during math instruction at all grade levels. However, some teachers minimally use them during instruction due to a lack of knowledge, even when these tools are available (Hill, Rowan, & Ball, 2005; National Council of Supervisors of Mathematics, 2013). Over the past decade, national efforts focused on increasing mathematical challenges of K-12 classes have not increased the number of teachers choosing to use manipulatives during instruction because teachers feel more comfortable using traditional methods and techniques to teach mathematical concepts (Alsup & Sprigler, 2003; Boggan et al., 2011; McNeil et al., 2010). With the advancements of technology, teachers are asked to shift from their traditional instructional methods to creative methods that include the use of manipulatives (Boggan et al., 2011). Due to the potential for differing teacher views, levels of PD, and feelings of efficaciousness in using manipulatives, it is imperative that teachers' beliefs and perceptions are explored to deeply understand the level and intensity of (a) the use by students, (b) the use related to math concrete (manipulatives) versus abstract (paper and pencil) learning, and (c) the use of VM and PM identified with the improvement of math concepts and progressive competence in students and specifically at the middle school grade levels.

## Problem Statement

This study addressed the problem of middle school math teachers' lack of use of manipulatives during instruction. A symptom of this problem was shown by low proficiency levels in mathematics among middle school students within CSD1 based on Transitional Colorado Assessment Program (TCAP) scores across Colorado. In the United States, there has been a refocus on increasing the use of virtual manipulatives (VM) and physical manipulatives (PM) during math instruction at all grade levels, but some teachers continue to minimally use them during instruction due to a lack of knowledge, even when these tools are available (Hill, Rowan, & Ball, 2005; National Council of Supervisors of Mathematics, 2013).

At the time of this study, concerns had been expressed in CSD1 by school personnel, parents, and myself over a three-year period regarding the consistently low middle school math TCAP scores and teachers lack of use of manipulatives (CDE, 2013). The K-12 math coordinator in CSD1 specifically expressed interest in adopting a PD math program in addition to teacher-district leader collaborations designed to assist middle school math teachers in designing and implementing high quality Colorado Academic Standards that align with math units and lessons for students (M. Coordinator, personal communication, July 31, 2014). The K-12 math coordinator in CSD1 stated there are no specific dates for continuous PD for math teachers throughout the school year and no district-wide PD specifically related to manipulatives offered to math teachers (M. Coordinator, personal communication, July 31, 2014). Because of this concern, this study specifically explored teachers' perceptions of PD and self-efficacy in the implementation of manipulatives to teach math to middle school students. This problem was explored by a qualitative case study to understand teachers' perceptions as they related to manipulatives in math achievement in urban middle schools. An outcome of this study was a deeper understanding of teachers' perceptions of self-efficacy regarding the use of manipulatives and teachers' perceptions regarding how to best support student learning with manipulatives. Teacher perceptions toward district and school PD regarding the use of manipulatives to support math achievement were also explored.

## Rationale

### Evidence of the Problem at the Local Level

Throughout my decade of teaching, I have observed two situations: (a) students struggling with how to effectively use manipulatives to learn new mathematical skills and (b) teachers struggling with effectively using manipulatives to teach new mathematical skills. I often walk into math classrooms and observe different types of physical manipulatives stored in baskets sitting on shelves. Based on the amount of dust accumulated on the manipulatives in the basket, leads me to conclude that the manipulatives are not being used on a consistent or regular basis. According to CSD1's Interest Based Strategies (IBS) team, "professional development needs to be redesigned to better support professional growth for teachers" (CSD1, 2014). The irregular use of manipulatives within the classroom and the IBS concerns regarding PD has raised concerns for me considering the low and declining proficiency levels in both state and local math performance scores, as evidenced on standardized assessment results (CDE, n.d.). An additional concern for me is the lack of PD that specifically trains teachers on the effective implementation of manipulatives during math instruction.

My analysis of annual state and district data that are available to the public on the CDE website demonstrates that my concern is valid and reasonable (see Table 1). In CSD1, math proficiency, as determined by the TCAP assessment scores, has consistently remained below the state proficiency percentages in Grades 6, 7, and 8 and decreased every year in Grades 6 and 8 since 2012 (CDE, n.d.). During the 2011-2012 school year, my local district's math proficiency percentage for sixth grade was 60.47%, seventh grade was 49.51%, and eighth grade was 46.77%, which was below the state math proficiency percentage for sixth, seventh, and eighth grades (61.32%, 53.14%, and 51.51%) that same school year (CDE, n.d.). During the 2012-2013 school year, math proficiency percentages, when compared to the previous school year in CSD1, remained statistically similar in Grades 6 and 8 (60.07% and 46.54%) and slightly increased in Grade 7 (51.60%), which were again below the state math proficiency percentage for sixth, seventh, and eighth grades (62.02 %, 54.96%, and 51.48%) that same school year (CDE). Finally, during the 2013-2014 school year, my local district's math proficiency percentage decreased in Grade 6 (59.64%) and slightly increased in Grades 7 and 8 (54.09% and 49.01%), which remained below the state math proficiency percentage for Grades 6, 7, and 8 (61.08 %, 54.62%, and 52.47%) that same school year (CDE, n.d.). In summary, the low math proficiency scores are an issue that must be investigated. These low scores make me wonder what effective tools and interventions might be used to support student success of mastering math concepts in middle school grade levels. One clear research finding is that manipulatives can make this difference (Puchner et al, 2008).

Table 1

*Analysis of Annual Colorado State and Local District Math Assessment Score Percentages in the Transitional Colorado Assessment Program*

| | State Math TCAP Proficiency Percentages | | | Local District Math TCAP Proficiency Percentages | | |
|---|---|---|---|---|---|---|
| Grade Level | 2011-2012 | 2012-2013 | 2013-2014 | 2011-2012 | 2012-2013 | 2013-2014 |
| 6th Grade | 61.32% | 62.02% | 61.08% | 60.47% | 60.07% | 59.64% |
| 7th Grade | 53.14% | 54.96% | 54.62% | 48.51% | 51.60% | 54.09% |
| 8th Grade | 51.51% | 51.48% | 52.47% | 46.77% | 46.54% | 49.10% |

**Evidence of the Problem From the Professional Literature**

Improving students' cognition of math concepts and skills has become an increased focus in United States classrooms (Marshall, Horton, Igo, & Switzer, 2009; McGee et al., 2013). United States math teachers and math instructional methods have become scrutinized due to consistently lower student achievement in mathematics achievement when compared to international students (McGee et al., 2013). There has been an overwhelming need to change the instructional methods and strategies of United States math teachers (McGee et al., 2013). One potential method for meeting this need is to increase students' understanding of mathematics through modeling with manipulatives. Math teachers and math instructional methods in the United States are less reluctant to change their instructional methods and strategies when students' understanding increases. with manipulatives when these are introduced and used appropriately.

Students at all levels and of all capabilities show increased understanding in mathematical concepts when manipulatives are effectively used, specifically during math instruction (Boggan et al., 2011). Therefore, the overall effectiveness of using manipulatives clearly substantiates the necessity to explore teachers' perceptions of PD and effectiveness of using mathematical manipulatives. Wright and Grenier (2009) noted that the instructional strategies as well as the role of the teacher change as the demands and expectations of curricula change. For example, prior curricula composed mostly of activities that were completed with paper and pencil have since been replaced with activities that are to be completed with manipulatives to evoke higher-order thinking and more abstract thought processes during math instruction. The higher-order thinking processes and abstract thoughts using manipulatives in math have greatly effected how math teachers must approach classroom instruction of mathematical concepts and skills. This notion further supports my intent to understand and address teachers' perceptions on teacher PD concentrated in learning about the use of manipulatives and efficaciousness of manipulatives during math instruction.

The State of Colorado's K-12 public schools, like those in other U.S. states, have been impacted by budget cuts that affect teacher improvement and PD. According to the CDE's FY2015-2016 Staff Budget Briefing report, its total annual appropriation for public schools in FY2012-2013 was $3.8 billion, with $432 thousand towards PD and instructional supports for content specialists (CDE, 2014b). In FY2013-2014, the total annual appropriation for public schools was $3.5 billion, with $443 thousand towards PD and instructional supports for content specialists (CDE, 2014b). In FY2012-2013, $26.5 million was allotted for the Colorado Assessment Program and an additional $8 million to conduct a longitudinal analysis of the student assessments (CDE, 2012). In FY2013-2014, $28.9 million was alloted for the Colorado Assessment Program and an additional $4 million to conduct a longitudinal analysis of the student assessments, which was half the amount allotted in FY2012-2013 (CDE, 2014b).

The CDE FY2013-2014did not request additional funds in the category Professional Development and Instructional Support: Closing the Achievement Gap, but included $3 million for the Office of Dropout Prevention and Student Re-engagement. The report's only reference to PD or training was the text, "The educator licensing office works with 45 designated agencies to provide high quality, on-the-job training programs" (CDE, 2012, p. 8). Despite evidence of declining math scores in the state and local regions, PD funds were still not requested or allocated to address the lack of teacher development.

Although CDE has not requested or allocated additional PD funding, this funding is necessary in order to update math instruction to address low math proficiency levels. When middle school teachers participate in PD, their familiarity with pedagogical strategies of math curriculum increases and they gain more comprehensive understanding of the mathematical content (Patel et al., 2012). Chauvot (2008) emphasized this need for more PD in mathematics at all United States grade levels, noting that when teachers implement instructional strategies that have been discussed during PD, they are effective in increasing student academic achievement. Students are the direct beneficiary of teachers' increased understanding of math concepts and pedagogical strategies as a result of participating in PD.

The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. By gaining a deeper understanding of the teachers' beliefs, thoughts, and feelings of efficaciousness around the use of manipulatives I will be able to point toward potential considerations to better support the teachers to further student learning in math skills. Teachers' perceptions may also lead to the re-design of PD sessions so that they are designed in such a way to better support the teachers' understanding and use of manipulatives related to student learning in math skills ad concepts. Consequently, this qualitative case study explored teachers' perceptions related to the self-efficacy in using the manipulatives to further student understanding of math concepts.

Teacher self-efficacy increases the teachers' sense of effectiveness and confidence in using the manipulatives that in turn has the possibility to greatly influence students' math achievement (Bruce et al., 2010). In addition, this study was within the construct of cognitive development theory concerning PD, or lack thereof, and the impact on teachers' understanding of the use of manipulatives during math instruction within the construct of andragogy theory and the CBAM. Teachers who believe that the content discussed during PD was useful are more apt to gain a better understanding on the use of manipulatives and feel more confident in changing instructional strategies (McGee et al., 2013).

## Definitions

*Applets:* Internet or web-based programs used to provide interactive math manipulatives (Moyer-Packenham, Salkind & Bolyard, 2008).

*Concerns-based adoption model (CBAM):* A conceptual model that discusses how individuals attitudes and beliefs are associated to changes within an educational setting (Hall & Hord, 2014).

*Concrete-representational-abstract (CRA):* A particular sequence of algebraic instruction that begins with (a) explicit instruction using concrete manipulatives, and then progresses to (b) semiconcrete representations (drawings or other pictorial representation of the concrete manipulatives) and, finally, (c) abstract algebraic equations using symbols and numbers (Butler, Miller, Crehan, Babbitt & Pierce, 2003).

*Continuing professional development* (CPD): A phenomenon that occurs when external specialists focus primarily on learning theories, pedagogy, and teaching strategies that support teacher leadership practices (CPDRG, 2007).

*Manipulatives:* Objects that can be controlled by learners either physically or virtually to learn new concepts in a formative and active manner (Zuckerman, Arida & Resnik, 2005).

*Preservice teacher:* A student who is pursuing a teaching degree prior to becoming a certified teacher (Brown, Davis & Kuhn, 2011; Brown, 2012; Akkan, 2012).

*Representational-abstract (RA):* A manipulative approach that has no physical or concrete manipulatives (Butler et al., 2003).

*Selecting, organizing, integrating (SOI) Instructional Model:* An approach of information building without the use of manipulatives through selecting, organizing, and integrating information with prior knowledge and understanding of concepts (Trespalacios & Uribe, 2006a).

*Semi-physical manipulatives (Semi-PM):* An algebraic concept and skill that uses drawings and pictorial representations in order for learners to internalize subconsciously the new algebraic knowledge that would otherwise be difficult if presented in an abstract form (Maida, 2004).

*Teacher self-efficacy:* Teachers' ability to self-assess their abilities to positively influence students' academic achievement (Bruce et al., 2010).

*Virtual manipulatives:* Interactive visual replacements for physical manipulatives (Moyer-Packenham et al., 2008).

## Significance

This study is significant because it explored possible efficiencies and deficiencies in math instruction per teachers' perceptions. United States President Barack Obama, in his 2014 State of the Union address, stated, "Of course, it's not enough to train today's workforce. We also have to prepare tomorrow's workforce, by guaranteeing every child access to a world-class education" (The White House, 2014, para. 54). However, guaranteeing this "world-class" education costs billions of dollars. According to Guthrie and Ettema (2012), the United States spends $700 billion annually on K-12 public schools, more money than any other nation in the world. However, many nations' students are significantly outperforming American students in subjects, such as math and science (Guthrie & Ettema, 2012).

Researchers' findings support the idea of math teachers improving the way mathematical concepts and skills are taught to better prepare students for the future (Kaminski et al., 2008). One assumption as to why physical manipulatives are minimally used during classroom instruction may be due to the lack of PD and understanding on how to effectively implement them during instruction. Green, Piel, and Flowers (2008) suggested that many teachers do not feel that manipulatives are necessary in order for students to understand a concept or skill in math. If teachers do not feel that manipulatives are a necessary part of instruction, then it would contribute to the issue of implementation and use of manipulatives during math instruction. Therefore, it appears that teachers might need more knowledge, skills, and PD on math manipulatives so that the learning is scaffold in a way that supports the student moving from the concrete to abstract as it relates to math skill development. By exploring middle school teachers' perceptions, this study enlightened and deepened the understanding of potential PD or resources needed to effectively implement manipulatives during math instruction.

## Research Questions

Teachers enter into the classrooms with predetermined views and beliefs about instructional methods in math based on the instructional methods that were used to teach them as students. Teachers' views and beliefs influence the way students perceive and think about math, favoring more of a constructivist learning theory. Teachers should continue to increase their self-efficacy to challenge their students' prevailing conceptual beliefs about mathematics. Teachers who changed methods during math instruction felt that PD prior to changing instructional methods was beneficial to increasing their self-efficacy levels. Therefore, participation in continuous PD allows teachers to gain a deeper understanding of the objectives and relate the learning to the effective use of manipulatives regarding mathematics instruction.

This research study explored teachers' perceptions and feelings of PD and efficaciousness related to the use of manipulatives in teaching middle school math concepts. The underlying issue related to teachers' perceptions center on student math achievement. This critical area needs attention in my local district because low math proficiency scores at the middle school level have been a cause for concern for administrators, teachers, and parents. Despite employing nearly 100% of teachers that meet the NCLB Act highly qualified teacher criteria, middle school students still appear to be struggling with math concepts and skills as revealed by the percentage of partially proficient and unsatisfactory scores achieved on the TCAP assessment in math. Upon examining the local district data, it may appear that these data do not represent a significant gap in student math achievement. However, when reviewing the data by grade, it is clear that middle school math scores within the three most recent consecutive school years (2011-2012, 2012-2013, and 2013-2014) remained statistically similar, or showing slight change or growth in student achievement over time.

While there are many variables that would affect the performance, I expect that slight changes or growth in math scores would be demonstrated to reflect student progress as measured by the TCAP assessment. Within the middle school grades during the 2013-2014 school year, the percentage of students who did not score at the proficient level was 40%, 45%, and 50% for Grades 6, 7, and 8 respectively on the TCAP (CDE, n.d.). This could indicate that there is a significant problem that should be addressed. Based on the observations presented thus far, it is imperative to investigate teachers' perceptions rather than administrators' and parents' beliefs because teachers are charged with keeping the students engaged and increasing student understanding of mathematical skills and concepts.

To explore how teachers perceive the implementation and the use of manipulatives to teach math this study focused on one central question: What are teachers' perceptions of professional development and self-efficacy in the use of manipulatives as it relates to math instruction in urban middle schools?

To further support the central question, there were six subquestions that were addressed:

1. What are middle schools teachers' perceptions of student learning related to math achievement?

2. What barriers do middle school teachers perceive prevent them from implementing manipulatives in teaching middle school math concepts?
3. What instructional supports do teachers perceive they need to implement the use of manipulatives during math instruction?
4. What professional development do teachers perceive they need to implement the use of manipulatives during math instruction?
5. How do middle school teachers implement the use of manipulatives during math instruction?
6. How do middle school teachers incorporate the use of manipulatives as indicated in classroom lesson plans used during math instruction?

## Review of the Literature

Teachers’ views and beliefs regarding the use of manipulatives during the instruction of algebraic concepts are critical in achieving learner success within mathematical education at all levels and at the middle school level in particular. When manipulatives are used during mathematical instruction, they are helpful tools in increasing students’ academic outcomes (Kaminski, Sloutsky & Heckler, 2008). Manipulatives are important for learning algebra (Kieran, 2007). Learning algebra at the middle school level is one of the foundational blocks of students' mathematical cognizance (Kieran, 2007). However, depending on teachers’ feelings of manipulatives, which may impact what mathematical concepts are being taught to learners, is a critical component of determining student success (Jansen & Spitzer, 2009).

Throughout my search for current, peer-reviewed sources, I read and annotated three types of literature sources relevant to the study: published books, peer-reviewed journal articles, and reputable scholarly web publications. Several key phrases, in various combinations, were used to identify the primary literature pool from which I have narrowed the search for relevant findings. These key phrases included: *academic achievement*, *instructional strategies*, *physical manipulatives*, *virtual manipulatives*, *mathematics instruction and professional development*, *teacher self-efficacy*, *teaching math with manipulatives*, and *middle grades math and manipulatives.* These key phrases were typed into Internet-based search engines and databases, such as Educational Resource Information Center (ERIC), ProQuest, ECHOST, WorldCat, Education Research Complete, Education from SAGE, and Google Scholar, to help access any relevant books, peer-reviewed journal articles, and reputable web publications published or accessible online. Over 100 sources, published within the last 5 years, were originally identified to bear significant relevance to the subject under study.

Relevant literature on manipulatives used during instruction at the middle school level from the teachers' perspective, integrating theoretical and experiential information in an effort to explore the conceptual frameworks of the purpose of this study was outlined within this section. This literature review concentrates on academic journals that represent a wide range of research pertinent to this premise. It is divided into several major subsections: conceptual frameworks, algebra and algebraic reasoning, physical manipulatives and virtual manipulatives during algebraic instruction, challenges of manipulatives during algebraic instruction, the impact of teachers' views and beliefs on students' understanding of mathematical skills and concepts, and an overview of manipulatives use to support mathematical learning.

## Conceptual Frameworks

This study drew on Knowles's (1970) andragogy theory and Piaget's (1952) cognitive development theory for the foundation of its conceptual framework. In addition, the use of the CBAM allowed me to assist teachers in pinpointing issues that they may have with changes in their math instruction, specifically with the changes of integrating manipulatives. Applying Knowles's andragogy theory and Piaget's theory of cognitive development to teachers who attend PD opportunities created a better insight not just about how teachers should teach, but also about why they are teaching. This is especially important in teaching mathematics. Both theories and CBAM were necessary to thoroughly convey the processes of how adults learn.

**Andragogy Theory.** Andragogy theory was first described by Knowles in 1968 and suggests that the combination of a person's life experiences and the notion of self-construction are the most significant resources that assist adults when learning new concepts (Knowles, 1970). According to this theory, as adults become more mature and independent, they become more responsible for their own learning. Knowles also maintained that all learners, regardless of age, learn and reinforce new concepts and skills by doing. This paradigm suggests that when teachers instruct new concepts and skills, the implementation of the teachers' preferred instructional strategies would be determined by their own experiences and practices (Knowles, Holton, & Swanson, 2012).

One goal of schools, particularly within the United States, is to raise the quality of teaching and learning in the area of mathematics (Ferreira, Ryan, & Davis, 2015). The need for teachers to remain abreast of how children learn and innovations in math is vital to students' overall academic achievement (Richards & Skolits, 2009). Students' academic success is directly related to teachers' experience and expertise within a subject area (Richards & Skolits, 2009). For example, the more exposed teachers are on how to properly use manipulatives within instruction, the higher students' test scores become in learning mathematical concepts (Uribe-Flórez & Wilkins, 2010).

Knowles et al. (2012) disscussed six assumptions within the andragogical model, all of which address the needs of adult learners: adults self-direct, adults link prior experiences to new knowledge, adults are eager learners, adults apply newly aquired knowledge and skills sooner, adults are motivated to learn. Knowles's (1970) andragogy theory yields significantly different results in comparison to other pedagogical theories on learning and teaching strategies, particularly when determining necessary learning outcomes for teachers during PD opportunities. Coleman and Goldberg (2010) suggested that PD opportunities help teachers in promoting higher student achievement.

Teachers typically employ pedagogical approaches when teaching students. According to Knowles et al. (2012), the pedagogical theory also yields several assumptions: learners are dependent, leaners are motivated by external factors, prior experience is not a factor of learning, and learners only need to know what the teacher is teaching. Knowles (1970) found that most pedagogical approaches, with the redundancy of lectures, readings, drills, memorization of information, and tests, left adults wanting more within their educational experiences. In summary, according to Knowles (1970), the strict use of pedagogical approaches is not sufficient when it comes to instructing adult students. In an effort to keep adults motivated to learn, specifically teachers who become the student in PD, should understand why they are teaching the content.

**Cognitive Development Theory.** When using manipulatives, teaching and learning are more appropriately applied because of the cognitive scaffolding that Piaget's theory of cognitive development states as occurring when using manipulatives. Piaget's (1952) theory of cognitive development suggested that learners encounter four stages of cognitive development, which may also be applied to adult learning processes. In turn, students develop each stage prior to moving on to the subsequent stage. Piaget (1965) maintained that children were able to best construct knowledge through physical and mental learning activities in educational environments, coining the term *schema* to describe when learners incorporate newly acquired information into information that had been previously learned (Piaget, 1965). According to Miller (2011), if learners are unable to apply prior knowledge, learners are unable to develop new schemata. When there is a lack of schemata, Piaget referred to this as cognitive disequilibrium. When cognitive disequilibrium occurs, learners will seek equilibrium, known as constructivism, to once again be satisfied academically, and, therefore, become motivated to continue their learning process (Beauchamp, 2005). Teachers who attend PD step into the role of the learner who seeks to build upon prior knowledge, understanding, and experiences to build new schemata.

**CBAM.** A conceptual model that was used within this study is the Concerns-Based Adoption Model (CBAM). The CBAM is a conceptual model that discusses how individuals' attitudes and beliefs are associated to changes within an educational setting (Hall & Hord, 2014). When an innovation or new tool is introduced to a teacher, specifically math teachers, they may hold different perceptions towards change or implementation of new tools related to math instructional methods and interventions (Hall & Hord, 2014). Teachers often possess an internal representation, or meaning, which is their own personal way to solve a mathematical problem of a mathematical process (Puchner et al., 2008). However, teachers assume manipulatives will mimic similar internal representations for the students (Puchner et al., 2008). Puchner et al. maintained that when students yield poor results after the teacher has implemented the use of manipulatives during math instruction it is because implementing manipulatives effectively is more difficult than teachers initially realize.

With a deeper understanding of the teachers' perceptions, the gap of practice of using manipulatives to further learning of sills and concepts will be heightened. In addition, PD opportunities can be developed to better meet the teachers' needs, increase teachers' perceived sense of self-efficacy in manipulatives, and increase student achievement. CBAM was originally developed as a manner to show when educational institutions become involved in highly complex processes that involved adopting innovations (Hall, 1974). Using the CBAM allowed me to better determine to what extent and why teachers at the target schools resisted change in instructional methods and innovations that involved manipulatives, despite having attended PD where change in instructional methods and innovations were the topics.

**Algebra and Algebraic Reasoning**

Algebra is traditionally described as the generalized form of arithmetic or as the natural extension or depiction of arithmetical thinking (Friel, Rachlin, & Doyle, 2001). Algebraic concepts and skills invoke thinking that is more abstract and at an increased difficulty level compared to basic computational mathematical thinking (Friel et al., 2001). It is critical to investigate the research findings related to algebra and algebraic reasoning in middle school and what strategies best support student success in order to determine the most effective PD. The question addressed in this section of the study is what students must learn to achieve understanding of algebraic concepts, irrespective of the method used to teach them.

Contemporary algebra instruction has become highly compelling and an integral component of mathematics (Battle, 2007). In addition, algebra is used in practical applications in various fields to portray the progressive world of man’s volitions and may be characterized as the component of mathematics that mainly addresses symbolic manipulation and understanding of patterns, and relationships and functions (NCTM, 2000). In a universal mathematics curriculum, algebra is taught chiefly as a precise symbolic structure that requires arithmetic-based rules to be memorized (NCTM, 2000). This static approach is used in most regions in the United States and is supplanted by the concept that algebra is the study of fundamental patterns and relationships and the operations possible between them (Battle, 2007).

Towards this new understanding of algebra, new instructional methods have been explored to establish the best ways to help students merge existing and new mathematical knowledge so that they can easily understand and apply their learning to other concepts in math (Tent, 2006). This explains why voluminous and diverse research, theory, and academic discourse has emerged in the last 20 years extemporizing on the inherent problems that students have in learning algebraic concepts as well as on the steps that should be taken to provide a better foundation for learning. Not every scholar agrees on this view, however; Tent (2006) featured an opposing view of these two theories: (a) where a flexible algebraic concept is seen as the study of fundamental patterns and relationships, and (b) the operations possible between them.

Tent suggested that computational math should be considered a generalization of computational math problems because understanding the properties of computation is what establishes the framework for students' overall learning and success in algebra. For example, students must first understand the properties of addition and multiplication to create a generalization of arithmetic, which will always lead to true statements for all numbers in algebra (Tent, 2006). In other words, students must gradually transition from an arithmetic-driven classroom to generalize relationships between numbers and symbols, typically found during the instruction of algebra. However, some differ with Tent's suggested methods of math instruction.

Most of the contemporary literature on the subject greatly negates Tent's (2006) stand. For instance, Maida (2004) contradicted Tent's views. Maida proposed that middle school students tend to struggle more with algebraic concepts because they come from computationally-driven instructional methods in elementary school. These computationally-driven instructions, according to Maida, do not prepare students for more advanced applications in algebra. Maida maintained one reason students are not prepared is because "…current math programs do not provide sufficient experiences" (p. 484) using logical reasoning during math instruction. Most educators and education planners currently advocate for the development of high-order thinking in mathematics (typical in algebra), based on strong arithmetic skills among students (Ponce, 2007).

Algebra curriculum takes a central place in this debated role of symbolic manipulation and representation. Researchers' findings indicate that students have difficulty in solving graphic to numeric transfer problems and that is a result of poor instructional methods (Cunningham, 2005). Cunningham (2005) argued that math teachers' overemphasis of symbolic manipulation and representation is the issue in schools today because fewer graphic to numeric transfer problems are on assessment tests. Brown et al. (2011) further supported Cunningham's paradigm and maintained that math classrooms use traditional instructional that primarily focused on symbolic representations, which "moves too quickly from concrete to abstract lessons" (p. 271).

The results of this type of traditional instruction, according to Brown et al., are that students possess poor skills development and a narrow conceptual understanding of algebra problems. While it is disputable whether symbolic representation is over emphasized current middle school algebra curriculum, it is an undisputable fact that mathematical symbols are fundamental components in all areas of algebraic problem solving.

In addition to algebra being considered the foundation of arithmetic and symbolic representation in mathematics, scholars have also emphasized the value of comprehension of the inherent patterns and relationships in mathematics that are enabled by algebra. Knuth, Stephens, McNeil, and Alibali, (2006) conducted a controlled study in which the findings suggested that students who were able to comprehend the equal sign as the symbol for equivalence were more successful in solving arithmetical equations in algebra than their peers who understood the symbol as simply giving the result to an arithmetic equation. Knuth et al. suggested, based on their findings, that a majority of middle school students did not have an adequate understanding of the equal sign and that this understanding did not appear to improve in subsequent grades as they progressed through school. These findings further suggested that a critical aspect in the successful application of knowledge and skills for solving algebraic equations is having the understanding of the equal sign (as an example of algebraic symbolism).

In essence, being able to understand arithmetic, manipulation and representation of symbols related to mathematical equations, sequential patterns, numeric and symbolic relationships, and functions are exceptionally imperative and interrelated aspects of arithmetical thinking and systematic problem solving. However, learners gain a much deeper and relevant meaning of variable based math, such as algebra, when they connect mathematical concepts to everyday life within the world around them. A vital goal of mathematics reform, according to Stein and Bovalino (2001), is to encourage learners to approach and think beyond using procedural methods to solve routine math problems. Piaget (1965) further suggested that learners failed to possess the mental maturity to comprehend theoretical mathematical concepts regardless whether those concepts are presented in words or symbols. Furthermore, learners greatly benefit from experiences with physical materials and pictorial representations of the mathematical question to support the learning process. The use of concrete manipulatives united with pedagogical approaches to provide genuine lessons for learners to make the necessary real-world association with mathematical concepts and skills may be one approach to enhance arithmetical understanding and achievement of middle school students. Attainment of such a command in algebra is desirable for students, teachers, and parents with an interest in student mathematics achievement.  Moyer-Packenham et al. (2008) further supported Stein and Bovalino by maintaining students make necessary connections among algebraic representations and explain mathematical relationships in written and verbal forms when manipulatives are used.

As algebra has gained importance, performance in the subject has become increasingly poor (Maida, 2004). Most middle school students admitted struggling with algebraic concepts, something Maida attributed to the fact that students begin elementary education with arithmetic-driven education programs. To solve this apparent problem, Maida opined that teachers should help students to progress from the arithmetic-based static approach to algebra to a more flexible and interactive understanding of algebraic concepts and algebra problem solving techniques using concrete manipulatives.

What is of greater interest to this study is how Maida (2004) recommended that teachers should accomplish this feat. Maida recommended that teachers should achieve increased student understanding of algebraic concepts and skills by blending PM (tactile approach) with drawings and pictorial representations (semi-PM). This instructional strategy is the best way to employ manipulatives in algebraic instruction because this technique allows the students to subconsciously internalize the new algebraic knowledge that would otherwise be difficult if presented in an abstract form (Maida). Friel et al. (2001) and Allen (2007) also supported the technique recommended by Maida, to combine PM with pictorial representation of the same algebraic concepts. This approach has been documented as an essential strategy that helps students think deeply about the manipulative activity, the overall purpose of the concept or skill, and relevance to algebraic knowledge (Friel et al., 2001). Additionally, this approach is important because according to Allen (2007), many students are rarely able to proceed directly from the PM model to the abstract algebra symbolism without bridging the process with pictures (semi-concrete models). Therefore, teachers should include this instructional method so that students are not left to struggle when attempting to maneuver through algebraic problems, which could directly influence future learning. The use of semi-PM is the instructional approach teachers should use to engage and motivate students during math instruction.

One of teachers' roles in a math classroom is to keep the students engaged and motivated during the math lesson (Allen, 2007). When teachers engage and motivate students to learn, they increase retention of the math lessons being instructed (Allen, 2007). One way to keep the students engaged and motivated is with manipulatives. Battle (2007) recommended that students use semi-PM models instead of the sole PM during the actual hands-on algebra manipulations. The semi-PM models, advocated by Battle, are an intermediate step, where teachers use pictorial representation of concepts (drawings) and reflective writing to represent the physical manipulation of concepts before the students are required to construct the abstract equations and their solutions (Battle, 2007). The difference between the stance taken by Battle and the one taken by Allen, Friel et al (2001), and Maida (2004) is the fact that Battle believed PM should never be used in algebraic instruction while the other scholars believe that PM should be used alongside the semi-PM. This is the reason why Battle's argument was rejected by the researcher in this paper while the stance taken by Allen, Friel et al., and Maida were accepted as the most viable in the context of this study.

**Physical Manipulatives during Algebraic Instruction**

The tangible manipulation of an animate object, rather than a mental operation performed on an abstract symbol, helps students to understand intangible concepts.

Goldsby (2009) noted that the procedural analogy theory discussed how using PM could assist students in understanding and developing the written systematic operations necessary to solve math problems. The paradigm hypothesized that this manipulation involves making comparisons, substitution, and simplification rather than a system involving symbols created from nothing. Goldsby also suggested PM are appropriate for two purposes: (a) permitting both learners and teachers to engage in discussions regarding how to figure out how to use and the associated meanings of learning tools and (b) offering a platform which learners are able to successfully perform. Thus, math education should focus more on the skills and knowledge teachers would like their students to understand versus the skills and knowledge teachers would like their students to simply compute (Goldsby, 2009). Teachers' self-efficacy of PM is contingent upon the student outcomes the teacher is trying to achieve because teachers may be inclined to think of mathematics as having separate sets of procedures and rules for solving and manipulating expressions instead of how those procedures and rules overlap to solve math problems. When students do not appear to understand how or when to properly apply PM, the teacher has a tendency to label students as possessing lower academic achievement (Akkan, 2012).

Maccini and Hughes (2000) noted that the use of PM in instructional methods for algebraic understanding and learning has not been systematically investigated beyond relational terminology found within word problems, such as more, less, or fewer. Applying a search, translate, answer, and review (STAR) algebra problem-solving technique along with semi-PM students with and without learning disabilities are able to draw a pictorial view of the math problem (Maccini & Hughes, 2009). Using PM and pictorial demonstrations learners in Maccini and Hughes’ study figured out how to embody and solve math problems that involved addition, multiplication, and division of positive and negative numbers, commonly referred to as integers. In addition, most of the student participants called attention to fact that manipulatives helped them in gaining a better understanding of how to compute positive and negative numbers and reinforced their learning by assisting and working with other students. Cass, Cates, Smith and Jackons (2003) and Re, Pedron, Tressoldi, and Lucangeli (2014) also found that the use of manipulatives were helpful with students with learning disabilities. Proper training and use of PM has been shown to assisted students with learning disabilities in computing basic geometry, such as area and perimeter of objects encountered on a daily basis (Cass et al., 2003). Witzel, Mercer, and Miller (2003) further supported the findings of Cass et al., Maccini and Hughes, and Re’s et al. advocacy toward using PM and pictorial demonstrations to learn algebraic concepts. However, Witzel et al. and Re et al. used the phrase concrete-to-representational-to-abstract (CRA) sequence of instruction, which is similar to STAR. Using STAR or CRA during math instruction with students who do and do not have learning disabilities resulted in an increased understanding and higher academic achievement in math (Cass et al., 2003; Witzel et al., 2003). Cass et al., Witzel et al., and Re et al. maintained that when students see that their understanding and academic performance in math concepts are improved, their attitudes improve.

Lorraine (2006) conducted a mixed method study in which the mathematics achievement of students was compared to their attitudes towards using PM and VM. In the study, algebraic units involving addition of integers, subtraction of integers, and the expansion of polynomial factors were taught over a period of 2 weeks during regular math periods in a crossover design (Lorraine, 2006). Lorraine established that there was no significant achievement difference between the achievements of students taught using virtual and concrete manipulatives. Nonetheless, a majority of students preferred VM to PM during algebra instruction (Lorraine, 2006). What was interesting, however, were the findings that suggested students' choices between VM and PM had no significant influence on their performance on the posttest. Further, Lorraine found that the highest active behaviors among students during the algebra lessons were observed when the students were using PM. This study underscores not only the benefits of using manipulatives in algebraic instruction, but also the ability of PM to engage the students actively to a level where they gain deep understanding of algebra concepts.

**RA and CRA.** Researchers have recommended ways in which teachers of algebra should employ manipulatives in their instruction (Allen, 2007; Battle, 2007, Friel et al., 2001; Maida, 2004; Swan & Marshall, 2010). Two approaches exist in this respect, representational-to-abstract (RA) and CRA. The least popular of these approaches, RA, is largely advocated by Battle. Researchers like Allen, Friel et al., and Maida support the more popular approach, CRA. A brief review of this two opposing approaches will help to introduce the benefits of using PM during algebraic instruction.

The CRA approach advocates that teachers use a particular sequence of algebraic instruction starting with (a) the explicit instruction using concrete manipulatives, then (b) progresses to the semi-concrete representations (drawings or other pictorial representation of the concrete manipulatives), finally, (c) the instruction involves abstract (use of symbols and numbers) algebraic equations (Butler, Miller, Crehan, Babbitt & Pierce, 2003). On the other hand, RA proponents advocate for the removal of concrete manipulatives from the classroom such that instruction begins with the pictorial representation of manipulatives (semi-concrete forms) before proceeding to the abstract algebra concepts (Allen, 2007; Battle, 2007; Butler et al., 2003; Friel et al., 2001; Maida, 2004). To settle this debate, Butler et al. conducted a study comparing the instruction effectiveness of the CRA and RA approaches.

Butler's et al. (2003) participants had mild to moderate learning disabilities and were randomly grouped to either a CRA or RA group. Butler et al. found that both the RA and CRA groups registered improvements in their performance, but the CRA group had the highest overall scores. The CRA group yielded scores that were 40% above the scores registered RA group (Butler et al., 2003). Witzel et al. (2003) further supported the viability of the CRA approach over the RA approach and traditional instruction methods in developing basics mathematical skills of middle grades students, including those with assorted learning disabilities. While the Butler's et al. (2003) study examined the use of CRA approach in teaching fractions, Witzel et al. studied the use of CRA in teaching algebraic equations. However, similarly to Butler's et al. results, Witzel et al. also found that the students taught using the CRA approach significantly better scores in performance after a 4-week teaching period than those students who were taught using the RA approach.

**Virtual Manipulatives during Algebraic Instruction**

Manipulatives are substantial for effective means to learn math concepts and are not limited to either physical or virtual materials. However, Trespalacios and Uribe (2006b) maintained that the use of manipulatives during instruction might not guarantee meaningful learning in math. Yet, the use of VM during math instruction increased understanding of math concepts and skills (Trespalacios & Uribe, 2006b). Guided by the curriculum, learning, teaching, and technology themes identified by the NCTM, Trespalacios and Uribe proposed that when students actively used the selecting, organizing, integrating (SOI) instructional model along with VM their learning on math concepts, specifically fractions, was enhanced. SOI is an approach of information building without the use of manipulatives through selecting, organizing, and integrating information with prior knowledge and understanding of concepts (Trespalacios & Uribe, 2006a). With the information age evolving to include more advanced technologies, VM have become more accessible for teachers to use during math instruction.

VM are direct models that students are able to interact with on a virtual learning platform (computer programs). A VM can best be described as computerized visual pictures of concrete objects that teachers and students are able to manipulate as to increase their competence of mathematical concepts (Moyer-Packenham et al., 2008).

Students can click and drag to move the VM into a chosen direction to assist in solving a given mathematical problem or question. VM can also be applied interactively (letting the user possess total control over the objects on the screen) to further build on mathematical ideologies and relationships. The rationale of being able to interactively experience mathematical ideologies and relationships through technology is what differentiates them as VM versus PM (Moyer-Packenham et al., 2008). With the advancements and accessibility of technology in public school classrooms, VM are most often used schools.

Goldsby (2009) suggested that computerized VM have two benefits: (a) the flexibility of allowing the user to record, replay, change, and view augmentations that assist mathematical assessment and (b) the direct, spontaneous connection between a physical object and the visual form. Zuckerman, Arida, and Resnik (2005) discovered that when students repeatedly used the computer to practice math skills, students focused more on using proper procedural knowledge rather than the lapsed time it took to setup and solve the math problem. Internet- or web-based manipulatives, such as applets, may enrich students' understanding with regard to the theory of mathematical principles better than possessing only a procedural understanding of the math problem (Goldsby, 2009). In addition to the Internet and applets, students have found that using their cell phones to support math instruciton outside of the classroom.

Students use technology, such as cellphones and applets, to enhance their learning of math concepts. Daher (2009) suggested that middle grade students preferred the use of cell phones to applets to reinforce the math instruction, mainly due to its portability. However, prior to this study none of the students used their cell phone or applets to support math instruction outside of school (Daher, 2009). Even though Moyer-Packenham et al. (2008) maintained that teachers should become more efficacious in using applets during math instruction, students' perceptions of using cell phones and applets during classroom instruction in Daher's study differed. Students in the Daher study believed that the use of cell phones and applets during class would be a distraction to the math lesson the teacher was lecturing, and should be limited. Although the use of cell phones and applets are helpful in further understanding more difficult math concepts, students' math skills using cell phones or applets are only enhanced after the teacher teaches the math skills that are to be learned. Students who are able to explore various methods and representations during mathematical lessons using manipulatives are more successful in making connection between the relationships between numbers.

**Manipulatives and Learning Mathematics: The Challenges**

Chamberlin et al. (2008) and Chang (2008) maintained that visual conceptions assume a significant part in the implementation of mathematics during instruction. It is imperative to explore the beliefs of learners and mathematics. The perception of preservice teachers that math is mostly procedural (formal) and omitting the process-oriented (informal) methods of mathematics is one of significant difficulties when learning mathematics (Jansen & Spitzer, 2009). Seaman et al. (2005) discussed university elementary school teacher candidates' conceptions between a formal belief system and an informal belief system. The study concluded that introduction to informal mathematics methods uncovered a movement of convictions towards the informal part of mathematical instruction. Carney, Brendefur, Thiede, Hughes, and Sutton's (2014) research findings that teachers became more bias towards the informal methods rather than formal methods further supported Chamberlin et al., Chang, Jansen and Spitzer, and Seaman et al.

While national efforts (NCTM, 2000) involved an increased focus on the problems of solving K-12 mathematical challenges in the classroom, these efforts do not change math teachers' views and beliefs according to researchers because of the conventional methods used during math instruction (Boggan et al., 2011; Holton et al., 2009; McNeil et al., 2010; Moyer-Packenham, Salkind & Bolyard, 2008). Now, teachers have been asked to shift from formal teaching methods to more imaginative strategies using manipulatives (Boggan et al., 2011).

As a whole, implementation of manipulatives in the classroom requires that PM be used, but the accessibility of the Internet has led to a new intangible type of manipulatives, VM. These types of manipulatives are computerized simulations of physical objects that can be manipulated with a computerized pointing device similar to their physical counterparts (Boylard & Moyer, 2003). Virtual recreations of physical manipulatives that are frequently applied during classroom instruction of math concepts, like tangrams, base 10 blocks, and Cuisenaire rods, are easily found online. These advancements of technology further support the need for teachers to participate in PD to increase teachers' perceived sense of self-efficacy in the best possible use of manipulatives in math classrooms (Neubrand, Seago, Agudelo-Valderrama, DeBlois, Leikin, & Wood, 2009).

**Teacher Self-Efficacy**

Teachers' existing knowledge and experiences help contribute to their beliefs about self-efficacy as it relates to math. Teacher self-efficacy is teachers' ability to self-assess their abilities to positively impact students' academic achievement (Bruce et al., 2010). An individual's personal mastery and vicarious experiences, mental states, and social influences are factors that greatly affect teachers' perceived sense of self-efficacy (Bruce et al., 2010). However, according to Bruce et al., personal mastery experiences have the greatest impact on teachers' beliefs about self-efficacy. When math teachers believe that they are capable of teaching more challenging curricula, the teachers' confidence levels increase paving the way for successful outcomes in student achievement (Tschannen-Moran & Barr, 2004). In addition to teachers' personal mastery experiences, self-efficacious teachers also are influenced by their vicarious experiences.

The social learning theory incorporated the importance of self-efficacy. According to Bandura (1997), "The people with whom individuals compare themselves influence how they judge their ability" (p. 121). When teachers vicariously watch other teachers, those experiences are another way in which teachers' perceived sense of self-efficacy is enhanced. These vicarious experiences give math teachers with higher levels of efficaciousness the confidence to experiment with different types of instructional strategies (Bruce et al., 2010; Brown, 2012). Professional development is one avenue where math teachers are able to increase self-confidence in their understanding to teach math and become more assured in their abilities to teach math and conquer fears and anxieties as they relate to math instruction (Bruce et al., 2010).

**Professional Development**

With an increased amount of pressure placed on math teachers to show student progress and growth, ongoing professional development is necessary. In CSD1, there are no specific dates for continuous PD for math teachers throughout the school year and no district-wide PD specifically related to manipulatives offered to math teachers (M. Coordinator, personal communication, July 31, 2014). The lack of PD may provide evidence as to why manipulatives may not be used or used improperly during math instruction. However, one issue could be that teachers believe that the content discussed in PD would be ineffective in the classroom to successfully enhance student performance in math. According to researchers, continuous PD is a critical component in showing teachers how to effectively teach concepts and skills and achieving an increase in student achievement (Brown, 2012; Coleman & Goldenberg, 2010; Francis-Poscente & Jacobsen, 2013; Tschannen-Moran & Barr, 2004).

Teacher collaboration with one another is a critical component of teachers' instructional practice. Brown (2012) maintained that teachers should be willing to take the time to learn and implement new teaching strategies, even if they are challenging and demanding. Regularly participating in PD, according to Zambo and Zambo (2008), changes teachers' beliefs about their self-efficacy level. When math teachers' increase their self-efficacy through PD, math teachers feel more confident in determining instructional strategies that may result in student success (Zambo & Zambo, 2008). Francis-Poscente and Jacobsen (2013) further supported this notion.

Francis-Poscente and Jacobsen (2013) conducted a study with an interpretive hermeneutic approach to better understand the gaps between how teachers used new technology during instruction and how teachers adapted to a more inclusive student population within the classroom. Hermeneutics is practical knowledge found within everyday experiences (Francis-Poscente & Jacobsen, 2013). With technology becoming an integral part of instruction and real world situations, especially in math, Francis-Poscente and Jacobsen found that when teachers simulated the learning experiences of their students in PD they were able to increase their understanding about math concepts and skills and the technology that was used to teach the math lesson. The study also found that collectively, the math teachers used vicarious experiences to increase self-efficacy and self-esteem in math. Darling-Hammond and McLaughlin (2011) further supported Fancis-Poscente and Jacobsen's findings by suggesting that PD via technology provides more diverse and meaningful learning opportunities for teachers.

The Continuing Professional Development Review Group (CPDRG) (2007) reviewed 76 studies on continuing professional development (CPD) that specifically explored the role of the specialist, the impact of CPD on student achievement, and teachers' perceptions. The study found that CPD showed positive results in student achievement as well as increased teachers’ perceived sense of self-efficacy (CPDRG, 2007). Teachers benefited most when the CPD focused primarily on learning theories, pedagogy, and teaching strategies (CPDRG, 2007). In addition, the CPDRG determined that when the specialists supported teachers via classroom observations and giving feedback that increased teacher leadership and practices. However, changing teachers’ beliefs and attitudes of math should be attempted prior to discussing the objectives of the PD.

Guskey (2002) maintained that PD should be conducted in stages that are considered to take place in a traditional PD. In traditional PD, Guskey suggested that it attempts to alter the beliefs and attitudes of the teachers prior to discussing the main objectives of the PD. Guskey further argued that the main way to change teachers’ beliefs and attitudes toward instructional changes that are demonstrated in PD is to provide evidence that the instructional methods increase student achievement. In addition, similar to the findings by the CPDRG (2007), Guskey found that there should be follow-up support for teachers, by way of feedback on student outcomes. Overall, PD should not be an occasionally encountered event. Rather, CPD is highly suggested and greatly beneficial to teachers and students, especially in mathematics.

## Summary

This literature review addressed gaps in practice as it related to teachers' views on manipulatives used in middle school. Representations in different forms were applied to develop an understanding of conceptual aspects of mathematics. Research findings indicated that middle school students could benefit from using manipulatives, provided they are instructed and implemented appropriately by the teachers (Goldsby, 2009). Through professional development, teachers will be able to learn about instructional strategies and useful tools, such as manipulatives, that specifically target teaching students math (Coleman & Goldberg, 2010).

## Implications

In the review of literature, I discussed some challenges and benefits of using manipulatives during math instruction. I also discussed teachers' perceived sense of self-efficacy and PD, or lack thereof, as it related to math instruction. One challenge of manipulatives was teachers lacked feelings of efficaciousness in the use of manipulatives during math instruction. After review of literature that further highlighted the problem of teachers' perceived sense of self-efficacy and potential issues with PD, I gained a better understanding of potential areas of need for math teachers that resulted for the findings of my research. The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. Guskey (2002) maintained that teachers should be provided evidence that the instructional methods used post PD are effective in increasing student achievement in math. As a result of this investigation, these data lead to a project that addressed teachers' perceptions of self-efficacy regarding the use of manipulatives to better support student learning and achievement in math. In addition, this study may result in enhancing teachers' skills and perceived abilities to use manipulatives and other effective skills to teach math, which may promote positive social change.

Developing a project that involves continuous PD that focuses on increasing teachers' perceived sense of self-efficacy as it relates to manipulatives, may yield positive outcomes on student academic achievement and assessment scores in math. In addition, developing a project that involves continuous PD that specifically caters to self-efficacy related to inquiry-based instructional methods with manipulatives during math instruction may be meaningful to math teachers within CSD1 and throughout the state of Colorado. Regardless of how teachers may feel about the use of manipulatives, using PM and VM may make a difference on the overall teaching and learning experiences during math instruction. The review of relevant literature discussed the importance and benefits of continuous PD focusing on PM and VM, yet many math teachers have remained reluctant to use any type of manipulatives during math instruction (Pelfrey, 2005; McNeil & Jarvin, 2007; Star et al., 2015).

The development of the final project was determined by the results of this study and may be meaningful to participants while promoting positive social change. By gaining a better understanding of teachers' perceived self-efficacy in the implementation of manipulatives to teach math to middle school students, I identified emerging categories and themes through the collection and analysis of the data. Once I reviewed the data that were collected, I developed a project that addressed the findings of this study. Another aspect of the project was promoting positive social change within math education. The first step in developing a project that may be effective in addressing the needs of math teachers in CSD1 as indicated during the data analysis stage of this study and addressing positive social change was to remember that a community is only as educationally involved and productive as the teachers who are teaching the communities' families. Teachers who do not effectively and comfortably teach their students may find difficulties in promoting social change. Developing a project that addresses teachers' perceived sense of self-efficacy might also directly impact social change within CSD1.

## Summary

Teachers' perceptions regarding the use of manipulatives during math instruction differ based on prior personal and vicarious experiences (Bruce et al., 2010; Empson et al., 2011; Goldsby, 2009; Jansen & Spitzer, 2009). However, research findings indicated that students who use PM or VM tend to have a better understanding of mathematics than those who do not use manipulatives (Boggan et al., 2011; Goldsby, 2009; Uribe-Flórez & Wilkins, 2010; Yuan, 2009;). The higher the perceived sense of self-efficacy by the math teacher in the use of manipulatives, the greater the opportunity for student academic achievement and success in math (Chamberlin, Farmer, & Novak, 2008; Moyer & Jones, 2004). Overall, to increase self-efficacy, manipulative use in the classroom, and student academic achievement in math, teachers need to be afforded the resource of PD to increase their understanding regarding the use of manipulatives. This increase in effective PD could influence teachers' beliefs and attitudes about instructional changes in math and thereby lead to changes in strategies used to teach math skills to middle school students

(Brown, 2012; Coleman & Goldenberg, 2010; Guskey, 2002; Tschannen-Moran & Barr, 2004).

Section 2: The Methodology

## Introduction

The purpose of this bounded collective case study was to explore United States middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. To explore how teachers perceive the implementation of math strategies and the use of manipulatives to teach math, this study focused on one central question: What are teachers' perceptions of professional development and self-efficacy in the use of manipulatives as it relates to math instruction in urban middle schools?

Six subquestions were used to support the central inquiry:

1. What are middle schools teachers' perceptions of student learning related to math achievement?
2. What barriers do middle school teachers perceive prevents them from implementing manipulatives in teaching middle school math concepts?
3. What instructional supports do teachers perceive they need to implement the use of manipulatives during math instruction?
4. What professional developments do teachers perceive they need to implement the use of manipulatives during math instruction?
5. How do middle school teachers implement the use of manipulatives during math instruction?

6. How do middle school teachers incorporate the use of manipulatives as indicated in classroom lesson plans used during math instruction?

In this section, I discuss the methodology used to determine the findings to the central and subquestions discussed in Section 1. I conducted a collective case study approach that focused on observations and interviews using separate homogeneous cases of CSD1. Observations provided data regarding teacher behavior and instructional strategies as they related to the teachers' perceived use of math manipulatives in support of student learning. Through teacher interviews, I determined how teachers perceived the implementation of specific math strategies, district-wide math professional development, and the perceived self-efficacy regarding the use of manipulatives to teach math skills. Additionally, I discuss the study's sample procedures, data collection, data analysis methods, and findings. By employing a collective case study approach, I obtained data that provided a rich and detailed description of the perceptions and experiences of middle school math teachers in CSD1.

**Research Design and Approach**

The research design and approach for this qualitative research study was a collective study using multiple homogeneous cases to investigate the central phenomenon. A case study is a practice design that seeks to gain an in-depth understanding of "one setting, or a single subject, a single depository of documents, or one particular event" (Bogdan & Biklen, 2007, p. 59). To align with the chosen design and approach, I purposefully selected 12 out of approximately 27 middle grade math teachers in a Colorado public school district. This district, hereafter referred to as Colorado School District (CSD1), had failing middle school math scores for three school years preceding the period of study.

To ensure that a collective case study was the most appropriate for this research study, I considered and rejected other qualitative designs such as phenomenology, grounded theory, ethnography, action research, and case study. A phenomenological design is an approach where the researcher would seek to understand a human condition (Bogdan & Biklen, 2007), which was not an appropriate design because I sought teachers' perceptions related to the self-efficacy in using the manipulatives to further student understanding of math concepts. I also considered and rejected grounded theory. Grounded theory is when cyclical and systematic data collection and analysis processes are used to explain the actions of people to develop a theory, which was not an appropriate design for this study because I did not build theories (Yin, 2014). Rather, I explored a central phenomenon to understand the nature of that phenomenon (Merriam, 2009; Yin, 2014). Because I did not have long-term access to participants, nor were the participants considered a culture-sharing group, meaning having "shared behaviors, beliefs, and language" (Creswell, p. 469), ethnography design was not appropriate. Finally, because I did not have the teachers change their instructional methods (Bogdan & Biklen, 2007) action research design was not appropriate. Based on this analysis of other research methods, a collective case study was the most appropriate design.

I conducted this qualitative research study to gain a deeper understanding of the teachers' beliefs, thoughts, and feelings of self-efficacy concerning the uses of manipulatives. I specifically explored this problem using a collective case study in order better understand teachers' perceptions as they related to PD and manipulatives in math achievement in urban middle schools. Yin (2014) and Creswell (2012) endorsed the use of case studies as appropriate for the exploration of a central phenomenon using a bounded system (case or cases). In addition, I gained an in-depth understanding of the cases within this study by collecting multiple forms of data, such as interview data, observational data, and pertinent archival documents (Creswell, 2012).

I specifically used a collective case study design to illuminate the issue of middle school math teachers' perceived sense of self-efficacy with regard to the use of manipulatives during instruction within a bounded system (Creswell, 2012; Merriam, 2009; Yin, 2014). I was granted access to explore the instructional methods of middle school math teachers' classrooms. In addition, I successfully elicited and subsequently coded participants' perceptions regarding the use of manipulatives using open-ended questions during a semistructured interview (Creswell, 2012; Merriam 2009; Yin, 2014). Therefore, a collective case study design aligned with the purpose of this research study.

## Participants

### Population and Sampling Procedures

The setting for this study is in a public school district, CSD1, in the State of Colorado. The district contains 32 elementary schools, six elementary/middle schools, two elementary/middle/high schools, seven middle schools, one middle/high school, and five highs schools (CDE, n.d.). During the 2014-2015 school year within CSD1 there were 15,980 students enrolled at the elementary grade levels (K-5), 11,850 students enrolled at the middle grade levels (6-8), and 10,871 students enrolled at the secondary grade levels (9-12) (CDE, n.d.). Additionally, during the 2014-2015 school year, there were approximately 1,600 teachers employed within CSD1, of which 5% (80) are middle school math teachers (M. Coordinator, personal communication, June 2, 2015). The target sample for this study was 27 middle school math teachers employed at three of seven middle schools within CSD1.

The 27 middle school math teachers, who were identified by the CSD1 math coordinator, were sent an invitation to participate letter (Appendix B). Although 27 middle school math teachers were invited to participate in this study, those teachers who voluntarily agreed determined the number of participants. The number of teachers who agreed to participate in this study was approximately 48%, which was equivalent to 13 teachers. However, the sample was reduced to only 12 case study participants (see Table 2) based on certain criteria: teachers must have had experience teaching both with and without manipulatives during mathematics instruction. Creswell (2012) suggested that only a few cases are necessary in qualitative research studies; selecting only 12 case study participants allowed me to gather in-depth, rich data that were coded about each participant and associated setting (Creswell, 2012).

Table 2

*Summary of Participants' Demographic Information*

| Gender (%) | | Highest Level of Education (%) | | Grade Level (% | | Years Teaching MS Math (%) | |
|---|---|---|---|---|---|---|---|
| Male | 2 (16.6%) | Bachelor's | 8 (66.6%) | 6th Grade | 4 (33.3%) | 1 to 4 years | 0 (0.0%) |
| Female | 10 (83.3%) | Master's | 4 (33.3%) | 7th Grade | 4 (33.3%) | 5 to 9 years | 5 (41.6%) |
| | | Doctorate | 0 (0.0%) | 8th Grade | 4 (33.3%) | 10 or more years | 7 (58.3%) |

*Note:* *N*=12; MS=Middle School.

In addition, only three middle schools were chosen because the scores at these schools reflected higher (one middle school) and the lower (two middle schools) TCAP scores in math within CSD1. Choosing one higher and two lower scoring middle schools in the area of math allowed me to compare perceptions, professional developments, instructional strategies, and lesson plans to understand the similarities and differences that may persist at high-performing and low-performing middle schools as it related to math instruction. In addition, choosing one higher and two lower scoring middle schools in the area of math allowed me to suggest a project that might be used to improve lower scoring middle schools as it relates to math instruction.

**Criteria for selection of participants.** Each case in this study was a middle school math teacher. Twelve middle grade math teachers were selected via homogeneous sampling. The primary criteria for selecting the participants was as follows: teachers must have experience teaching both with and without manipulatives during mathematics instruction. I used an additional criterion of having taught middle school math for 5 or more years within CSD1 because more than 12 teachers agreed to participate and met the criteria. Applying the additional criterion of middle school math teaching experience of 5 or more years excluded one potential participant. Teachers with 5 or more years of teaching within CSD1 may have: (a) a clearer understanding of the school district's instructional expectations and guidelines and (b) have a well-established instructional process in place as it relates to math instruction. Placing an additional criterion reduced the volunteer sample to 12. Homogeneous sampling allowed me to purposefully select teachers that meet the criteria necessary for this study (Yin, 2014). Prior to the selection of the participants, I gained access to the schools and teachers.

**Access to participants.** To secure approval for research data collection within CSD1, in November 2014 I submitted a Request to Conduct Research application to the Director of Assessment and Accountability. After the approval of my proposal and associated documents by Walden University, I notified the Director of Assessment and Accountability of the changes. Final district approval of the research application was provided in March 2015. In addition, I obtained an electronically signed letter of cooperation (Appendix C) from the Director of Assessment and Accountability and each of the principals at the targeted middle schools. However, prior to soliciting middle school math teachers to volunteer to participate, I received Walden University Institutional Review Board (IRB) approval (#04-16-15-0338986).

**Researcher-participant relationship.** I worked to develop a researcher-participant relationship to safeguard all individuals so that each participant felt comfortable sharing their perceptions and beliefs with me prior to, during, and post interview and observation. As an instrument of the research, I played an elemental part of the researcher-participant relationship in order to be able to support instrumental changes for administrators, middle school math teachers, parents, and students within CSD1 (Merriam, 2009; Maxwell, 2013). I achieved a researcher-participant relationship by obtaining approval to conduct research from CSD1 and Walden University IRB. In addition, I obtained informed consent (Appendix D) from each participant. The informed consent process ensured that each potential participant understood his or her responsibilities prior to agreeing to participate in this study.

The Director of Assessment and Accountability emailed the initial solicitation, via an invitation to participate letter, to each middle school math teacher at the three targeted schools. The invitation to participate letter included the informed consent form. The informed consent process was conducted via an online link provided to each potential participant within the initial email sent by the Director of Assessment and Accountability. Both the invitation to participate and informed consent form explained the purpose of the study, the data collection procedures, the voluntary nature of the study, the risks and benefits of being in the study, confidentiality of his or her participation, and contact information. To ensure potential participants did not feel as if participation in this study was a district mandate, the voluntary nature of the study was reiterated within the email to the middle school math teachers. The Director of Assessment and Accountability served only as the initial conduit to electronically distribute the documents with no further directions from the district office. A total of 13 middle school math teachers responded to the email by clicking on the link to electronically sign the informed consent form. Using an additional criterion of having taught middle school math for 5 years or more, I reduced the sample size to 12 participants.

Basic contact information was requested for each middle school math teacher who agreed to voluntarily participate in this study. This descriptive information included the participant's name, school, email address, and phone number. This information was requested to ensure timely communication was made so the participant could schedule an observation and interview date, time, and location. In addition to basic contact information, each participant was asked to complete a brief, four question demographic survey that included participants' gender, highest level of education, years of middle school teaching experience, and current grade level. In the event a participant did not wish to disclose an answer to one or all of the four demographic questions, each demographic question included an 'I do not wish to answer' option. I emailed each consenting participant a copy (in PDF format) of his or her completed consent form and associated responses to the basic contact information and demographic survey questions for his or her records. This initial email correspondence also included my request for a date, time, and location to conduct the observation and interview. All of the participants scheduled the observation prior to a scheduled break to ensure there was enough time to complete the interview post hoc observation.

**Protection of participants.** As evidence that I fully understood the ethical protection of all participants, I obtained a certificate from The National Institutes of Health (NIH) Office of Extramural Research. This research study had a low risk level to participants, and none of the participants had ever worked with me. Furthermore, I have never been employed by CSD1. Participation was voluntary. If a potential participant decided not to participate, when he or she selected the option stating *No, I do not consent to participate*, the respondent was immediately taken to a thank you page, finishing the informed consent process and providing no other information. I compiled a list of the 12 consenting teachers' names used for this study in the event that a participant wished to later withdraw from the study. Numeric pseudonyms (from 1 to 12) were randomly assigned as each participant voluntarily agreed to participate in this study, as denoted via an informed consent form. Randomly assigning each participant prior to conducting any observations or interviews was done to protect participants' identities prior to, during, and post data collection when reporting the findings of this study. Only I have knowledge of the true identities of each participant within this study.

An email was sent to each school principal to reiterate the voluntary nature of the study, discuss the purpose of the study, and address any questions or concerns. Only one principal requested that we speak over the phone to clarify the purpose, participant expectations and responsibilities, and future plans regarding my study. The other two principals did not request any further explanation beyond what was provided within the letter of cooperation.

Overall, the safety, well-being, and confidentiality of each participant were a priority throughout the duration of the study. In addition, all electronic data collected from each participant is stored in password-protected, encrypted files on my home computer. Encrypting the files ensured confidentiality, that in the unlikely event that my computer was lost or stolen, data were coded in a manner that any third party will not be able to read the data. All nonelectronic data is stored securely in a locked desk located within my home. I will store these data for five years, per Walden University protocol, and then destroy all electronic and nonelectronic data.

## Data Collection Methods

Within this case study design, I methodically and carefully considered the data collection methods. Data collection methods were central in exploring the perceptions of teachers. The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. Teachers' perceptions are important because over time, teachers' perceptions may affect student academic achievement in math. The data for the study consisted of 12 classroom observations, 12 post hoc semistructured one-on-one interviews, and the review of specific archival documents that were provided to me by both the participants and CSD1.

The archival documents requested and reviewed were: (a) participants’ current school year’s lesson plans and (b) a list of the participants’ current school year’s completed professional development/training whether formal or informal. In addition to the archival documents requested from each participant, I requested a copy of any PD documentation from CSD1. Although I fully understand that archival documents did not allow me to explore teachers’ perceptions, per se, the archival documents I obtained (i.e., lesson plans and curriculum calendars) showed me learning activities that either did or did not involve the use of manipulatives.

**Observations.** Conducting observations allows a researcher to watch each participant within the natural setting (Creswell, 2012; Merriam, 2009). Merriam (2009) noted that an advantage to conducting observations is that an individual who is considered an outsider will “notice things that have become routine to the participant” (p. 119). An additional advantage of conducting observations is to observe behaviors that might emphasize or support a response from an interview (Merriam, 2009). Creswell (2012) noted that a disadvantage of observations is it might be difficult receive permission to observe participants. However, securing permission to be a nonparticipatory observer was granted.

For the purposes of this study, I conducted 12, 60-minute, nonparticipatory observations within each participant’s classroom to observe teachers’ behavior and instructional strategies as they related to math manipulatives. The 60 minutes amounted to only one class period per participant. I arrived approximately 5 to 10 minutes prior to the start of each observed class on the agreed time, date, and location. Each participant stated that either sitting at their desk or placing a chair in the back of the room would provide me with the best viewing advantage so that all the classroom instructional methods and behaviors could be visible with little disruptions. During each observation, descriptive and reflective fieldnotes were recorded within an observation protocol (Appendix F), as suggested by Creswell (2012), Merriam (2009), and Yin (2014). For example, I observed and recorded whether teachers did or did not use manipulatives during the lessons and whether the teachers' behavior indicated that he or she felt confident explaining and using said manipulatives during the lessons. When no manipulatives were used, I observed and recorded the activities for the daily lesson taught and recorded whether manipulatives might have presented the students with opportunity to increase math skills and understanding, and might have afforded the students a more impactful learning experience. In addition, I reflectively noted what types of manipulatives could have been used to potentially achieve the desired student learning growth and/or goals of the math skills and concepts instructed during that class period.

To maintain the confidentiality of each participant's identity, each participant was randomly assigned a numeric pseudonym (1 to 12) upon completion of the informed consent process. This method of assigning numeric pseudonyms was to ensure that the participants, in the event that any participants were somehow made aware of who and when a fellow participant was observed or interviewed, the numeric pseudonyms would not merely be an assignment of the order in which the participants were observed and interviewed. Thus, the assigned numeric pseudonym remained the identifying number of the participant throughout the remaining data collection processes (post hoc interviews and obtainment of archival documents), and was written on participants' observation and interview protocols, as well as on the top corner of archival documents received from each participant. Soon after the conclusion of each observation, I electronically recorded the data in a narrative format within a case study database so that the data can be easily coded, analyzed, and stored or retrieved post research (Merriam, 2009; Yin, 2014). Each observational narrative was saved with the file name only listed as *Observation Narrative. Participant #* (# represented the numeric pseudonym that was assigned to the participant) in a password protected, encrypted file on my home computer. Immediately concluding each observation, post hoc interviews were conducted.

**Interviews.** According to Yin (2014) and Creswell (2012), data collected via interviews provide the most important sources of information that cannot be gathered during observations. Creswell (2012) also maintained an additional advantage of conducting interviews is the researcher is able to control and structure the information that is gathered. A disadvantage of conducting interviews is the information will be disseminated through the lens of the researcher, which leads to uncertainties as to whether the individual being interviewed is providing responses that are honest and whole versus providing responses that may be what the researcher wants to hear (Creswell, 2012). However, conducting an observation prior to conducting an interview afforded me the ability to minimize potentially misleading or incomplete participant responses because some interview questions referenced instructional methods and behaviors that were observed.

For the purposes of this study, I conducted 12, one-on-one post hoc interviews within the participants classroom during non-instructional time. Using data collected from multiple semistructured interviews allowed me to compare and illuminate the perceptions of each participant. In addition, conducting semistructured, one-on-one post hoc interviews allowed me to ask open-ended questions based on those observations to solicit responses that are specific to the purpose of this study. Merriam (2009) maintained that interviews are conducted when there is an interest in past events that may not be able to be replicated. Having multiple respondents increased the accuracy of the research study because the information came from more than one individual (Yin, 2014). Although Bogdan and Biklen (2007) suggested that multicase studies might be more complicated, the authors also suggested that after the first case is completed that subsequent cases become easier and take less time than the initial case because of the replicated processes. As Bogdan and Biklen suggested, after I conducted the first interview, subsequent interviews were easier and took less time to complete. The first interview took approximately 30 minutes to conduct, and the other interviews were approximately 20 minutes in duration.

The semistructured interviews were guided by a pre-established list of 12 open-ended questions. The interviews were scheduled via email prior to observations at a mutually agreeable date, time, and location for each participant. Prior to asking any interview questions, I established rapport through concise, general introductory conversations not related to the topic of this study. This succinct, general introductory conversation was followed by reiteration of the purpose of the study, the research procedures, and methods to protect confidentiality. It was important for participants to clearly understand how all identifying information, such as names of participants and schools, was kept confidential to safeguard confidentiality and promote candid responses. In addition to protecting confidentiality, participants were reminded that their participation was voluntary and that they may choose to withdraw from the study at any time, without consequences. The semistructured nature of the interview questions allowed the participants the flexibility to respond to 12 open-ended questions that were not leading and did not solicit yes/no only responses (Creswell, 2012; Merriam, 2009). In addition, semistructured questions afforded me the ability to ask the questions in any order that I saw fit, based on the observation (Merriam, 2009).

Using the guided interview questions, participants were asked to express their perceptions regarding the instructional supports and methods used to instruct students, district professional development, use of manipulatives in teaching middle school mathematics, and their thinking process related to lesson plan development and implementation following PD for math manipulatives. In addition to the 12 interview questions, probes (see Appendix E) were used in an unbiased nature to elicit additional information that may be relevant to my study and to allow the participants to enhance or clarify their own responses (Creswell, 2012). Each participant interview was audio recorded and only labeled with the assigned numeric pseudonym.

All interview data were transcribed, verbatim, so that an electronic case study database of the data was coded, analyzed, and stored or retrieved post research (Yin, 2014). Using an audio recording and interview protocol helped minimize any anticipated ethical issues that might bring harm to the participants, such as risks, confidentiality, deception, and informed consent (Creswell, 2012; Yin, 2014). Member checking was used so participants could assess the accuracy of the findings and minimize any ethical issues (Creswell, 2012). Organizing the data into a case study database when multiple individuals are being sampled is the most effective and efficient way to keep track of the collected data during the analysis processes, which were triangulated with observations and archival documents. In an effort to make certain the interview protocol received honest and whole responses, I sought and secured the participation and assistance of an expert review panel.

Two educational experts (one a math specialist and the other a methodologist) outside the faculty committee, prior to IRB approval, were asked to review and provide feedback regarding the quality of my interview questions in soliciting teachers' perceptions. Using an expert review panel to review the data collecting instrument, in this case the interview protocol (Appendix E), not only increased validity and reliability, but also is a primary evaluation strategy among researchers. One expert, a math expert, has nearly 20 years of teaching and administrative experience within the local public school systems, including CSD1, and higher education. In addition, the secured math expert was considered highly knowledgeable in substantive math instruction. The second expert, a methodologist, has nearly 15 years of research and data collection experience, primarily within the field of K-12 education. I emailed each expert information regarding the background of the problem and my problem statement, in addition to the interview protocol, to use as a guide so that meaningful suggestions regarding the possible revisions of my interview questions could be effectively and efficiently done. I requested each expert to consider the following areas to increase the reliability and validity of the interview protocol:

- clarity
- wordiness
- leading of negative affirming
- overlapping responses
- open-ended questions
- leading or biased questions
- jargon
- technical language
- specificity of questions related to math instruction
- questions sufficient to resolve the proposed problem of the study
- questions sufficient to answer the research questions proposed within the study.

The expert review panel did not see any issues regarding the interview questions as they related to my study background and problem. Rather, the expert review panel only suggested I consider making minor revisions regarding clarity and remove potentially negative wording of a few questions. Once those were revised, I emailed the interview questions back to each expert, at which time the experts found the questions to be sufficient and no further suggestions were expressed. The final method of data collection was to receive any available archival documents from each participant and CSD1.

**Documents.** Additional data, archival documents, were requested from each participant and CSD1. The archival documents received contained clues and provided additional insights into types of activities that teachers' had planned during math lessons throughout the school year (Merriam, 2009). In addition, archival documents provided me with a richer source of information that increased validity observational and interview data (Creswell, 2012; Yin, 2014). I asked each participant to provide typed or photocopied archival documents to me at the time of his or her scheduled interview. Each participant was also given an option to email the archival documents to me prior to the scheduled interview date. The two requested archival documents from participants were: (a) lesson plans during the 2014-2015 school year and (b) a list of completed PD or training during the 2014-2015 school year, whether formal or informal.

Ten (83%) participants decided to email me the requested archival documents, and two (16%) participants stated that they could not provide either archival document because they simply did not exist. However, all 12 (100%) of the participants provided a copy of their syllabus and a document provided to them by CSD1, referred to as Curriculum Calendars (Appendix G). Syllabi and Curriculum Calendars were not requested archival documents, but they may provide additional information during triangulation of the data. CSD1's math coordinator maintained that he did not have access to middle school math training agendas or specific course descriptions for the past 5 years (M. Coordinator, personal communication, July 31, 2014). In addition, CSD1's math coordinator maintained that no specific trainings on manipulatives have been offered in the past 5 years; rather, CSD1 has focused primarily on new teacher trainings (M. Coordinator, personal communication, July 31, 2014).

All of the archival documents that I received were examined for completeness and usefulness (Creswell, 2012; Merriam, 2009; Yin, 2014). In addition, all archival documents were de-identified so that names of participants and schools were not present. After examination of the archival documents, the documents were triangulated with observational and interview data to determine the use of math manipulatives and PD specific to the use of math manipulatives. I fully understand that lesson plans and PD documentation would reveal whether manipulatives have been used in math instruction, but they cannot be related to teachers' perceptions.

**Role of the researcher.** Although I have never been employed by or held any professional relationships with CSD1, there were some experiences and biases that I brought to the study that were related to the topic. Taking on the role of a researcher, it was impossible for me to completely immerse myself into the data and not become affected (Corbin & Strauss, 2015). I teach math content at the adult basic skills level. However, I do not hold a teaching credential in mathematics nor would I be considered highly qualified to teach math within the public school system. Although I teach math to adult students pursuing a high school equivalency, I minimized the influences of my experiences and biases more and more as each interview was conducted by acknowledging them within a personal research journal.

Corbin and Strauss (2015) maintained that keeping a personal research journal allows a researcher to acknowledge any biases prior to, during, and post data collection. A personal researcher journal "provides a record of the thoughts, actions, and feelings that are aroused during the research" (Corbin & Strauss, 2015, p. 102). Prior to entering each middle school to conduct an interview, I recorded my thoughts and potential biases while in the school parking lot sitting in my car. After the interview was completed and prior to driving out of the school parking lot, again, I reflected and recorded my thoughts and potential biases. Although there are different primary approaches typically employed when teaching adults (andragogy) versus children (pedagogy), over the course of 12 participant interviews I acknowledged any thoughts, actions, feelings, and potential biases I had during the data collection processes about teaching math within a personal research journal.

The second bias that I minimized was potential physical influences, such as facial expressions, tone, or body language. While I may have a tendency to be physically expressive, I diminished the influences of this possible bias by keeping my body language bias neutral while making eye contact with the participant during the interview. In addition, I minimized possible biases by showing interest in their responses without interjecting my personality into the interview responses and maintaining a normal, polite conversational tone to deliver each question and probe. I responded with, “Thank you for your response to that question,” only after the participant completed a response to an interview question and probe. Remaining consistent with my responses and maintaining pleasant and neutral facial expressions did not indicate approval or disapproval of any responses provided by the participants and minimized any biases resulting from physical influences.

Lastly, in an effort to create a comfortable environment, I built a rapport with each interviewed participant prior to asking any research questions. This particular bias was minimized using brief, introductory conversations not related to the topic of my study. This approach prior to beginning each interview was consistently executed so that I did not mistakenly influence the participant by giving any personal opinions about any aspect of my study. In addition, I minimized any biases by not asking any questions that might relate to the study topic during the brief, introductory conversations with each participant. Ensuring that any potential biases were minimized was particularly critical during the data analysis stage of my study.

**Data Analysis Methods**

An essential component of any research study is data analysis (Creswell, 2012; Hatch, 2002; Yin, 2014). Creswell, Hatch, and Yin maintained that data analysis allows the researcher to gain a deeper understanding of the data, particularly qualitative data, to communicate the findings with others. Unlike quantitative data analysis methods, qualitative data analysis methods holistically rely on responses from multiple data sources. According to Hatch and Yin, when interview questions are written in a manner to solicit sought after responses in order to adequately answer the research questions, participants are more likely to divulge more information. The researcher is then able to use the inductive process of coding the rich, in-depth information into categories and themes (Creswell, 2012; Hatch, 2002; Yin, 2014).

The data analysis for this study used specific analytic techniques of coding and categorizing the interview and observational data. A general inductive approach was used to analyze the collected data. The inductive process is an important characteristic when analyzing qualitative data in an effort to adequately explain the central phenomenon (Merriam, 2009). Using a general inductive approach to analyzing the data was straightforward, efficient, and allowed me to determine which data are important and which data are not important (Thomas, 2008).

The first step in the inductive process was to prepare the data for coding. Prior to the coding process, the observational and interview data was transcribed, verbatim, into a Microsoft Word document on my computer post hoc each observation and interview. The transcribed data resulted in 72 pages of raw observational and interview data. This created a clean, organized copy of the raw data (Thomas, 2008). To ensure accuracy and increase validity of the interview data prior to beginning data analysis, each participant was asked, via email, to review the transcribed interview and inform me if he or she wished to correct, elaborate, or fine-tune any responses. None of the participants opted to change their responses provided during the original interview. After I received an approval of accuracy from each participant, I began the process of carefully reading, dividing, and coding the transcribed data. Bogdan and Biklen (2007), Creswell (2012), Merriam (2009), and Stake (2005) recommended carefully reading and sectioning the transcribed data to find emerging themes, patterns, and relationships.

Since the data analysis was done by hand, I read the typed interview transcriptions, observation narratives, and archival documents several times in order to gain familiarity with the data so that categories and themes would emerge. To holistically explore the data for each research questions from each participant, I created a Microsoft Excel Workbook that consisted of seven separate spreadsheets. Each spreadsheet corresponded to one research question from the study, totaling seven spreadsheets (one central and six sub questions). The raw data was then recorded or transferred from the Microsoft Word documents into one of the seven spreadsheets. I printed out the workbook (seven spreadsheets) and began to search for and identify salient words and phrases within the data that allowed me to identify themes, patterns, and relationships within each category.

To help guide me in an initial direction, I explored categories related to: setting, teachers' perceptions of self-efficacy using manipulatives, teachers' perceptions of student learning and math achievement, instructional techniques and behaviors using manipulatives, teachers' perceptions of strengths and barriers regarding the implementation of manipulatives, teachers' perceptions of instructional supports (e.g., PD and teacher collaborations), and teachers' incorporation of manipulatives within lesson plans. These categories were appropriate and applicable to the central and sub- research questions. In addition, these categories coincided with the interview questions and observation protocol with regard to teacher self-efficacy, student learning and achievement, instructional practices, and PD. Once the categories were identified, I began to search for themes, patterns, and relationships within the data. I tallied and coded the observational and interview data into themes under each category within each research question. In a separate column within each spreadsheet, I included any personal reflections and fieldnotes written during each observation and about each interview under each category. The archival documents that I received were triangulated to corroborate, increase the accuracy and credibility, and reduce researcher bias of the observational and interview data. I emailed each participant my written findings to member check for accuracy or and to validate my interpretations. Participants did not know the numeric pseudonym they were randomly assigned. However, each participant could determine which areas were specific to them through descriptions of participant settings, participant quotes, and observational descriptions described within my findings. None of the participants opted to correct, elaborate, or fine-tune any information within my findings that related to only their interview and observation.

**Accuracy and credibility.** For this study, participants reviewed transcripts to validate the accuracy of my interview data. In addition, I conducted member checking during the data analysis stage. During the data collection stage, I emailed each participant a copy of the transcribed interview to review for accuracy. Each participant was instructed to read the transcribed interview and notify me if he or she wished to revise, change, or omit any responses (Creswell, 2012). None of the participants opted to revise change, or omit any responses. During the data analysis stage, as recommended by Glesne (2011) and Yin (2014), I emailed each participant a copy of my findings to review the accuracy of and to validate my interpreted findings. Again, each participant was instructed to read my findings and notify me if he or she wished to correct, elaborate, or fine-tune any information within my findings that related to only his or her interview and observation (Creswell, 2012). Again, none of the participants opted to correct, elaborate, or fine-tune and information within my findings. My goal, as Creswell (2012) noted, was to ensure that my interpretations of the participants' personal reflections and views were accurately portrayed within the final report of the study. It is important that the participants review for accuracy and validate the any data and research findings, in addition to being given an opportunity to correct, elaborate, or fine-tune any information to ensure that I did not misinterpret the meaning of his or her responses (Glesne, 2011; Merriam, 2009; Yin, 2014).

Another method used to increase overall credibility and validity of my study was triangulation of multiple sources of data (Creswell, 2012; Merriam, 2009). For this study, data collected from observations, interview, and archival documents were triangulated. Creswell (2012) and Merriam (2009) suggested that multiple data collected in qualitative studies are triangulated to increase credibility and validity of research studies. Data triangulation uses inductive reasoning that allowed me to check observational data against interview data against relevant archival documents to this project studies central phenomenon (Creswell, 2012; Merriam, 2009).

**Discrepant cases.** Dealing with discrepant cases was possible with 12 potential participants. According to Gast and Ledford (2014), discrepant cases are data that are considered to be outliers or hold inconsistencies with the initially identified themes or categories. Although discrepant cases might provide contrary evidence regarding the perspectives about the central phenomenon (Yin, 2014), Silverman (2011) suggested not to completely exclude the alternative perspectives rather place a focus on those perspectives. When discrepant cases emerged, I reanalyzed the data determining additional themes or categories. Discrepant cases were referenced in the findings of this study.

## Data Analysis Results

The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. After the data were collected and analyzed, an aggregation of my findings helped me to arrange responses to the central and sub questions within this study. During each interview, all participants were willing to share experiences as a middle school math teacher within CSD1. In addition, participants provided examples and details to further support shared experiences as middle school math teachers, when asked. The combination of participants' experiences along with the use of direct quotes in the subsequent sections contributed to the rich, in-depth details under each research question. Therefore, the findings were organized by research question.

## Findings

### Central Research Question

The central research question was: What are teachers' perceptions of professional development and self-efficacy in the use of manipulatives as it relates to math instruction in urban middle schools? Based on the analyzed data, all participants believed that PD and maintaining higher self-efficacy in the use of manipulatives as it related to math instruction were beneficial. In addition, all participants agreed that to increase self-efficacy in the use of math manipulative teachers should possess a certain level of knowledge and understanding about how to use them effectively during math instruction. In addition, all participants maintained that PD opportunities are one resource that may increase self-efficacy and effective teaching of math manipulatives. Participants shared similar perceptions that as students' understanding of math skills and concepts grew through the use of physical manipulatives (PM) and virtual manipulatives (VM), teachers believed in their own ability to teach using PM and VM. In addition, teachers' determined the overall academic and social benefits of using manipulatives during math instruction increased their desire to seek out PD focusing on manipulatives. Finally, all of the participants agreed that the use of PM and VM were critical instructional elements for students' overall academic success in math.

## Theme 1: Advantages of PD

**Teacher collaboration.** The theme that emerged among all of the participants' responses and observations was that teacher collaboration, whether in formal or informal settings, increased self-efficacy to using manipulatives during math instruction. All participants maintained that teacher collaboration played a huge and valuable influence to their instructional practices, particularly when manipulatives were determined a beneficial instructional tool for a particular math lesson. Chong and Kong (2012) suggested that supportive collaborations allowed teachers to scrutinize each other's current instructional methods and lessons in an effort to improve and revamp those instructional methods and lessons. Participants 1, 4, and 9 shared feelings that teacher collaboration impacted instructional practices, such as developing math lessons and activities that fostered increased student achievement, determining when and how to use manipulatives during math lessons and activities, and increasing teachers' self-efficacy in teaching math lessons and activities with or without manipulatives.

Participants maintained that collaboration among fellow teachers was a vehicle that increased their knowledge and perceived sense of self-efficacy in using PM and VM. Roseler and Dentzau (2013) suggested that a critical component of teacher learning is the collaboration "between novice and experienced participants where understanding within the group evolves to incorporate knowledge reciprocally" (p. 620). Forte and Flores (2014) defined collaboration as a way teachers share and interact with each other to promote excellence in teaching and student learning. "Collaboration is critical to teacher development and school improvement" (Forte & Flores, 2014, p. 91). Participant 1 stated, "Teacher collaboration gives me an opportunity to learn and explore best practices of other math teachers, regardless of what grade they teach." Participant 2 stated, "I attribute my current understanding of manipulatives that use the computer to teacher collaboration." In addition, during the observation, Participant 7 collaborated with a service teacher in her classroom during a lesson on geometry where various shapes were presented and subsequently manipulated on a computer in front on the students. By the end of the geometry activity, a visible increase and confidence emerged in Participant 7's demeanor while using the VM. As a result of the collaborative nature between Participant 7 and the service teacher, Participant 7 understood how to better use the VM and addressed students' geometry-based questions using the VM.

**Professional development.** A majority of participants found PD to be favorable in guiding teachers to properly choosing and effectively using manipulatives during math instruction. Participant 10 asserted, "Professional development is a great resource to provide teachers new and seasoned." Participants 3, 5, 6, and 11 expressed an overall interest in participating in PD that focused more on manipulatives. However, all participants maintained that since there has been no district-wide PD specific to manipulatives offered during the 2014-2015 school year, PD yielded little to no influence over their instructional practices. Participants 2, 4, 10, and 12 did not feel participating in PD influenced their instructional practices. Roseler and Dentzau (2013) maintained that PD is an individual process and there has been a subtle deprofessionalization of teachers typically occurs upon hire. However, changes in reform have resulted in PD that is not effective or not implemented to take into account the best interest of student or teacher learning (Roseler & Dentzau, 2013).

**Theme 2: Motivation Relates to Student Learning and Math Achievement**

Eleven out of 12 (92%) participants believed that there was a direct relation between student learning and math achievement and math instruction. Participants also felt that the relation between motivation and student learning and math achievement was reflective among students with and without learning disabilities. Despite this relation between motivation and student learning and math achievement, participants expressed availability, time, and money as factors that influenced their decisions to use or not to use manipulatives. Regardless of these influences, all participants felt that a strength of using manipulatives to teach algebra and algebraic reasoning was that students with learning disabilities understand and retain the math skills over longer periods of time.

**Directly related.** From the results of the interview process, approximately 92% of participants felt there was a direct relation between teachers' motivation and student learning and math achievement. McCollister and Sayler (2010) maintained that rigorous math tasks completed during the learning process could increase students' math achievement and growth. Participants 1 and 4 agreed that when student learning occurs, student achievement and outcomes, as displayed on assessment scores, increase in math. However, if the teachers are not motivated to teach, then students may not be motivated to learn. Therefore, when motivation is low among teachers and students, math achievement may decrease.

According to Yildirim (2012), student learning outcomes and motivation, specifically in math, greatly influence academic achievement. For students to understand and retain information, students should possess conceptual understanding of math tasks and skills for academic success. Participants 7 and 11 referred to students being motivated to perform at higher levels when teachers are motivated to teach. Ghilay and Ghilay (2015) and Saeed and Zyngier (2012) maintained that when teachers and students exude higher levels of motivation, students' overall learning of math skills increase, which increases math achievement. Participant 7 stated, "When I am teaching with a high level of energy the students get hyped and motivated to learn." Only one outlier, Participant 3, stated, "Regardless of how I teach, if my students do not want to learn the skill, then they will only do enough to pass the time in class." Although a majority of participants' responses yielded a direct positive relationship between motivation, student learning, and math achievement, participants agreed that time and money were factors that were considered in determining whether manipulatives were used or not used during a math instruction.

**Theme 3: Barriers**

**Time and money.** All participants referenced time and money as being barriers they experienced that determined their use or none use of manipulatives. Participants 1, 4, 3, 7, 10, 11, and 12 shared similar feelings of not having the time and money to participate in necessary PD that might enhance math instruction. In addition, Participants 4, 3, and 12 maintained that there were minimal PM and VM available for use during math instruction at their schools, which affected teachers' self-efficacy and students' learning and achievement in math. Participants 10 and 11 suggested due to the lack of time and money to purchase PM and VM they do not utilize manipulatives during math instruction. Participants 10 and 11 also suggested when manipulatives are not used during instruction, students' math achievement may be impacted by a reduced motivation to complete math activities and a delay in students' learning of math skills and concepts. However, Participants 3 and 12 stated they utilized drawing pictures (a type of PM) on the board as a way to incorporate manipulatives during math instruction that was cost effective and enhanced student learning and achievement. During my observations, I only observed three participants (4, 7, and 8) using manipulatives during classroom instruction. Participants 1, 2, 3, 5, 6, 9, 10, 11, and 12 were all observed using only procedural-based instruction on the whiteboard. Participants 4 and 8 used pictorial manipulatives on the whiteboard during the math lesson, but this approach was brief and only applied when a student approached the teacher to ask a questions during the activity.

Participants also referred to availability of manipulatives and PD as the two top barriers that prevented them from implementing manipulatives during math instruction.

**Availability of manipulatives and PD.** If math teachers are not provided manipulatives to implement during math instruction or do not have PD to properly and effectively implement the manipulatives during math instruction, teachers' self-efficacy and self-confidence are negatively affected (Golafshani, 2013). Participants cited having manipulatives available and being properly trained via PD to effectively use the manipulatives as additional barriers of using manipulatives to teach algebra and algebraic reasoning. Participants 1 and 8 shared similar sentiments regarding the constricting time schedule to teach math concepts and skills and lack of effective PD that focused specifically on manipulatives during math instruction as impacting their efficacious feelings of manipulatives and students' math achievement. Participants 2, 6, 8, and 12 referenced the lack of PD offered by the district with regard to incorporating manipulatives in lesson plans and using manipulatives during math instruction. Patel et al. (2012) found when math teachers participated in professional development opportunities, formal and informal, several things occurred: (a) teachers' attitudes and perceptions positively shifted toward teaching math and learning and (b) teachers' mathematical and pedagogical content knowledge increased. Participant 8 stated, "None of the training I have had through the district this school year [2014-2015] specifically dealt with how to use, create, or direct students to use manipulatives during math instruction." Participant 5 stated, "I lack both the training and manipulatives to incorporate into any math lesson." With the apparent lack of PD opportunities afforded to math teachers specifically dealing with manipulatives, all of the participants felt that they needed more PD and training opportunities.

### Theme 4: Additional Instructional Supports

Other than teacher collaboration and PD, all participants suggested an additional instructional support that would influence instructional practices, specifically when manipulatives are used, was technology. However, all of the participants determined that standardized assessment data, coaching and mentoring, and online resource banks provided by the CDE and CSD1 did not influence their instructional practices.

**Technology.** All of the participants' maintained the use of VM and technology would greatly influence their instructional practices. Staniger (2011) maintained that, "Improved changes in pedagogy could be accomplished using technology as a teaching and learning tool" (p. 19). In addition, the use of technology during math instruction may increase academic achievement in math (Staniger, 2011).

Based on my observations, Participant 7 was the only teacher who attempted to use technology during a math lesson, but frequently asked the pre-service teacher for guidance, which halted the instruction at times. Participants 1, 2, 3, 5, 6, 9, 10, 11, and 12 were all observed using only procedural-based instruction on the whiteboard. Participants 3 and 11 included students using the whiteboard to show the systematic problem to solving a given equation.

**Summary**

This collective case study used multiple homogeneous cases to investigate the central phenomenon. A case study is a practice design conducted to gain an in-depth understanding of "one setting, or a single subject, a single depository of documents, or one particular event" (Bogdan & Biklen, 2007, p. 59). The participants were considered seasoned middle school math teachers who taught middle school within CSD1 during the 2014-2015 school year. A rich, in-depth exploration of 12 middle school teachers' perceptions allowed me to triangulate observational, interview, and archival documents using a general inductive approach to identify emerging categories and themes. Using a general inductive approach to analyzing the data was straightforward, efficient, and permitted me to determine which data are important and which data are not important (Thomas, 2008).

Through a data analysis process, the findings presented within this study determined that there is a need for ongoing professional development specifically focusing on using manipulatives during math instruction. Effective PD for math teachers should focus on four areas: math content, math pedagogy, math curriculum, and incorporating VM into math instruction (Killion, 2015). Participants' reported feeling less efficacious when using manipulatives during math instruction because of the lack of PD that focused specifically on manipulatives. Participants reported the lack of self-efficacy in using manipulatives during math instruction impacted student learning and achievement. Killion (2015) maintained that there is a direct relationship between PD and student learning and achievement in math. During my observations, math instruction was primarily procedural and systematic despite sample activities using manipulatives during math lessons written within the Curriculum Calendars. In only a few instances did I observe participants using PM or VM to enhance student learning experiences. However, the consensus among participants was that they believed using manipulatives would positively affect several aspects of their instruction, such as lesson planning, instructional methods, and increased use of technology. The need for district offered PD opportunities specifically focusing on math manipulative is present, based on the analysis of participants' perceptions. In addition, to adhere to teaching and learning 21$^{st}$ century math skills, instructional supplies, such as manipulatives and up-to-date technology resources, are necessary.

According to Voogt, Erstad, Dede, and Mishra (2013), teachers and students must possess three 21$^{st}$ century competencies to enhance learning math skills and concepts: foundational knowledge, meta knowledge (problem solving, critical thinking, communication, collaboration, creativity, and innovation), and humanistic knowledge (self-awareness). One aspect of the three competencies for 21$^{st}$ century learning includes the incorporation of technology during math instruction. To make the necessary changes to enhance students' 21$^{st}$ century learning in math skills and concepts, PD is a key element. According to Krawec and Montague (2014), there are significant gaps between PD and instructional practices that should be addressed in an effort to impact teachers' self-efficacy when using manipulatives during math instruction, and students' learning and achievement in math. The lack of PD that specifically focused on using manipulatives during math instruction within CSD1 left the participants reporting a low sense of self-efficacy regarding the use of manipulatives. The use of the CBAM allowed me to pinpoint issues that participants had with changes in their math instruction, specifically with the changes of integrating manipulatives.

Applying Knowles's (1970) andragogy theory and Piaget's (1952) theory of cognitive development to participants who might have attended PD opportunities specifically focusing on manipulatives during math instruction created a better insight not only about how teachers should teach, but also about why they are teaching. However, during the 2014-2015 school year, there were no PD opportunities offered by CSD1 that focused on incorporating and using manipulatives during math instruction. Therefore, based on Knowles' and Piaget's theories, inferences could be made that teachers within CSD1 possess minimal understanding on how and why they should incorporate PM and VM during math instruction. These conceptual frameworks are especially important for teaching mathematics in the 21st century. In addition, to thoroughly convey the processes of how teachers' feelings and beliefs may change toward manipulatives during PD, both theories and CBAM are necessary.

## Conclusion

In Section 2, I discussed the methodology of the study. The methodology included topics, such as research design and approach, participants, and data collection, analysis methods, and findings. To maintain alignment with the purpose of the study stated in

Section 1, the qualitative research design with a collective case study approach was used to further explore the central phenomenon. Based on the results of this study, a blended PD was designed to assist middle school math teachers to increase teachers' perceived sense of self-efficacy using PM and VM during math instruction. Increasing teachers' self-efficacy using PM and VM during math instruction might impact students' learning and achievement of math skills and concepts.

In Section 3 of this study, I discussed the project, a blended PD, the resulted from the findings of this study. In addition, I discussed the description and goals, rationale, review of literature, implementation, and formative and summative evaluations of the project. Finally, I discussed the implications of this project including positive social change.

Section 3: The Project

## Introduction

The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to United States middle school students. I developed a blended PD entitled *Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction* after I gained insight from the review of relevant literature and the findings of this study, and is included in Appendix A. In this section, I discuss important aspects of the project such as the description and goals, rationale, review or literature, implementation, and project evaluation. Finally, I discuss the local and far-reaching implications for social change.

## Description and Goals

An exploration of the perceptions of 12 middle school teachers' allowed me to triangulate observational, interview, and archival documents using a general inductive approach to identify emerging categories and themes. Analyses of the study findings showed that there was a need for professional development (PD) at the study site, with a specific need for PD focusing on increasing teacher self-efficacy using manipulatives during math instruction. The development and implementation of the Common Core State Standards (CCSS) in the United States suggests teachers shift from procedural instructional methods to methods that use manipulatives, which provide students with deeper conceptual understanding of math concepts and skills (Rothman, 2012). In addition, teachers should intertwine procedural methods along with critical thinking and situational application using manipulatives to guide students to solve math problems using conceptual understanding of math concepts and skills (McNeil et al., 2015).

Educational reforms, such as the CCSS, enhance teaching, student learning, and overall fairness among the educational systems as a whole. However, there have been minimal PD opportunities over the past several years for math teachers employed in CSD1 to increase their self-efficacy in shifting to instructional methods where manipulatives are used. As a result of the findings from this study, I have developed a blended PD that focuses on increasing self-efficacy in developing lesson plans and implementing instructional methods that incorporate manipulatives. The overarching goal of the resulting blended PD was to increase teachers' knowledge and understanding of developing lesson plans and implementing instructional methods that incorporate manipulatives.

This PD follows a blended delivery format using both face-to-face and distance learning environments. There are five goals of the 1-day, face-to-face portion of the PD:

- Goal 1: Teachers will begin to build a learning community concerning the use of manipulatives.
- Goal 2: Teachers will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math.

- Goal 3: Teachers will apply and analyze mathematical concepts using manipulatives.
- Goal 4: Teachers will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans.
- Goal 5: Teachers will understand the expectations of the distance learning portion the PD.

The distance learning portion of the blended PD will include two modules over a 2-month period. A key component of this PD is that participants will share various experiences during the distance learning portion of the PD. Potential experiences to share include successful and unsuccessful instructional methods, classroom activities using manipulatives incorporated within lesson plans, and reflections on thoughts, actions, and feelings about their instructional experiences and outcomes. The goal of the distance learning portion of the PD will be for teachers to successfully write and implement a lesson plan that incorporates manipulatives. Both distance learning modules will occur via a learning platform that supports asynchronous learning.

This PD was specifically designed to address study participants' feedback. The participants in this study maintained one reason they possessed low feelings of self-efficacy was because of the lack of PD that focused specifically on manipulatives offered by the district. Teachers' participation during the blended PD will promote positive social change by increasing teachers' knowledge and understanding, thereby perceived sense of self-efficacy, in the use of manipulatives during math instruction, in turn, increasing student learning of math concepts and skills.

## Rationale

The findings presented within this study showed that there is a need for ongoing professional development that specifically focuses on using manipulatives during math instruction. Participants reported low feelings of self-efficacy related to the use of manipulatives during math instruction because of the lack of PD that focused specifically on manipulatives. CSD1's math coordinator maintained that no specific trainings on manipulatives have been offered in the past 5 years; rather, CSD1 focused primarily on new teacher trainings (M. Coordinator, personal communication, July 31, 2014). This suggests that the study participants would strongly benefit from PD that focuses on increasing teachers' understanding of manipulatives during math instruction, which will also increase perceived feelings of self-efficacy.

During my observations, math instruction was primarily procedural and systematic. In only a few instances did I observe participants use drawing or technology to enhance student learning experiences. The consensus among participants within this study was that they believed using manipulatives would positively affect several aspects of their instruction, such as lesson planning, instructional methods, and increased use of technology. However, there were no district-wide professional development opportunities focusing on manipulative during math instruction.

The need for district offered professional development opportunities specifically focusing on math manipulatives is present, based on the analysis of participants' perceptions. To adhere to teaching and learning 21st century math skills, I created the PD project entitled *Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction* and aligned it to the outcomes of this study. Teachers who believe that the content discussed during PD focusing on manipulatives will impact student achievement are more apt to use manipulatives and feel more confident in changing instructional strategies (McGee et al., 2013). During the PD, math teachers and associated district math specialists will increase perceptions of self-efficacy in planning and incorporating manipulatives during instruction.

## Review of the Literature

A majority of the participants in this study stated PD opportunities that involved manipulatives were not offered during the 2014-2015 school year. As a result, math teachers felt low self-efficacy in using manipulatives during math instruction. In addition, a majority of participants possessed a level of understanding of the benefits when manipulatives are used during math instruction and would participate in PD that focused on manipulatives. Critical aspects of learning are "attitude, motivation, willingness to participate, valuing what is being learned, and ultimately incorporating the discipline values into real life" (Kasilingam, Ramalingam, & Chinnavan, 2014, p. 29). Changing feelings and attitudes, also known as Bloom's affective domain (see Table 3), goes beyond traditional text on a paper or screen (Kasilingam et al., 2014). Therefore, increasing math teachers' self-efficacy regarding the use of manipulatives through a PD focusing on manipulatives may be directly related to student success (Bruce et al., 2010; Jansen & Spitzer, 2009).

Table 3

*Affective Domain*

| Domain | Description | Keywords |
|---|---|---|
| Receiving<br>Willing to listen | *Awareness, willingness to hear, selected attention* | Ask, choose, describe, follow, identify, locate, name, select, reply, use |
| Responding<br>Willing to Participate | Active participation, interaction or response to new information or experiences | Answer, assist, aid, compile, conform, discuss, help, label, perform, practice, present, read, recite, report, select, tell, write |
| Valuing<br>Willing to be Involved | Value or worth a person attaches to particular object, phenomenon or behavior. This ranges from simple acceptance to more complex state of commitment | Complete, demonstrate, differentiate, explain, follow, form, initiate, join, justify, propose, read, share, study, work |
| Organization<br>Willing to be an Advocate | Incorporating new information or experiences to existing systems | Adhere, alter, arrange, combine, compare, complete, defend, formulate, generalize, identify, integrate, modify, order, organize, prepare, relate, synthesize |
| Characterization<br>Willing to change one's behavior, lifestyle, or way of life | Value system that controls their behavior. The behavior is pervasive, consistent, predictable, and most importantly, characteristic to the learner | Act, discriminate, display, influence, listen, modify, perform, practice, propose, qualify, question, revise, serve, solve, verify, use |

*Note.* Reprinted from "Assessment of learning domains to improve student's learning in higher education," by G. Kasilingam et al., 2014, *Journal of Young Pharmacists*, *6*, p. 30. Reprinted with permission (Appendix H).

Throughout my search for current, peer-reviewed sources, I read and annotated three types of literature sources relevant to the study: published books, peer-reviewed journal articles, and web publications. Several key phrases, in various combinations, were used to identify the primary literature pool from which I have narrowed the search for relevant findings. These key phrases included: *self-efficacy*, *affective domain*, *common core state standards*, *Colorado academic standards, constructivism, educational change*, *professional development methods*, *andragogy*, *best practices in math using manipulatives*, *teacher training*, and *shifts in math instruction*. These key phrases were typed into Internet-based search engines and databases, such as Educational Resource Information Center (ERIC), ProQuest, ECHOST, WorldCat, Education Research Complete, Education from SAGE, and Google Scholar, to help access any relevant books, journal articles, and reputable web publications published or accessible online. Thirty sources were originally identified to bear significant relevance to the subjects under study with regard to the project.

Relevant literature directly related to the genre of PD included face-to-face PD, virtual PD, hybrid PD, self-efficacy and PD, and contents of productive math PD (Common Core State Standards, shifts in math instruction, and best practices) are addressed. Additionally, integrating theoretical and experiential information in an effort to explore the conceptual frameworks of the project is outlined within this section. This literature review concentrated on academic journals that represent a wide range of research pertinent to this premise. Subsections under this section include conceptual frameworks, common core state standards alignment during math instruction, shifts in math instruction, and best practices. The subsections within this review of relevant literature were explored in order to support mathematical learning, as well as enhance teachers' self-efficacy regarding the use of manipulatives during math instruction.

## Conceptual Frameworks

An issue for CSD1 was minimal to no PD that specifically focused on using manipulatives during math instruction. This lack of PD left the participants in this study feeling low self-efficacy when manipulatives were used during math instruction. The project, a blended PD, of my study primarily used Vygotsky's (1978) social development theory and Shulman's (1986) pedagogical content knowledge theory as foundational conceptual frameworks. Applying Vygotsky's social development theory supports this study's PD project because Vygotsky's theory suggested that social interactions assist with the learning process (Vygotsky, 1986). In addition, applying Shulman's pedagogical content knowledge theory maintained that teachers possess information that students do not know or clearly understand (Shulman, 1986). These notions are especially important in teaching mathematics. To thoroughly convey the processes of how teachers' feelings and beliefs may change toward manipulatives during PD, both theories are necessary.

**Social development theory.** Vygotsky maintained that meaningful learning occurs when individuals are able to collaborate with others (Vygotsky, 1978). Participants will be given an opportunity to become the student to learn new instructional methods incorporating manipulatives during math instruction. In addition, it is through the collaboration between seasoned teachers and less experienced teachers during PD when instructional methods are enhanced (Lamb, 2015). With the social collaborations occurring during activities tasked during the PD, meaningful learning and increased self-efficacy occur with each teacher regardless of initial feelings towards using manipulatives during math instruction (Alt, 2015). Vygotsky (1978) also maintained that through social interactions individuals process and organize information provided by an expert, which in this project is the use of manipulatives during math instruction.

**Pedagogical content knowledge.** Shulman's (1986) idea of pedagogical content knowledge (PCK) is a combination of teachers' knowledge of the subject matter and the instructional methods teachers use to relay that subject matter knowledge. PCK focused on the why aspects of teaching, in addition to the curricula development of what is being taught (Shulman, 1986). When a level of trust between the teacher and the students is formed, the students become more aware of their own learning processes (Chan, 2010). Professional development opportunities, such as those about mathematical manipulatives, allow teachers to gain the necessary pedagogical content knowledge so that they do not just follow a pedagogical approach based on redundancy, drills, and memorization of information.

## Face-to-Face PD

One mode of PD is face-to-face. Face-to-face PD is when the facilitator and participants are together, typically in a classroom setting. One key aspect of participating in face-to-face PD is the social interactions that occur among the participants (Moon, Passmore, Reiser, & Michaels, 2014). "People naturally have tendency to seek out interpersonal contacts and cultivate possible relationships" (Ghadirian et al., 2014, p. 41).

Social interactions among fellow teachers create a level of trust that can foster authentic learning experiences (Tseng & Kuo, 2010). These authentic learning experiences, along with face-to-face discussions may increase teachers' self-efficacy and willingness to implement new instructional methods in math.

**Professional Learning Communities**

Professional learning communities (PLC) are defined as a collaborative process in which teachers engage in shared learning to increase self-efficacy to improve student outcomes (Harris & Jones, 2010). According to Mintzes, Marcum, Yates, and Mark (2013), teachers who participate in a PLC feel empowered and more confident implementing new instructional methods. In addition, teachers reflect and modify instructional methods after participating in PLC until instructional mastery is achieved (Mintzes et al., 2013). The collaborative learning environment and peer support derived from PLC, increases teachers' perceived self-efficacy (Lin, 2013).

**Blended PD Model**

A blended PD model was determined to be the most productive PD model that might resolve barriers experienced by participants in this study. A blended PD model integrates face-to-face and distance learning interactions, which is a more favorable PD model among teachers (Matzat, 2013). Blended PD, which is considered a modernized form of traditional PD, consists of three characteristics: (a) shifts from teacher-centered to student-centered instructional methods where participants become interactive learners; (b) increases participant interactions (participant-facilitator, participant-participant,

participant-content, and participant-outside resources); and (c) provides formative and summative evaluations for participants and facilitators (Yeh, Huang, Yeh, 2011). When blended PD is redesigned with these characteristics, the benefits may impact teacher learning and student achievement. According to Graham, Woodfield, and Harrison (2013), the benefits of blended PD are accessibility, flexibility, cost-effectiveness, and teachers are more committed to increasing student achievement. In addition, when teachers participate in a blended PD format, "discussions in online communities with common interests can lead to offline contacts between members" (Matzat, 2013). Using both face-to-face and distance learning platforms in a blended PD increases teachers' ability to organize, create, capture, and distribute new concepts and skills, which increases perceived sense of self-efficacy (Yeh et al., 2011).

**Lesson Study Model**

A highly effective PD that involves teacher collaboration is based on the Japanese Lesson Study model. The Lesson Study model is an effective PD practice that was brought to the United States and used as a method to increase student learning outcomes. According to Doig and Groves (2011), the Lesson Study model "provides a model for large-scale, sustainable professional development" (p. 78). The Lesson Study cycle involves four phases: goal-setting and planning during the development of a lesson plan, teaching and observing the lesson, in-depth discussion post hoc instruction, and suggested modifications to the lesson by observers (Doig & Groves, 2011). One component of my project is teacher collaboration during the initial phases (goal-setting and planning) during the lesson planning process. Doig and Groves maintained that the goal-setting and planning stage of the lesson planning process is considered the most critical foundation to support and strengthen the further development of the lesson plan.

**Increasing Efficacy Through Effective PD**

Providing educators with quality and effective PD opportunities can improve their content-area knowledge, instructional practices, and perceived self-efficacy (Carlisle, Cortina, & Katz, 2011). Factors that contribute to the effectiveness of PD can inform the creation, implementation, and evaluation of PD (Darling-Hammond & McLughlin, 2011). The design of PD should be effective and impact perceived self-efficacy; teachers should participate in long-term PD. In addition, PD should use a bottom-up approach for teachers to understand intricate information and be able to increase perceived self-efficacy through application of learned information during classroom instruction (Gulamhussein, 2013). "With traditional professional development, only 10 percent of teachers transfer the skill" (Gulamhussein, p. 37). When teachers participant in long-term, regular PD, teacher feel more efficacious and are more willing to participate in additional PD and change instructional methods (Ross & Bruce, 2007). When teachers increase self-efficacy as a result of participating in effective PD, they set more advanced goals for themselves and their students and approach instructional challenges with decreased fear of failure (Ross & Bruce, 2007).

**Contents of Effective Math PD**

**Common core state standards.** The CCSS were adopted by 46 states within the United States and three territories (Dalton, 2012). The math standards outlined within the CCSS are explicitly written to promote learning in each grade level through curricula that exhibits rigor, clarity, coherence, and internationally comparable benchmarks (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). After review of the Colorado Academic Standards established in 2009, Colorado decided to integrate the CCSS into already established Colorado Academic Standards (CDE, 2014a). "Integrating the Common Core State Standards and maintaining rich Colorado specific values resulted in a set of standards that is best for the success of Colorado's teachers and students" (CDE, 2014a, p. 3). However, participants within this study stated that no PD opportunities offered by CSD1 during the 2014-2015 school year that focused on CCSS or Colorado Academic Standards as they related to incorporating manipulatives during math instruction. The newly revised standards incorporate 21st century learning, as well as set a higher expectation for student learning in order to adequately prepare students to be college and career ready upon high school graduation (Porter, McMaken, Hwang, & Yang, 2011; Rothman, 2012). Yet, participants stated feeling less efficacious when PM and VM were used during math instruction, which are used to increase students' conceptual understanding of math concepts and skills.

The CCSS were designed to ensure that graduating high school students are globally competitive and can use conceptual understanding in daily life as they encounter new situation (National Governors Association Center for Best Practices & Council of Chief State School Officers, 2010). One of the key elements of math standards is developing conceptual understanding of math ideas. According to Clements and Sarama (2011), arithmetic concepts and skills are important in order to guide foundational mathematical thinking and learning. The CCSS in math, which are integrated into the Colorado Academic Standards in math, sustain a level of unity and equality among instructional methods as they relate to increasing students' conceptual understanding of math skills beyond middle and high school (Confer & Ramirez, 2012; Rothman, 2012). Gaining a better understanding of the CCSS as they relate to math instruction through PD, teachers may incorporate instructional methods using manipulatives that enhance conceptual understanding, cognitive skills, conative (self-efficacy) skills for teachers and students (Marzano et al., 2013). Major shifts in math instruction resulted from the CCSS. As a result, math teachers struggled as to how to effectively teach the standards.

**Shifts in math instruction.** Math teachers and specialists have struggled for years to determine whether using models that actively engage students (i.e., manipulatives) or procedural instructional methods during math instruction are the most efficient method for teaching math concepts and skills (Bottge et al., 2015). One of the key shifts in math discussed within the CCSS is rigor (Common Core State Standards Initiative [CCSSI], 2010). Rigor is essential in order for teachers to pursue conceptual understanding of math concepts and skills (CCSSI, 2010). Determining how this shift is implemented during math instruction is a continuous struggle for teachers (Porter et al., 2011). Instructional methods within math classrooms have transformed from memorizing procedures and formulas to one that fosters and promotes conceptual understanding of concepts and skills.

As math instruction evolves to implement the CCSS in a more effective manner, teachers are shifting from a traditional math instruction that involved sole procedural-based instruction to instruction that supports constructivist principles (Grady, Watkins, & Montalvo, 2012). The shift in instruction that promotes constructivist principles and frameworks as they relate to math instruction will help teachers  implement the Colorado Academic Standards with an increased focus on cognitive and conative skills (Conley, 2011; Grady et al., 2012). A study conducted by Carroll (as cited in Grady et al., 2012), suggested that when students in the United States were taught using a constructivist approach in math, those students out performed students taught using traditional methods in both China and the United States. The participants stated that they desired to shift their instructional methods from traditional to constructivist by incorporating more manipulatives, but lacked the PD to enhance their efficacy of manipulatives during math instruction.

Another shift in instruction is the use of multiple choice tests to determine students' understanding of math concepts and skills. Wickett and Martin (2011) maintained that teachers should rely less on multiple choice assessments when determining students' progress in math. Multiple choice assessments can conceal students' true level of mathematical understanding (Wickett & Martin, 2011). Wickett and Martin's investigation of students' understanding of math concepts and skills after a multiple choice test determined that students' multiple choice responses depicted an inaccurate or incomplete picture of students' understanding of math concepts and skills. Uncovering whether students understand math concepts and skills allows teachers to determine the best instructional practices based on what students might need to progress in math. PD that focuses on incorporating manipulatives during math instruction might help teachers shift current math instructional methods that do not yield higher expectations for student learning and better align with instructional expectations within Colorado Academic Standards.

**Best practices.** During any PD that focuses on math, it is important to present teachers with examples of best practices when incorporating manipulatives into math instruction. Participants (Ortega, Velazquez, & Levano, 2012) suggested that best practices are, "Singular, contextualized, and can be transferred to other educational contexts… taking into account student characteristics, interests, expectations, and contextual information in the teaching–learning process" (p. 8). Participants also maintained that there is not just one way to define what best practices are; rather, best practices are defined based in the context where those practices might occur. However, all of the participants were in agreement that there were certain factors that aided assist administrators, teachers and school in the successful implementation of best practices (Ortega et al., 2012). The factors were as follows (Ortega et al., 2012):

- A committed teaching staff that is autonomous, motivated, empathetic, optimistic, and has the capacity to commit themselves and take on responsibilities.
- A stable leadership team in the school, capable of coordinating, innovating, achieving consensus, and being dynamic.
- The school's participation in innovation and improvement projects.
- Families' participation in school life.
- Coordination among teachers.
- A good student–teacher relationship, in an appropriate atmosphere.
- Principles of equity, equality, tolerance, and social justice are basic requirements for a best practice to be carried out. (p. 8)

One highly successful best practice, at all levels, is differentiated instruction primarily incorporating manipulatives during math instruction. Bender (2012) and Suanrong and Herron (2014) discussed similar ideas about and support toward the use of differentiated instruction to teach math concepts and skills. Bender suggested differentiated instruction was necessary for students to prosper academically. Suanrong and Herron maintained that differentiated instruction was an effective teaching method to meet diverse learners' specific academic needs, especially in math. The advancements of technology allow teachers to easily differentiate instruction to bolster students' academic success in math.

Computers and interactive smart boards are pieces of technology that are commonly found in today's classrooms. Computers and smart boards are used to incorporate VM during math instruction. A VM can best be described as computerized visual pictures of concrete objects that teachers and students manipulate to increase their competence of mathematical concepts beyond memorizing procedures and rules (Cooper, 2012; Moyer-Packenham et al., 2008). When students and teachers explore math concepts by creating virtual models that represent the math equations, this practice forces them to think about the concepts more deeply (Cooper, 2012). A national survey of conducted by Harris (2008) determined that

- over 50% of the teachers surveyed reported that using digital technologies has strongly influenced the ways they teach;
- nearly 80% thought computer use as an important component of success with regard to their communication, planning, and instruction;
- only 37% of the participants reported using computers with their students on a daily basis during math instruction. Similarly, the participants in this study agreed that the use of VM might positively impact student academic progress in math. (p. 18)

Another similarity between the participants in Harris's study and the participants in this study was the lack of district supports. Harris maintained that the participants decreased the use of technology during math instruction as a result of decreased in district funding and minimal to no PD that focused on using technology during math instruction.

Beside lacking the technology, such as computers, in the classroom, many of the participants believed that a lack of PD greatly impacted their use and efficacy of VM during math instruction. Few participants in this study had a computer in their classroom, and none had access to an interactive smart board. In many cases, incorporating PM is an alternative hands-on approach during math instruction when technology is not readily available.

Another differentiated instructional technique that math teachers use during instruction is the use of PM. Goldsby (2009) noted that applying the procedural analogy theory when using PM could assist students in understanding and developing the written systematic operations necessary to solve math problems. When students use PM during math instruction, students' gain a deeper understanding of math concepts and skills. Bouck, Satsangi, Doughty, and Courtney (2014) found that a high percentage of students with disabilities who used PM accurately and independently solve math problems. Through the use of PM, students expressed their understanding of math concept and skills. Through PD, teachers may increase self-efficacy in using manipulatives by applying learned best practices in order to enhance student learning outcomes in math.

## Summary

The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. A blended PD, entitled *Increasing Teachers' Understanding of Manipulatives to Enhance Math*

*Instruction* was developed after I gained insights on the possible answers to the central and subquestions. The findings of the data presented within this study determined that there is a need for PD that might increase self-efficacy, specifically on using manipulatives during math instruction. Literature on the project's genre was presented in the literature review, such as: face-to-face PD, virtual PD, hybrid PD, self-efficacy and PD, and productive PD. In addition, literature was presented on the content that might be addressed within a productive PD for math teachers: CCSS, shifts in math instruction, and best practices in math. Students at all levels might benefit from using manipulatives, provided they are instructed and implemented appropriately by the teachers (Goldsby, 2009). Through PD, teachers will be able to learn about instructional strategies and useful tools, such as manipulatives, that specifically target teaching students math (Coleman & Goldberg, 2010). Although there are a plethora of topics that could be discussed during a math related PD, the topics addressed within this literature review are designed to assist math teachers in increasing their understanding of CCSS as they relate to math standards and increase their perceived levels of self-efficacy in using PM and VM during math instruction.

## Implementation

The project will be a blended PD, entitled *Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction,* designed to increase teachers' perceived self-efficacy in the use of manipulatives during math instruction. To alter teachers' perceived sense of self-efficacy in using manipulatives during math instruction, quality

PD should be designed and implemented (Ruchti, Jenkins, & Agamba, 2013). When teachers attend quality PD, potential changes in teachers' instructional practices and attitude, such increased used of PM and VM, may lead to an overall improvement in student learning (Ruchti et al., 2013). In addition, a clearer understanding of the CCSS and using best practices that involve the use of manipulatives to teach math using the aligned standard will be promoted during the blended PD. The criteria and subsequent steps of the blended PD were determine based on the study's findings and review of relevant literature.

**Potential Resources and Existing Supports**

The resources for this PD include math specialists employed for the CDE and CSD1. The CDE has a math specialist who is required to know and understand state standards, shifts in instruction, and research-based instructional methods that support student achievement and learning in math. In addition, the CDE maintains a website (http://www.cde.state.co.us/comath) that math teachers of all levels can use to find resources regarding academic standards, family and community communication, curriculum support, Colorado mathematics, and instructional resources.

The school district, CSD1, also has an existing math specialist, the K-12 math coordinator. In addition, current CSD1 teachers have access to online resources located on the district website. Additional support materials and resources necessary to effectively conduct the PD will be supported by the district and individual schools. The support materials and resources that might assist the teachers during the PD include, but are not limited to: writing tools, technology, paper, CCSS in math handouts, PM and VM, and reflection log.

Additional existing supports include state and national teacher organizations. The teacher organizations, which are listed on the CDE website, are “designed to bring content, news and information to support quality mathematics education to educators in Colorado” (CDE, 2015). The teacher organizations listed include (CDE, 2015):

- National Council of Math Teachers
- Colorado Council of Math Teachers
- Colorado Mathematics Leaders
- Colorado Education Initiative STEM.

**Potential Barriers**

Potential barriers of this PD project are resistance to change instructional methods, resistance to using technology during math instruction, time and budget, and meeting a wide range of students’ needs in the classroom. Regardless of how many changes or what type of changes are made to federal and state educational standards, some teachers may remain resistant to changing their instructional methods. Many seasoned teachers believed that if their instructional methods for teaching math content and skills are successful and effective, then there is no need to change their instructional methods. When this is the case, teachers are less inclined, or resistant, to changing instructional methods. According to Musanti and Pence (2010), teachers’ resistance to change instructional methods is unavoidable regardless of the quality of PD. However, if changes in instructional methods in math are discussed in a positive manner and evoke a positive, collaborative PD experience, then teachers may explore the notions of, or accept, various way their instructional methods may be enhanced or changed.

With the advancements of technology and students' wide range of academic needs, using technology in the classroom is an invaluable asset to student learning. Staniger (2011) maintained that, "Improved changes in pedagogy could be accomplished using technology as a teaching and learning tool" (p. 19). However, another barrier of this project is teachers' resistance to using technology during math instruction. Teachers may feel less efficacious in their own skills, when compared to the students they teach. Regardless of the 21$^{st}$ century skills and standards that incorporate technology during instruction and quality PD with a technology component, specifically in math, teachers' may remain resistant to using technology during math instruction. This barrier might be overcome when teachers attend technology-enriched PD, such as a technology enriched instructional training for educators.

Teachers frequently use their personal finances to purchase items or training that may be necessary to compete those tasks. Another potential barrier of this project is time and budget. According to Masuda, Ebersole, and Barrett (2012), school districts should afford teachers time and a budget during the school year for high-quality PD. Teachers may find attending PD difficult because teacher PD days are scheduled during the school year in CSD1. In addition, with cuts in funding, teachers may find it difficult to afford resources recommended in the PD for the use in classroom implementation when using

PM and VM. This barrier might be overcome when teachers participate in PD using web-based platforms and commercially available learning management systems.

**Proposal for Implementation and Timetable**

The need for professional development focusing on math manipulatives was created based on the outcome of the findings of this study. CSD1's professional development is generally organized by the Director of Professional Development or administrative staff at each school. It is not yet determined whether CSD1 will mandate the proposed project deliverable developed from of this study, but there is a possibility of the project becoming a voluntary option for math teachers. If CSD1 decides to offer the project deliverable as a voluntary option, the Director of Professional Development will email PD registration information to middle school math teachers. This PD will follow a blended delivery format: face-to-face and distance learning environments. The goals of the face-to-face portion of the PD will be the following:

1. Teachers will begin to build a learning community around the use of manipulatives;
2. Teachers will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math;
3. Teachers will apply and analyze mathematical concepts using manipulatives; and

4. Teachers will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans.

In addition, teachers will understand the expectations of the distance learning portion the PD. The face-to face portion of the PD will begin at 8:00 am and conclude at 2:00 pm on a date that will be determined by CSD1.

The distance learning portion of the PD will include two modules over a 2-month time period. The goal of this section of the PD will be for teachers to successfully write and implement a lesson plan that incorporates manipulatives. Both distance learning modules will occur via a learning platform that supports asynchronous learning. Participants will initially access and view a Power Point presentation. After viewing the Power Point presentation, participants will have up to 3 weeks to develop and implement a lesson plan that will incorporate activities using manipulatives. Once the assigned tasks have been completed, participants will post reflections on thoughts, actions, and feelings about their instructional experiences and outcomes. The distance learning portion of the PD will also allow participants to share various experiences, such as successful or unsuccessful instructional methods, classroom activities using manipulatives incorporated within lesson plans, and reflections on thoughts, actions, and feelings about their instructional experiences and outcomes. Throughout a 4-week period, participants will read, respond, and reflect fellow participants’ discussion board posts are submitted. The PD facilitator will monitor and respond to the participants’ discussion board posts.

## Project Evaluation

Both formative and summative evaluations will be used during the blended PD. The insight gained from the formative evaluations will be used to monitor participants' learning and assist the facilitator in determining whether immediate changes and modifications should be made to improve the blended PD. The summative evaluations will be used to evaluate whether the participants have reached the goals during the blended PD. Summative evaluations will also provide formative information to guide the facilitator, CSD1, and stakeholders in making necessary modifications for subsequent PD for math teachers.

The overarching goal, increasing teachers' knowledge and understanding of developing lesson plans and implementing instructional methods that incorporate manipulatives, will be evaluated via formative and summative evaluations. The blended PD may be redesigned if the participants feel less efficacious in the use of manipulatives, based on the data gathered from the summative evaluation. If participants feel more efficacious in the use of manipulatives, the blended PD may be improved based on the data gathered from the summative evaluations.

The five auxiliary goals will contribute to achieving the overarching goal and will be evaluated using formative and summative assessments. The first goal will be evaluated through a formative evaluation and include observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other. During the introductions and ice breaker activity, the facilitator will observe the participants. Participants who are participatory, attentive, and relaxed during the introductions will be determined to have met the goal to meet and build a rapport with each other.

The second goal, teachers will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math, will be evaluated through summative and formative assessments. A summative assessment will used during the Pass the Standard and Madeline Hunter Lesson Plan activities. During the Pass the Standard activity, participants will be asked to collaborate with each other to analyze a math standard and determine the most effective instructional method incorporating manipulatives so that students make connections to the math concepts. Summatively, if the participants are able to analyze the math standard by determining the most effective instructional method incorporating manipulatives, the goal will be met. During the Madeline Hunter Lesson Plan activity, participants will begin to develop a lesson plan by choosing and aligning a standard in the CCSS. Summatively, if the participants are able to develop a completed lesson plan that includes manipulatives, then the goal will be met. Formatively, observations will be conducted during all activities to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

The third goal, teachers will apply and analyze mathematical concepts using manipulatives, will be formatively and summatively evaluated. Summatively, participants will be evaluated based on whether they are able to use manipulatives to complete each problem within the activities. All of the activities will be formatively evaluated through observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

The fourth goal, teachers will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans, will be evaluated through summative and formative evaluations. Summatively, the content of participants' responses to the following prompts will be evaluated: (a) Identify an instructional goal that involves using manipulatives; (b) How will you persevere through challenges that you might encounter?; (c) What is a positive message you might say to yourself to remind you of your capabilities in achieving your instructional goal? Formatively, participants will be evaluated through observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

The fifth goal, teachers will understand the expectations of the distance learning portion the PD, will be evaluated through formative evaluations. Formatively, participants' interactions (verbal and non-verbal communications and actions) with each other participants will be observed. In the next sections I will discuss the implications for social change as a result of implementing this project in the local district.

## Implications Including Social Change

### Local Community

The project presented in this study, a blended PD that focuses on manipulatives, was designed to addressed middle school math teachers’ perceptions of feeling less efficacious in using manipulatives. The overarching goal this project is to increase teachers’ knowledge and understanding of developing lesson plans and implementing instructional methods that incorporate manipulatives. Students are only contingent beneficiaries to academic achievement in mathematics in relation to teachers’ knowledge, skills, and PD. Although students may have previously obtained a foundation in math content, when teachers exhibit a deeper understanding of math concepts students’ may perform at higher levels. One way teachers’ knowledge, skills, and instructional methods may affect students’ academic achievement in mathematics is through quality PD.

Based on the findings in this study, quality PD and maintaining higher self-efficacy in the use of manipulatives as it related to math instruction were beneficial. However, teachers should possess a certain level of knowledge and understanding about how to use them effectively during math instruction, which increases self-efficacy in the use of math manipulative. In addition, based on the findings in this study, quality PD opportunities are one resource that may increase self-efficacy and effective implementation of math manipulatives. Therefore, this project is a valuable resource for math teachers.

**Far-Reaching**

In a larger context, the blended PD can be presented as a PD opportunity beyond CSD1. Developing a PD that specifically caters to self-efficacy related to inquiry-based instructional methods with manipulatives during math instruction may be meaningful to math teachers throughout the state of Colorado and beyond. Throughout the United States, there has been an overwhelming need to change the instructional methods and strategies during math instruction to better align with the 21st century skills and standards (Hill et al., 2005; National Council of Supervisors of Mathematics, 2013). Regardless of how teachers may feel about the use of manipulatives, using PM and VM may make a difference on the overall teaching and learning experiences during math instruction.

**Social Change**

The overall academic success of students, particularly in math, is an important component of the educational system. When teachers implement what they are taught during the project, social change can be realized. “When PD is appropriately applied, instruction balances knowledge and strategies in a way which increases learning and application of that knowledge” (Mundy, Howe, & Kupczynski, 2015, p. 118). For example, social change will occur when teachers’ self-efficacy increases and manipulatives are implemented during math instruction. Therefore, enhancing students’ math learning and assessment outcomes.

## Conclusion

In Section 3 of this study, I discussed the aspects of the project that were developed after gaining insight of middle school teachers’ perceptions of using manipulatives during math instruction. I discussed the description and goals, rationale, review or literature, implementation, and project evaluation of the project based on the data collected and analyzed within Section 2. Finally, I discussed the project’s implications including social change. In Section 4, I discuss the project’s strengths in addressing middle school math teachers’ use of manipulatives during instruction and discuss alternative approaches to address the problem. Finally, I reflect and self-analyze on what I learned about scholarship, project development, and leadership and change.

# Section 4: Reflections and Conclusions

## Introduction

The purpose of this bounded collective case study was to explore middle school teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives to teach math to middle school students. This qualitative project study was conducted to gain a deeper understanding of the teachers' beliefs, thoughts, and feelings of self-efficacy concerning the uses of manipulatives. The findings of the data showed that there was a need for professional development (PD) that increases self-efficacy, specifically on using manipulatives during math instruction. I therefore developed a blended PD program entitled *Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction* after I gained insights of middle school teachers' perceptions of using manipulatives during math instruction.

In this section of the study, I discuss the study's strengths in addressing middle school math teachers' use of manipulatives during instruction, such as: (a) incorporating hands-on activities, discussions, and technology, and (b) using the study as a resource to increase self-efficacy in the use and implementation of manipulatives during instruction. In addition, I recommend alternative approaches to address the problem, such as : (a) involving teachers in decisions involving changes in instructional methods, and (b) increasing self-efficacy through peer coaching. Finally, I reflect and self-analyze on what I learned about scholarship, project development, and leadership and change

## Project Strengths

One strength of the project is that it was designed to incorporate hands-on activities, discussions, and technology in a face-to-face environment. According to Mundy, Howe, and Kupczynski (2015), face-to-face PD is successful when hands-on activities, discussions, and technology are incorporated. PD opportunities that offer a face-to-face, collaborative environment will increase teachers' self-efficacy in using and implementing manipulatives during math instruction that may lead to increased effective instruction and an increase in students' standardized test scores throughout CSD1.

Another strength of this project is that it can be used as a resource for math teachers to increase self-efficacy in using and implementing manipulatives during instruction that may result in student success in math. This project is designed to minimize the struggle math teachers have faced with determining the most effective instructional method: procedural or actively engaging students using manipulatives (Bottge et al., 2015; Porter et al., 2011). Therefore, using this project as a resource has a potential for increasing both student achievement and standardized test scores in math.

## Project Limitations

One of the project's limitations in addressing the problem is the significant likelihood of participants resisting changing their instructional methods. According to Park and Jeong (2013), teachers are resistant to change instructional strategies regardless of federal and state educational reform. This resistance is a result of the time and commitment it might take to learn new instructional methods and develop new curricula or lesson plans, even if changing instructional methods will increase students' academic success in math (LeFevre, 2014; Park & Jeong, 2013). This aligned with the participants in this doctoral study stating that they felt less efficacious when manipulatives were used during math instruction, which increased their resistance to change instructional methods.

Another limitation of the potential project is a more general resistance to using technology during math instruction. Teachers are encouraged by administrators to incorporate technology during instruction of 21st century skills and standards. Yet, teachers are less experienced using technology when compared to their students (Walder, 2014). Participants in this study had the ability to request access to technology, but were more resistant to using technology due to a lack of PD focusing on implementing technology during instruction. When teachers lack technological supports, such as PD, from the school district they become more resistant to using technology regardless of availability (Walder, 2014).

A lack of available time is another potential issue. Teachers who participate in the blended PD will find that they lack the time to participate in PD and financial resources to implement manipulatives during math instruction. Masuda et al. (2012) suggested that school districts afford teachers the time and budget to participate in PD throughout the school year. When teachers are able to participate in PD instructional methods are improved, which increase student achievement in math. Regardless of research that supports an increase of budget and designated PD days for teachers, school districts such as CSD1 have been historically plagued with decreasing financial support.

## Recommendations for Alternative Approaches

Teachers, especially math teachers, should understand that change is an evident and unavoidable component of education that educational organizations have to endure in order to increase student learning and achievement (Terhart, 2013). One alternative approach to increasing teachers' self-efficacy in using manipulatives during math instruction is to allow the teachers to become more involved in decisions involving changes in instructional methods. Park and Jeong (2013) maintained, "Schools where teachers reported that their principals were well aware of the change process and the necessity of teacher participation in decision-making were found to experience more implementation success" (p. 35). Administrators within CSD1 are influential in the successful acceptance and implementation of instructional change among teachers (Park & Jeong, 2013). Resistance to changing instructional methods may be reduced or eliminated by maintaining a strong sense of collaboration with administrators, along with encouraging teachers to attend PD.

Another alternative approach to increasing teachers' self-efficacy in using manipulatives during math instruction is through peer coaching. Peer coaching improves teaching and increases student learning (Arslan & Ilin, 2013). Peer coaching in educational contexts typically occurs between seasoned and novice teachers. If teachers feel that they are a member of a highly-qualified, supportive cohort of math teachers, the implementation of certain instructional methods like those that incorporate technology might become less daunting.

## Scholarship

Scholarship is a process in which anyone, at any educational level, can participate. Scholarship begins with asking questions to identify a potential problem. For example, my project study began with an inquiry that I had after observing middle school math teachers not using manipulatives despite the potential benefits to student achievement. After an exhaustive search of assessment data and informal discussions with middle school math teachers, I was able to identify a problem within my local school district. After the problem is identified, scholarship involves researching relevant data and literature to support potential solutions to the problem. My project was a result of relevant, current, peer-reviewed literature and data that I gathered and analyzed. I learned that scholarship is a process that begins as an independent inquiry to a problem that, over time, may develop into potential solutions.

## Project Development and Evaluation

It was important that I remained well organized during the development of my project. One organizational technique that I used was initially writing down the goals I would like the participants to achieve during the implementation of the project. As I acquired more information, I was able to develop and refine those goals. Aligning my goals, the research study's problem, and review of peer-reviewed literature addressing the project, increased the credibility of the project and provided evidence in order to understand why aspects of the project were developed. Maintaining a systematic process allowed me to reflect on each stage of the project during the development process. As a project developer, I learned that my review of relevant, current, peer-reviewed literature assisted me in determining whether the goals would be achieved by the participants. In addition, I learned that the formative and summative evaluations of aspects of my project should be specifically and explicitly discussed. As the developer of this project, it is important to determine whether participants achieved each goal and to what extent.

## Leadership and Change

I learned that leadership means being open and willing to change, as noted by Ferreira, Ryan, and Davis (2015). Although one person may be considered the leader, change cannot be accomplished alone. When multiple people share a passion and scholarship toward improving teacher and student outcomes in an educational system, they are committed to spending the amount of time it might take to achieve the desired change (Ferreira et al., 2015).

During each stage in the project study process, I have learned that becoming an efficient leader starts with being able to collaborate with seasoned individuals about various how to best reach a desired outcome. With respect to this project study, I listened to the members of my doctoral committee and asked for guidance when I was in need. Prior to this project study, I considered myself to be an independent individual who could figure out solutions without seeking the guidance of others. Throughout this project study I learned that asking for help does not expose a person's incoherencies; rather, asking for help promotes positive leadership and change. The support I had from stakeholders in the school district (administrators, principals, and teachers) assisted me in completing this project study. The development of the project allowed me to become a leader of the change that might occur among all stakeholders as a result of its implementation.

## Analysis of Self as Scholar

Developing this project from the findings of my study allowed me to observe that the journey to becoming a scholar begins with a desire to change lives and provide students with tools to become the next generation of successful thinkers and problem-solvers. Throughout my career, I have made conscience efforts to collaborate with administrators and fellow educators to determine effective and efficient ways to provide students with the high-quality education that they expect and deserve. This doctoral experience presented opportunities to develop my scholarly approach and skills of expertise. I refined scholar-practitioner skills, such as data analysis, critical analysis of information, as well as writing in a professional scholarly manner.

This project study taught me to explore issues in a systematic manner from the lens of a scholar, student, teacher, and researcher. Through those lens, I demonstrated scholarship during the development of my project study and extensive research on the problem I chose to explore. With each article I read, I was left with more questions that needed to be answered. As a result of the information I found during my review of relevant literature on the problem, my PD project was developed.

I demonstrated scholarship through the development of a blended PD that combined each major components of this project study (problem, research, and findings). I have developed a unique project that has a practical purpose and is derived from an actual phenomena. I can evaluate my project through a critical eye to determine the strengths, limitations, and whether the overarching goals were achieved to determine alternative approaches that might resolve the problem stated in my project study.

## Analysis of Self as Practitioner

As a practitioner in the educational realm, I grew in my ability to improve my instructional methods to promote change and scholarship in the classroom. Throughout the development of the project, I often reflected on my instructional methods to determine whether goals and learning outcomes were met by each student. I grew in my ability to develop and implement lesson plans through the lens of a scholar, teacher, student, and researcher. Additionally, I developed my ability to assist administrators and teachers to determine educational goals and instructional strategies using research-based strategies. With a better understanding of scholarship, developing the project allowed me to appreciate the tools and resources Walden University provided and strive for others to promote positive social change based on the findings of my study.

## Analysis of Self as Project Developer

As a teacher, I explore different opportunities that evoke positive learning experiences. However, this is the first time I have developed a project for this of this magnitude. However, I am familiar with using the theory of andragogy to determine activities during my classroom instruction. My students are adults who wish to obtain a General Education Diploma (GED). Considered at-risk, retention was a critical factor in determining my success as a teacher. Prior to this project, I felt that creating activities as the lesson progressed instead of following a systematically developed lesson plans improved the retention that might be reflected in my students' academic achievement. Now, I take the necessary time to methodically think about, research, and develop my lesson plans to support academic achievement before student retention.

The project was developed using the theory of andragogy, which was a familiar process. However, the project was not based on a preexisting curricula. Rather, extensive research on best practices and theoretical frameworks was used to support the development of the project to help me hone my skills as a project developer.

## Reflection on the Importance of the Work

The development of a project that specifically catered to self-efficacy using manipulatives during math instruction and incorporating manipulatives in lesson plans is important for math teachers in an effort to increase student achievement. Students throughout the United States have struggled in becoming proficient in math concepts and skills. Hence, there is an overwhelming need to change the instructional methods and strategies during math instruction to better align with 21st century skills and standards.

The participants within this study felt less efficacious in using manipulatives during math instruction; therefore, suggesting there is a need for PD focusing on increasing teachers' self-efficacy using manipulatives and incorporating manipulatives in lesson plans. All the participants in this study agreed that using manipulatives may increase students' achievement in math. The project is important because those who participate in the PD will become more efficacious in using manipulatives and incorporating activities using manipulatives in their lesson plans, which can promote positive learning environments.

## Implications, Applications, and Directions for Future Research

### Impact on Social Change

The education system is a fluid process of change (Ferreira et al., 2015); however, the mission and vision remain constant -- the overall academic success of students. Teachers that interact with each other may improve the overall PD experience (Hochberg & Desimone, 2010). Hochberg and Desimone (2010) maintained that teachers who participate in PD are educators who focus on improving their instructional practices and gaining a better understanding of how to align standards to meet the needs of diverse student populations. As a result, the project developed in this study offers teachers an opportunity to increase their PD experience to enhance their instructional practices, which may increase student academic achievement. Positive social change at the local level can occur through the project developed in this study. The project can enhance teachers' perceived self-efficacy in using manipulatives, which may increase students' learning and assessment outcomes in math.

### Directions for Future Research and Applications

Future research may expand the scope of this project to determine whether the PD increased teachers' perceived sense of self-efficacy. In addition, follow-up research can be conducted to determine if activities incorporating manipulatives, post hoc PD, actually increased student achievement and growth. I would also recommend that further research be conducted on whether teachers' lesson plans were aligned and grounded in best practices post hoc PD. Finally, research can be conducted to determine whether the collaborative, hands-on learning format of the PD was effective. If the format is determined to be effective, then other PD can be similarly structured to promote effective learning environment that evokes an increase in student outcomes.

## Conclusion

Within Section 4 of this study, I discussed the project's strengths, limitations, and alternative approached. Finally, I reflected and self-analyzed on what I learned about scholarship, project development, and leadership and positive social change. During my journey through the doctoral process, I renewed my views of scholarship and social change. I have used scholar, teacher, student, and researcher lens to develop my skills as a practitioner. Although I welcome the end of my doctoral journey, I will encounter subsequent events in my career with a renewed efficacy in applying the skills I have learned in an effort to promote social change.

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Appendix A: Project Study

## Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction

### Purpose and Goals

The development and implementation of the Common Core State Standards (CCSS) required teachers to shift from procedural instructional methods to methods that use manipulatives, which provide students with deeper conceptual understanding of math concepts and skills. Educational reforms, such as the CCSS, enhance teaching, student learning, and overall fairness among the educational systems as a whole. However, there have been minimal PD opportunities for math teachers employed in CSD1 to increase perceived self-efficacy in shifting to instructional methods where manipulatives are used. As a result, I have developed a blended PD with an overarching goal of increasing teachers' knowledge and understanding of developing lesson plans and implementing instructional methods that incorporate manipulatives.

This PD will follow a blended delivery format: face-to-face and distance learning environments. The goals of the face-to-face portion of the PD will be the following: (a) participants will begin to build a learning community around the use of manipulatives; (b) participants will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math; (c) participants will apply and analyze mathematical concepts using manipulatives; (d) participants will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans; and

(e) participants will understand the expectations of the distance learning portion the PD. The face-to face portion of the PD will begin at 8:00 am and conclude at 2:00 pm on a date that will be determined by CSD1.

The distance learning portion of the PD will include two modules over a 2-month time period. The goal of the distance learning portion of the PD will be for teachers to successfully write and implement a lesson plan that incorporates manipulatives. The distance learning portion of the PD will also allow participants to share various experiences, such as successful and unsuccessful instructional methods, classroom activities using manipulatives incorporated within lesson plans, and reflections on thoughts, actions, and feelings about their instructional experiences and outcomes. Both distance learning modules will occur via a learning platform that supports asynchronous learning. Participants will initially access and view a Power Point presentation. After viewing the Power Point presentation, participants will have up to 3 weeks to develop and implement a lesson plan that will incorporate activities using manipulatives. Once the assigned tasks have been completed, participants will post reflections on thoughts, actions, and feelings about their instructional experiences and outcomes. Throughout a 4-week period, participants will read, respond, and reflect on fellow participants' responses as discussion board posts are submitted.

**Target Audience**

The primary target audience for this PD will be middle school math teachers employed within CSD1. As the PD develops, the audience may be broadened to provide an opportunity for all math teachers employed within CSD1 and surrounding school districts who may see a need for their math teachers to attend a PD that focuses on increasing perceived self-efficacy using manipulatives during math instruction.

**Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction**

**Face-to-Face Timeline**

- Goal 1: Teachers will begin to build a learning community around the use of manipulatives. (20 minutes)

    Participant Introductions and Ice Breaker (20 minutes)

        Name, school, years teaching, current grade level

        Marooned Island Activity

- Goal 2: Teachers will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math. (1 hour 30 minutes)

    Assumptions, feelings, and thoughts about CCSS and lesson planning writing activity (20 minutes)

    Lecture and Power Point (30 minutes)

    Pass the standard activity (30 minutes)

    Madeline Hunter Lesson Plan activity (10 minutes)

**Break (15 minutes)*

- Goal 3: Teachers will apply and analyze mathematical concepts using manipulatives. (2 hours 10 minutes)

    Group discussion (30 minutes)

    Tangram activity (40 minutes)

    Algebra tiles activity (40 minutes)

    Geometric shapes activity (10 minutes)

**Lunch on your own (1 hour)*

- Goal 4: Teachers will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans. (25 minutes)

  Self-esteem vs. self-efficacy (5 minutes)
  "I think I can" activity (20 minutes)

- Goal 5: Teachers will understand the expectations of the distance learning portion the PD. (20 minutes)

  Introduction to Blackboard (10 minutes)

  Discussion on distance learning format and expectations (10 minutes)

- Closure (10 minutes)

  Assumptions, feelings, and thoughts about CCSS and lesson planning writing activity (10 minutes)

**Increasing Teachers' Understanding of Manipulatives to Enhance Math Instruction**

**Face-to-Face Activities**

- Goal 1: Teachers will begin to build a learning community around the use of manipulatives.

  **Participant Introductions:**

  - Facilitator will welcome participants and ask each one to answer the following questions:

    What is your name?

    Where do you currently teach?

    How many years have you been teaching?

    What grade level do you currently teach?

    Why did you become a math teacher?

  **Ice Breaker:**

  - (Marooned Island Activity): Facilitator will ask each participant to answer the following question: If you were marooned on an island, what are three items and/or people you would bring with you?

  **Evaluation:**

  - Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

- Goal 2: Teachers will demonstrate knowledge of CCSS curriculum in math and how to develop lesson plans that incorporate the use of manipulatives to increase student knowledge and skills in math. (1 hour 30 minutes)

  **Assumptions, feelings, and thoughts about the CCSS and lesson planning, writing activity:**

  Purpose: The purpose of this writing activity is for participants to reflect on current assumptions, feelings, and thought about the CCSS and lesson planning.

  - Facilitator will ask each participant to think about and write down any assumptions, feelings, and thoughts about the CCSS and lesson planning.

  **Evaluation:**

  - Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

  "**Pass the standard" activity:**

  Purpose: The purpose of this activity is for participants to analyze a math standard and determine the most effective instructional methods so that students make connections to the math concepts. Participants will be able to collaborate and learn from each other.

  - Directions:

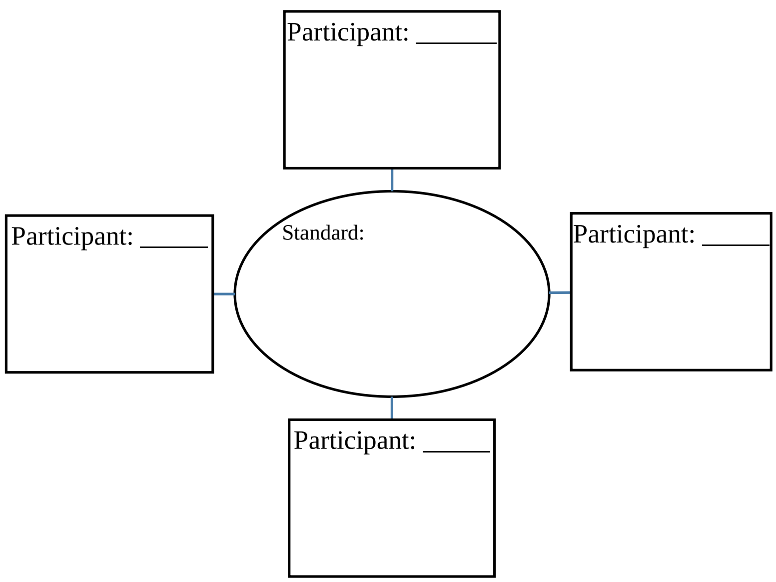
    Step 1: Ask participants to sit in groups of four.

Step 2: Hand one envelope to each group. (Each envelope will have one math standard inside.)

Step 3: One participant will write the standard in center circle of the paper.

Step 4: Each participant will write an activity and/or instructional method incorporating manipulatives you might include in a lesson targeting this standard.

Step 5: Each participant will pass the standard to the person on your right. The next person will write a new activity and/or instructional method to the chart.



**Evaluation:**

- Summative: The content and instructional methods will be analyzed.
- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

**Madeline Hunter Lesson Plan activity:**

Objective: Participants will begin to develop a lesson plan by choosing and aligning a standard in the CCSS.

- Directions: Hand out CCSS, per grade level, and Madeline Hunter lesson plan template to each attendee.
- Facilitator: Please sit in groups of 3-4, per grade level. During this activity you will choose one standard from the CCSS. After you have chosen one standard, you will fill-out the applicable sections of the Madeline Hunter lesson plan within the template. You will continue to develop your lesson plans over the next couple of months.

Lesson Title: Madeline Hunter Lesson Plan Activity

Subject: Aligning CCSS and Colorado Academic Standards

Grade: 6th, 7th, 8th

| | |
|---|---|
| **Standard(s)** | • Participants will gain a better understanding of how to develop a lesson plan. |

| | |
|---|---|
| | • Participants will align CCSS and Colorado Academic Standards to their instructional methods.<br>• Participants will begin to develop a lesson plan as part of their daily classroom instruction. |
| **Materials & Resources** | Madeline Hunter lesson plan template<br>Pen or pencil<br>CCSS and Colorado Academic Standards |
| **Anticipatory Set-up** | Participants will use prior knowledge of building a lesson plan. |
| **Objective(s)** | • Participants will begin to develop a lesson plan by choosing and aligning a standard within the CCSS and Colorado Academic Standards. |
| **Input** (What do students already know?) | • Participants should already know how to develop lesson plans.<br>• Participants should already know how to align lesson plans to CCSS and Colorado Academic Standards.<br>• Participants should already know how to implement lesson plans during math instruction. |
| **Model** (How will you demonstrate concept or skill?) | Participants will be able to view facilitator's lesson plan as an example. |

| | |
|---|---|
| **Check for Understanding** | After viewing the Power Point presentation during the distance learning portion of the training, participants will have no longer than 3 weeks to develop and implement a lesson plan that will incorporate activities using manipulatives. |
| **Guided Practice** | Lesson plan activity using Madeline Hunter's lesson plan template. |
| **Closure** | Facilitator will close the activity and group discussion by stating some benefits of developing a lesson plan that aligns with CCSS and Colorado Academic Standards. |
| **Independent Practice** | Lesson plan activity using Madeline Hunter's lesson plan template. |

**Lesson plan template:**

Name: _______________ Subject: ________________

Grade: _______________ Unit: _________________

Lesson Title: _________________________

| | |
|---|---|
| **Standard(s)** | |
| **Materials & Resources** | |
| **Duration** | |
| **Anticipatory Set-up** | |
| **Objective(s)** | |
| **Input** (What do students already know?) | |
| **Model** (How will you demonstrate concept or skill?) | |
| **Check for** | |

| | |
|---|---|
| **Understanding** | |
| **Guided Practice** | |
| **Closure** | |
| **Independent Practice** | |

*Note.* Not all steps may be present in every lesson plan. It is not a rigid formula. It is intended to guide thinking about what may be necessary within a particular lesson or activity. Sometimes it may take more than one class period to complete all of the necessary suggested instruction and activities.

**Evaluation:**

- Summative: The content and instructional methods will be analyzed.
- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

- Goal 3: Teachers will apply and analyze mathematical concepts using manipulatives.

  Overarching Learning Objective: Participants will gain a deeper understanding of how to use and incorporate manipulatives into daily lesson plans.

  **Whole group discussion:**

  - The facilitator will initiate the whole group discussion with a series of prompts:

    What standard did you chose? Why?

    What activity did you chose to align with the standard? Why?

**Evaluation:**

- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

Lesson Title: Hands-on PM activities

Subject: Mathematics

Grade: 6th, 7th, 8th

| | |
|---|---|
| **Potential Student Standard(s)** | **6th Grade:**<br>CCSS.Math.Content.6.NS.A.1; CCSS.Math.Content.6.NS.B.2;<br>CCSS.Math.Content.6.NS.B.3; CCSS.Math.Content.6.NS.B.4;<br>CCSS.Math.Content.6.NS.C.5; CCSS.Math.Content.6.NS.C.6;<br>CCSS.Math.Content.6.NS.C.7; CCSS.Math.Content.6.NS.C.8;<br>CCSS.Math.Content.6.EE.A.1; CCSS.Math.Content.6.EE.A.2;<br>CCSS.Math.Content.6.EE.A.3; CCSS.Math.Content.6.EE.A.4;<br>CCSS.Math.Content.6.EE.B.5; CCSS.Math.Content.6.EE.B.6;<br>CCSS.Math.Content.6.EE.B.7; CCSS.Math.Content.6.EE.B.8;<br>CCSS.Math.Content.6.EE.C.9; CCSS.Math.Content.6.G.A.1;<br>CCSS.Math.Content.6.G.A.2; CCSS.Math.Content.6.G.A.3;<br>CCSS.Math.Content.6.G.A.4<br>**7th Grade:**<br>CCSS.Math.Content.7.NS.A.1; CCSS.Math.Content.7.NS.A.2;<br>CCSS.Math.Content.7.NS.A.3; CCSS.Math.Content.7.EE.A.1;<br>CCSS.Math.Content.7.EE.A.2; CCSS.Math.Content.7.EE.B.3;<br>CCSS.Math.Content.7.EE.B.4; CCSS.Math.Content.7.G.A.1;<br>CCSS.Math.Content.7.G.A.2; CCSS.Math.Content.7.G.A.3;<br>CCSS.Math.Content.7.G.B.4; CCSS.Math.Content.7.G.B.5;<br>CCSS.Math.Content.7.G.B.6<br>**8th Grade:** |

| | |
|---|---|
| | CCSS.Math.Content.8.NS.A.1; CCSS.Math.Content.8.NS.A.2;<br>CCSS.Math.Content.8.EE.A.1;CCSS.Math.Content.8.EE.A.2;<br>CCSS.Math.Content.8.EE.A.3; CCSS.Math.Content.8.EE.A.4;<br>CCSS.Math.Content.8.EE.B.5; CCSS.Math.Content.8.EE.B.6;<br>CCSS.Math.Content.8.EE.C.7; CCSS.Math.Content.8.EE.C.8 |
| **Materials & Resources** | Pen or Pencil<br>**Tangram Activity:** Tangram template, scissors<br>**Algebra Tiles Activity:** Algebra tiles template, scissors<br>**Geometric Shapes Activity:** Cube template, scissors, scotch tape, ruler |
| **Anticipatory Set-up** | **Tangram Activity:** Participants will watch a video on tangrams, and cut their own tangram to use during the activity.<br>**Algebra Tiles Activity:** Participants will watch a video on algebra tiles, and cut their own algebra tiles to use during the activity.<br>**Geometric Shapes Activity:** Participants will cut and build their own cube to use during the activity. |
| **Objective(s)** | **Overarching:**<br>Participants will gain a deeper understanding of how to use and incorporate PM into lesson plans and daily math instruction.<br>**Tangram Activity:**<br>Participants will increase their understanding of how to use tangrams to learn fractions.<br>**Algebra Tiles Activity:** |

| | |
|---|---|
| | Participants will learn how you can use algebra tiles to learn about adding and subtracting integers and solving equations with x-variable.<br>**Geometric Shapes Activity:**<br>Participants will learn how you can use algebra tiles to learn about adding and subtracting integers and solving equations with x-variable. |
| **Input** (What do students already know?) | Participants will already possess procedural knowledge and understanding of how to approach each math problem. |
| **Model** (How will you demonstrate concept or skill?) | Facilitator will model one problem using the applicable manipulatives for each activity to use as a guide for participants.<br>Participants will be able to view facilitator's lesson plan as an example. |
| **Check for Understanding** | Participants will incorporate a PM activity within their lesson plans. |
| **Guided Practice** | Tangram Activity, Algebra Tiles Activity, Geometric Shapes Activity, Lesson Planning Activity |
| **Closure** | Facilitator will close the activity and group discussion by stating some benefits of incorporating PM into lesson plans for daily math instruction. |
| **Independent Practice** | Tangram Activity, Algebra Tiles Activity, Geometric Shapes Activity, Lesson Planning Activity |

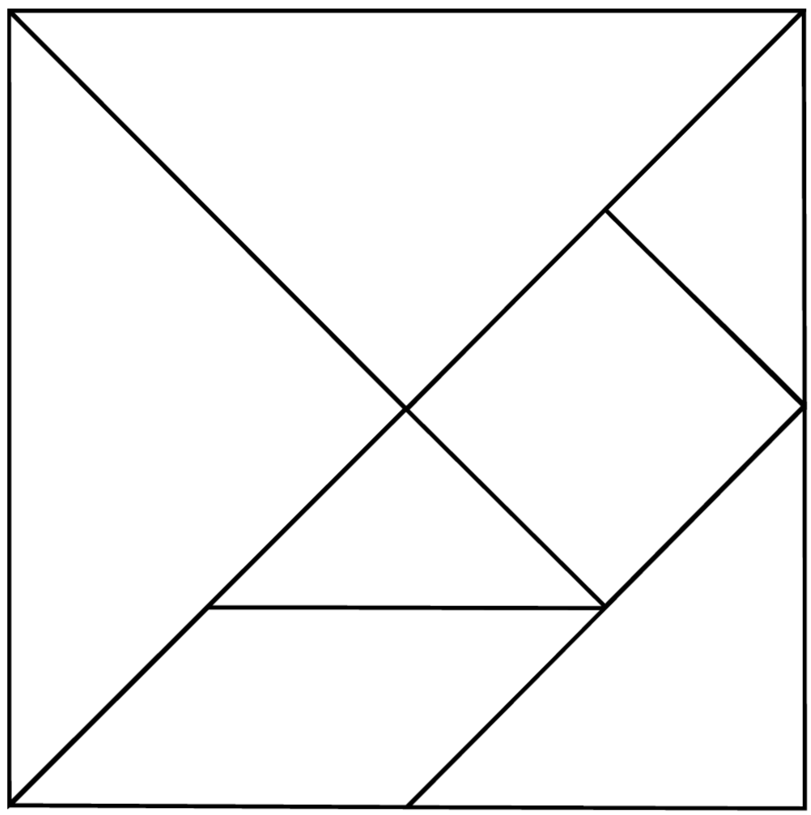
**Tangram activity:**

Learning Objective: Participants will increase their understanding of how to use tangrams to learn fractions.

- Directions: Hand out tangram template and scissors.
- Facilitator: Please cut out the tangram along the solid black lines so that you have seven shapes (1 square, 1 parallelogram, 1 medium triangle, 2 large triangles, 2 small triangles). You will use your manipulatives during the next two activities. As you can see, it is easy for your students to make their own manipulatives to use during class or at home.

# Tangram Template

**Print out onto card and cut very carefully along the lines to separate the seven pieces.**

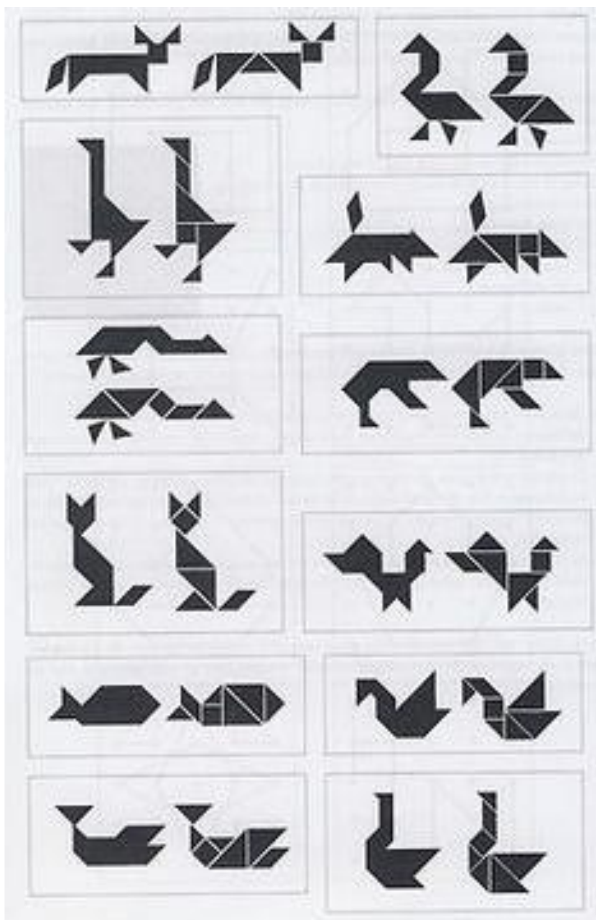


http://winnetka36.org/sites/default/files/5/TangramTemplate.pdf

**Tangrams: Fun Warm-up Activity**

Learning Objective: Participants will become comfortable using tangrams in a fun and interactive way.

- Directions: Once participants cut their tangrams. Facilitator will use an overhead projector to display the shapes, covering the solutions.
  - Facilitator: Can you make any of these shapes?



https://s-media-cache-ec0.pinimg.com/236x/0f/89/50/0f8950e45c2132d32b3543198ed48ce3.jpg

**Evaluation:**

- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

**Tangrams (Fractions Activity):**

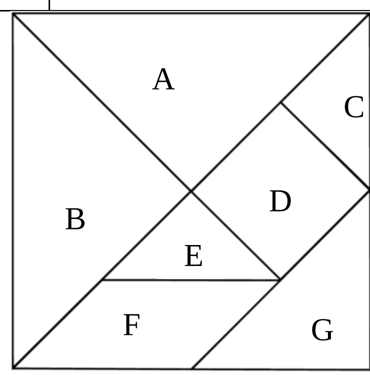
Learning Objective: Participants will complete one activity using tangrams to solve fractions.

- Directions: Hand out fractions activity worksheet. Allow participants to work independently on fractions activity using tangrams. After time has lapsed, participants will watch a video about tangrams (https://www.youtube.com/watch?v=-u2ZqIpTdIw).
    - Facilitator: Please take no more than 20 minutes to complete the fraction activity worksheet using your tangram.

Activity Questions:

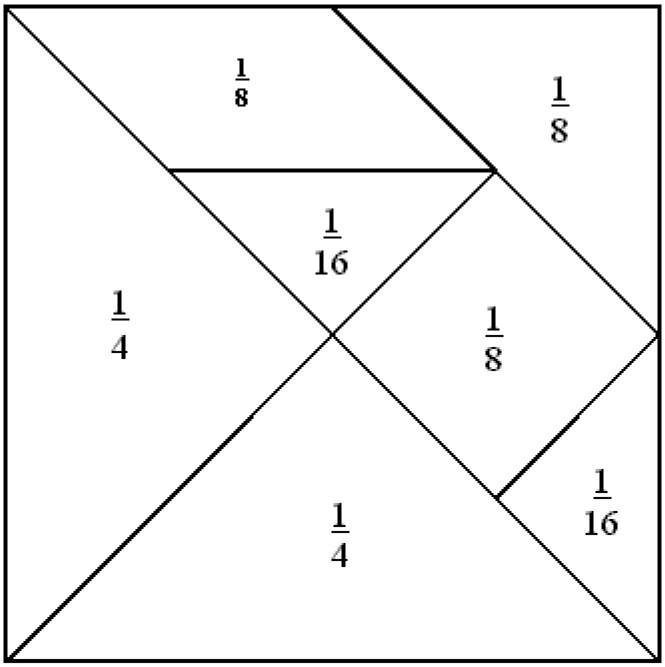
1. If the whole tangram equals 1, what fraction does each shape represent?
2. If the square piece (D) equals 1, what fraction does each shape represent?

| | Tangram = 1 | Square (D) = 1 |
|---|---|---|
| SMALL TRIANGLES (C, E) | | |
| MEDIUM TRIANGLE (G) | | |
| LARGE TRIANGLES (A, B) | | |
| SQUARE (D) | | 1 |
| PARALLELOGRAM (F) | | |



Solutions:

1. Watch video about tangrams (https://www.youtube.com/watch?v=-u2ZqIpTdIw).




2. A= 4  times ½ = 2

   B= 4 times ½ = 2

   C= ½

   D= 1 (Given)

   E= ½

   F= 2 times ½ = 1

   G= 2 times ½ = 1

**Evaluation:**

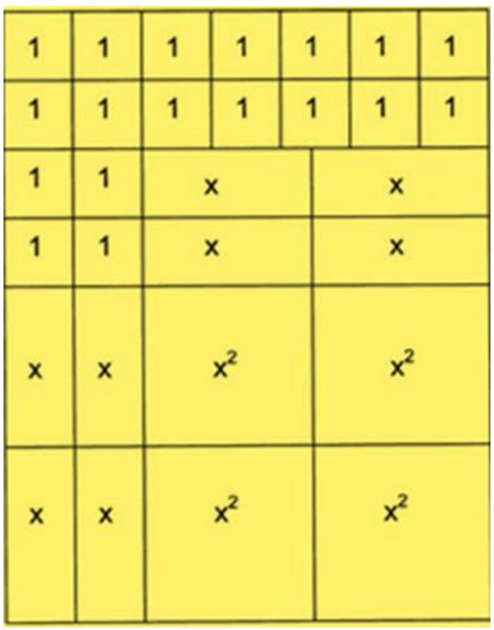
- Summative: Participants will be evaluated based on whether they are able to use manipulatives to complete each problem.

- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

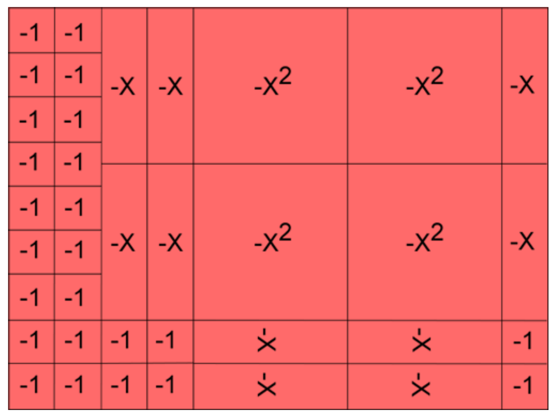
**Algebra Tiles:**

Learning Objective: Participants will learn how to use algebra tiles during one activity to add and subtract integers to solve equations with an x-variable.

- Directions: Hand out algebra tiles template and scissors.
- Facilitator: Please cut out the algebra tiles to use during this activity. The yellow tiles represent positive numbers and variables, and the red tiles represent negative numbers and variables.




**(YELLOW)**




**(RED)**

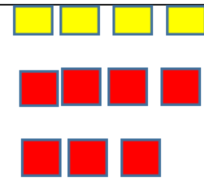
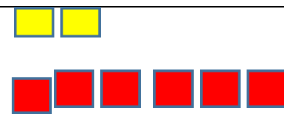
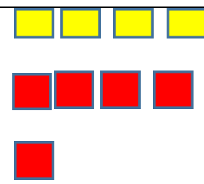
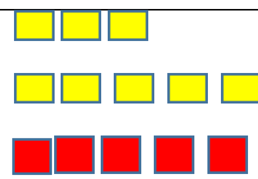
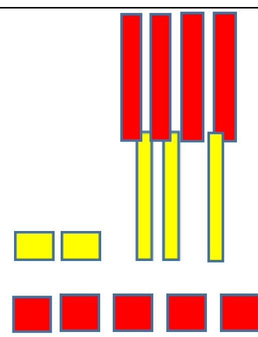
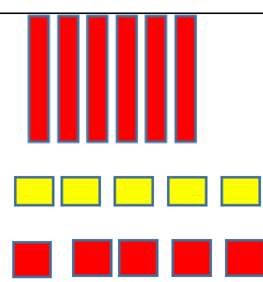
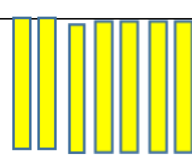
http://mathbits.com/MathBits/AlgebraTiles/AlgebraTiles/data/images/img14.jpg

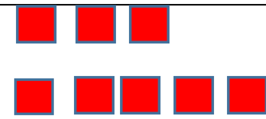
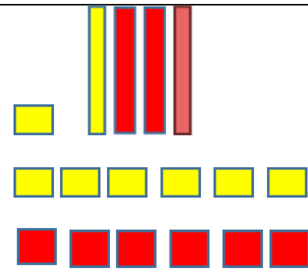
**Algebra Tiles Activity:**

- Directions: Watch video about algebra tiles (http://mathbits.com/MathBits/AlgebraTiles/AlgebraTiles/AlgebraTiles.html).
- Facilitator: Now that you have watched the video on algebra tiles, please work independently no more than 20 minutes to solve math equations within the worksheet using algebra tiles. Column 1 is the math equation. Column 2 where you are to model (draw) the algebra tiles that you used to solve the math equations. Column 3 is where you write the answer.

| Math Equations | Model the Algebra Tiles Used | Answer |
|---|---|---|
| 1. 4 – 7 | | |
| 2. -6 + 2 | | |
| 3. 4 + -5 | | |
| 4. 8 – 5 | | |
| 5. 3x + 2 – 4x – 5 | | |
| 6. -2x + 5 – 4x - 5 | | |
| 7. 4x – 8 + 3x | | |
| 8. -3x + 7 + x – 6 | | |

Solutions:

| | | |
|---|---|---|
| 1. 4 – 7 |  | - 3 |
| 2. -6 + 2 |  | - 4 |
| 3. 4 + -5 |  | - 1 |
| 4. 8 – 5 |  | 3 |
| 5. 3x + 2 – 4x – 5 |  | - x – 3 |
| 6. -2x + 5 – 4x - 5 |  | - 6x |
| 7. 4x – 8 + 3x |  | 7x – 8 |

| | | |
|---|---|---|
| |  | |
| 8. -3x + 7 + x – 6 |  | - 2x + 1 |

**Evaluation:**

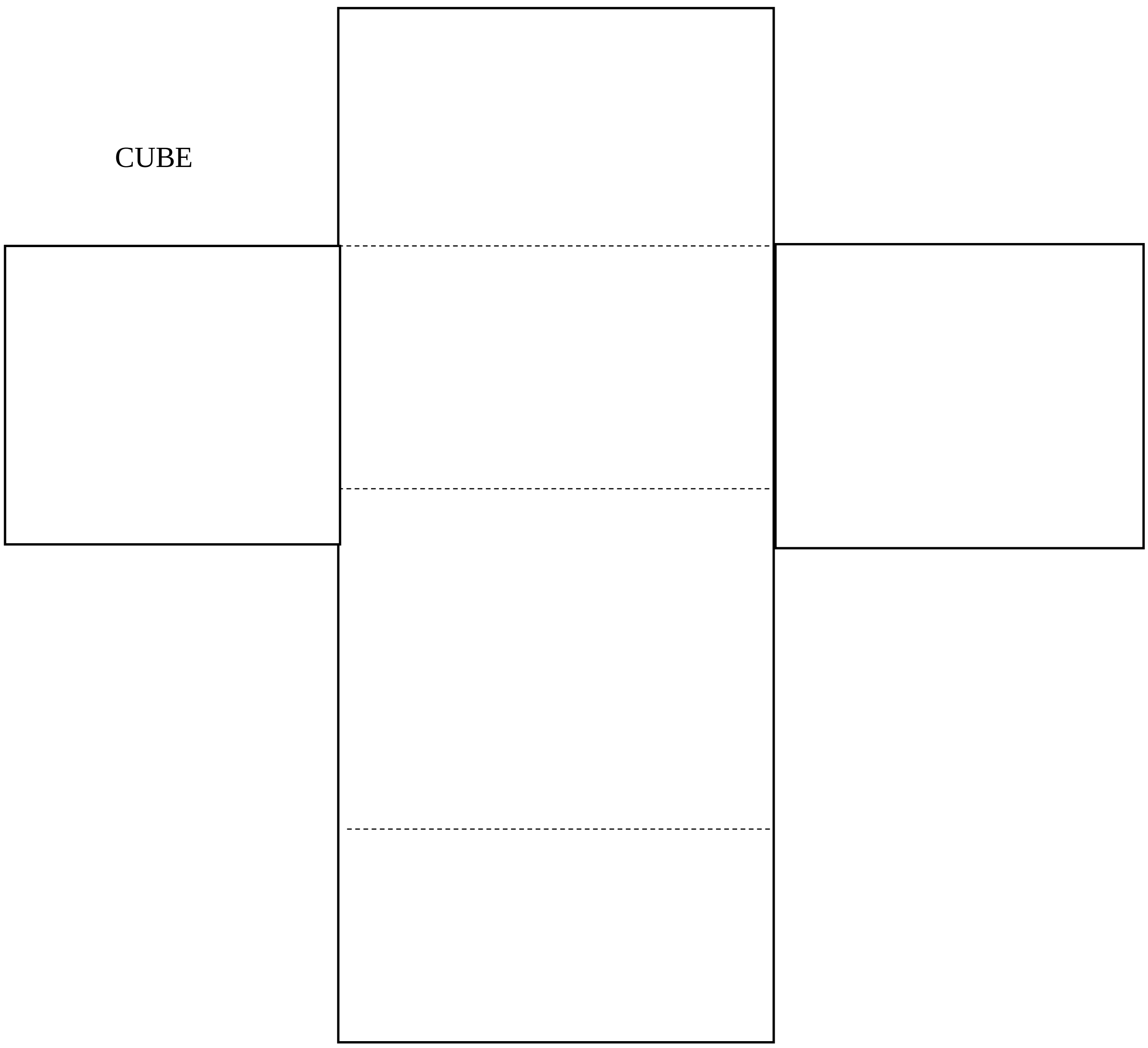
- Summative: Participants will be evaluated based on whether they are able to use manipulatives to complete each problem.
- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

**Geometric Shapes (Cube):**

Learning Objective: Participants will learn how you can use one geometric shape (cube) to calculate geometric formulas.

- Directions: Hand out geometric shape template of a cube, scissors, scotch tape, and ruler.
- Facilitator: Please cut out and build the cube from the template. You will use this manipulative during this activity.

CUBE



**Geometric Shapes Activity:**

- Directions: Once participants cut out the cube from the template, have the participants follow the steps below. Read each step to participants.
- Facilitator: Please complete each step.
- Directions:

Step 1: Build the cube.

Step 2: Measure the cube.

Step 3: Find area of one side. (area = side$^2$)

Find volume of a cube. (volume = side$^3$)

Find perimeter of a cube. (perimeter = 12 x side)

Find surface area of a cube. (SA = 6 x side$^2$)

Solutions: Answers may vary depending on measurements.

**Evaluation:**

- Summative: Participants will be evaluated based on whether they are able to use manipulatives to complete each problem.
- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

- Goal 4: Teachers will increase perceived sense of self-efficacy in using manipulatives through the creation and application of lesson plans.

  Purpose: The purpose of this activity is to identify instructional strengths and determine how to combine the instructional strengths and manipulatives into daily instruction.

  **“I think I can…” Activity:**

  - Facilitator will ask participants to answer the following questions:

    Identify an instructional goal that involves using manipulatives.

    How will you persevere through challenges that you might encounter?

    What is a positive message you might say to yourself to remind you of your capabilities in achieving your instructional goal?

**Evaluation:**

- Summative: The content of the participants’ responses will be evaluated.
- Formative: Facilitator will use observations to determine the amount of participants’ interactions (verbal and non-verbal communications and actions) with each other.

- Goal 5: Teachers will understand the expectations of the distance learning portion the PD.

  **Discussion on distance learning format and expectations**:

  - Participants will be given URL information, the format, and expectations.

URL information: Each participant will be emailed an invitation that will contain a link to the Blackboard course.

Participants will initially access and view a Power Point presentation.

After viewing the Power Point presentation, participants will have no longer than 3 weeks to develop and implement a lesson plan that will incorporate activities using manipulatives.

Once the assigned tasks have been completed, participants will post your lesson plans and reflections on thoughts, actions, and feelings about their instructional experiences and outcomes.

Throughout a 4 week period, participants will read, respond, and reflect fellow participants' as discussion board posts are submitted.

**Evaluation:**

- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

- Closure

**Assumptions, feelings, and thoughts about the CCSS and lesson planning, writing activity:**

Purpose: The purpose of this writing activity is for participants to reflect on current assumptions, feelings, and thoughts about the CCSS and lesson planning.

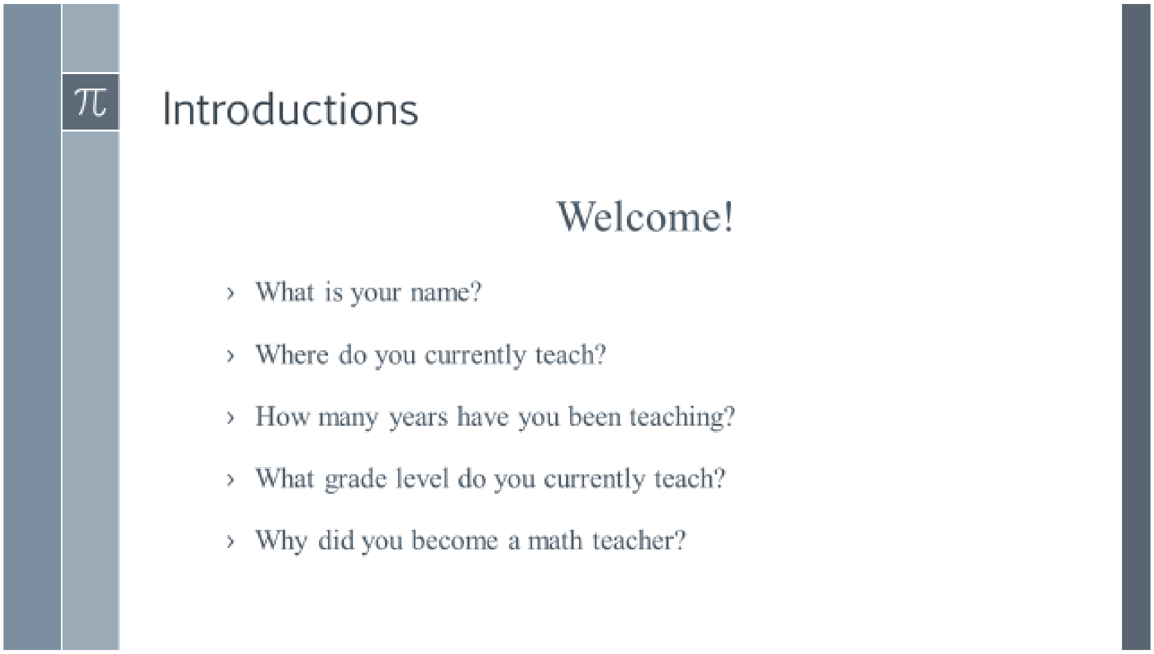
Participants will compare current assumptions, feelings, and thoughts with what they wrote at the beginning of the professional development.

- Facilitator will ask each participant to think about and write down any assumptions, feelings, and thoughts about the CCSS and lesson planning.

**Evaluation:**

- Summative: Participants will be evaluated based on whether their perceptions changed during the face-to-face portion of the blended PD.
- Formative: Facilitator will use observations to determine the amount of participants' interactions (verbal and non-verbal communications and actions) with each other.

**Power Point: Face-to-Face PD Session**

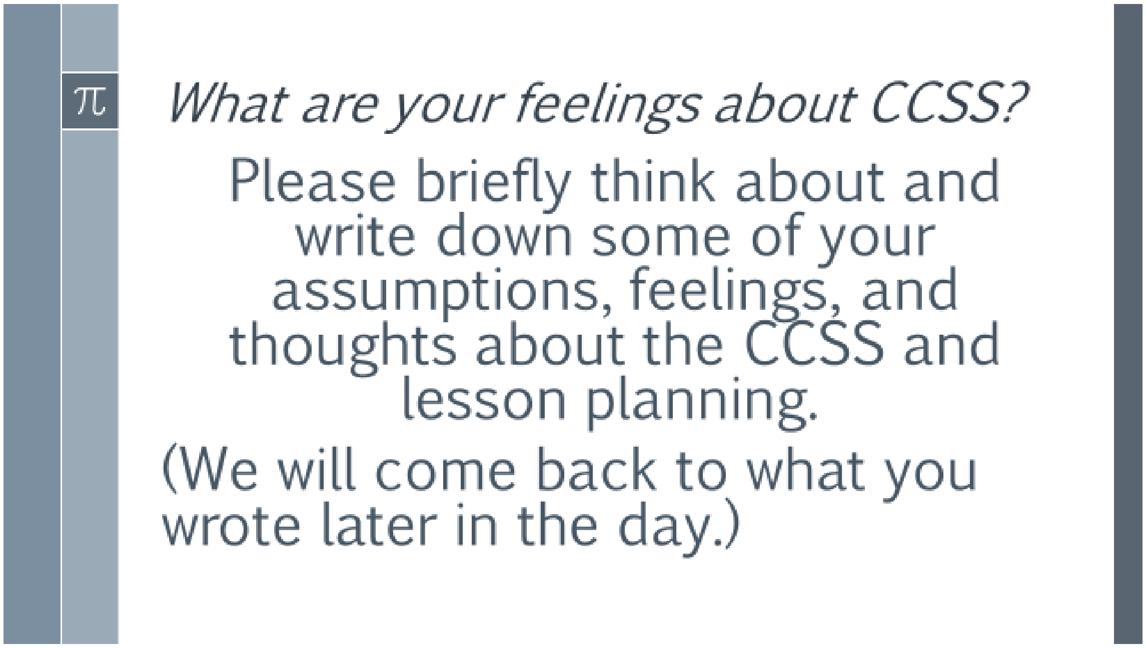



Welcome and thank each person for attending.
Have each person introduce him- or herself. The questions on the slide can be used as a guide for those who may not know what to say or may be shy.

Ice Breaker

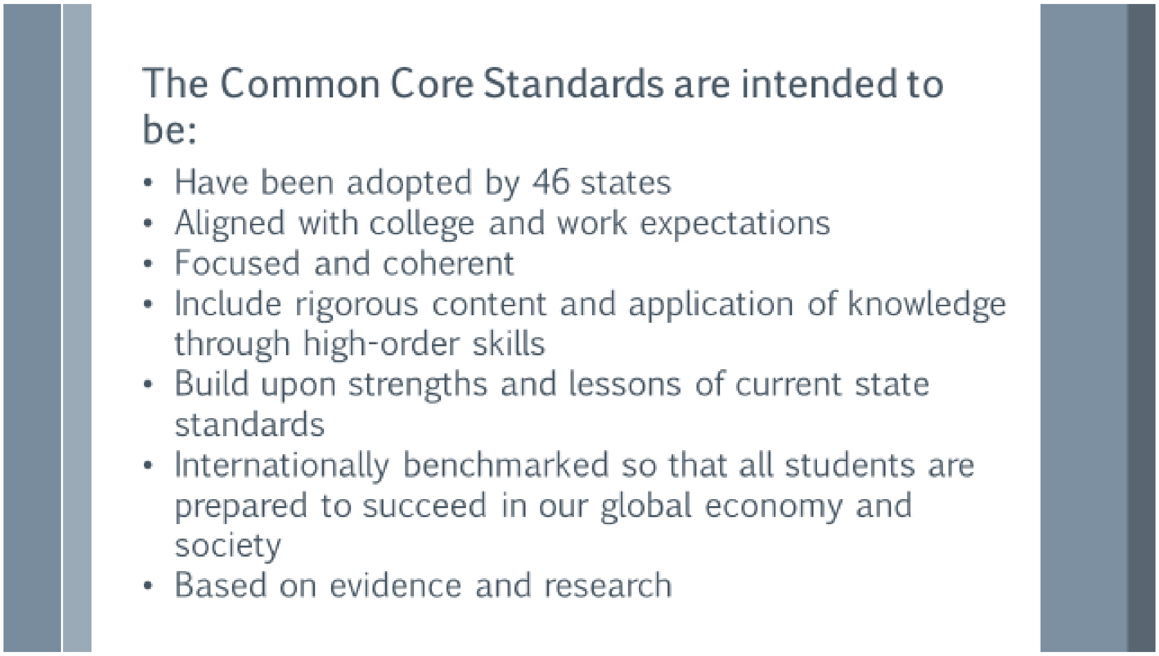
If you were marooned on an island, what are three items and/or people you would bring with you?

Common Core State Standards (Colorado State Standards)



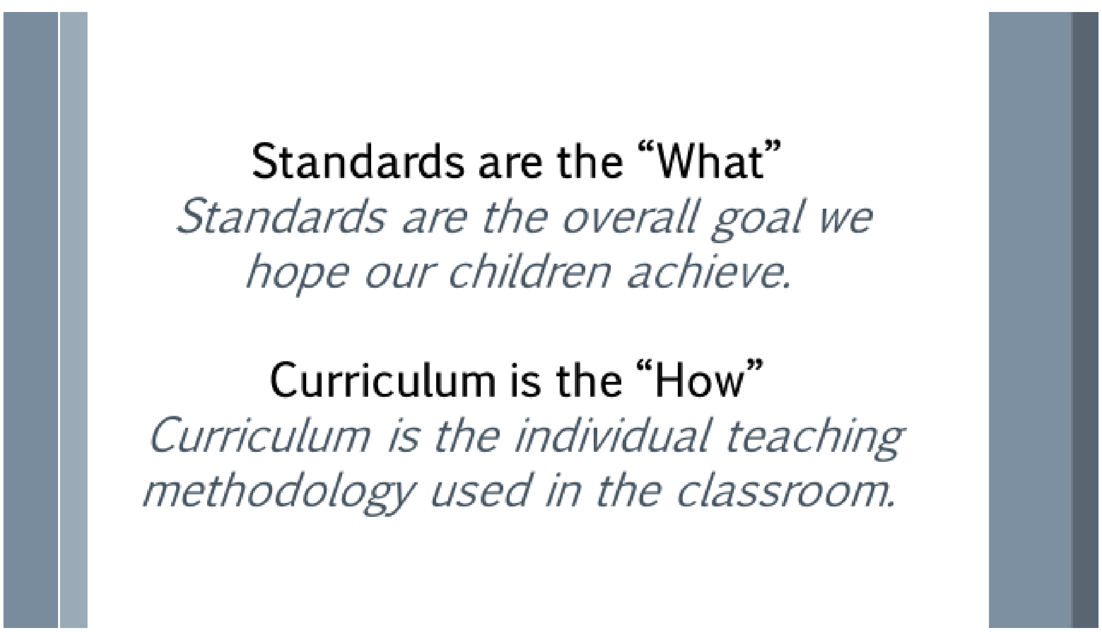

On a sheet of paper and without taking a lot of time, briefly answer the question on the slide.
We will come back to see how your feelings may have changed after this presentation.

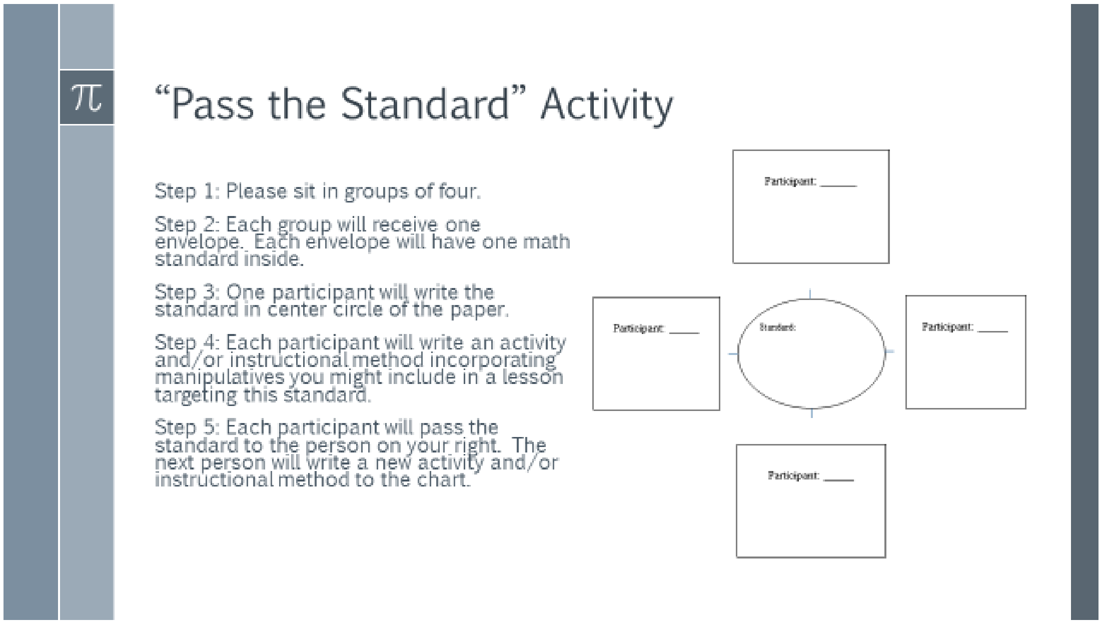

Have attendees watch the 3 minute video of CCSS.
*Three-minute video explaining the common core state standards.* (2012). Retrieved from https://vimeo.com/51933492



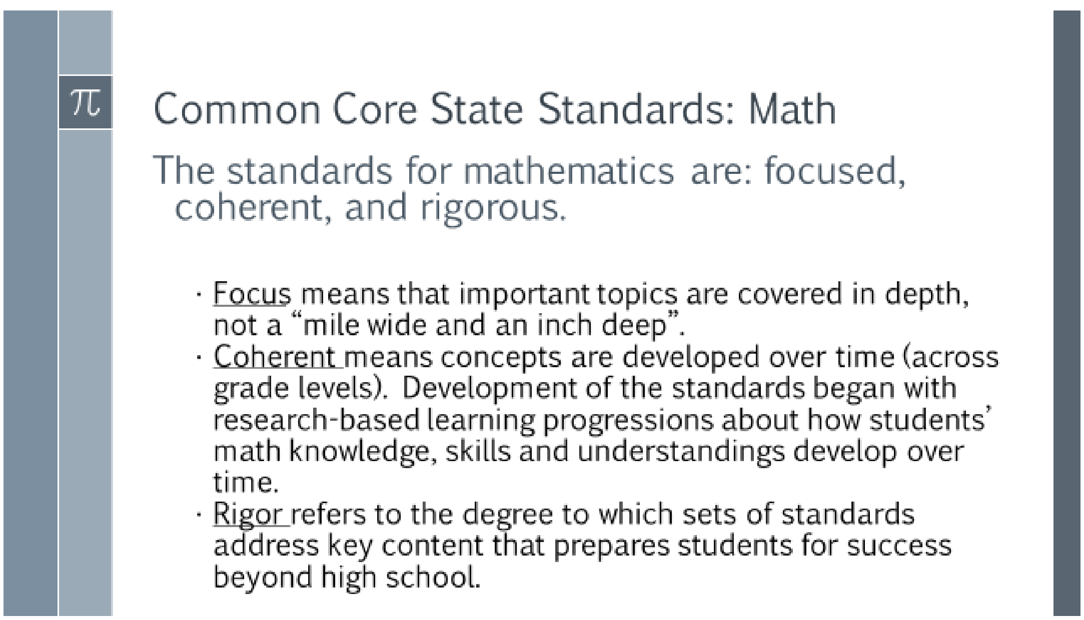

Dalton, B. (2012). Multimodal composition and the common core state standards. *Reading Teacher*, *66*(4), 333-339. doi:10.1002/TRTR.01129

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards initiative.* Retrieved from www.corestandards.org






The purpose of this activity is for participants to analyze a math standard and determine the most effective instructional methods so that students make connections to the math concepts. Participants will be able to collaborate and learn from each other.




The Common Core State Standards for Mathematics, specifically:

- Are focused, coherent, and rigorous.

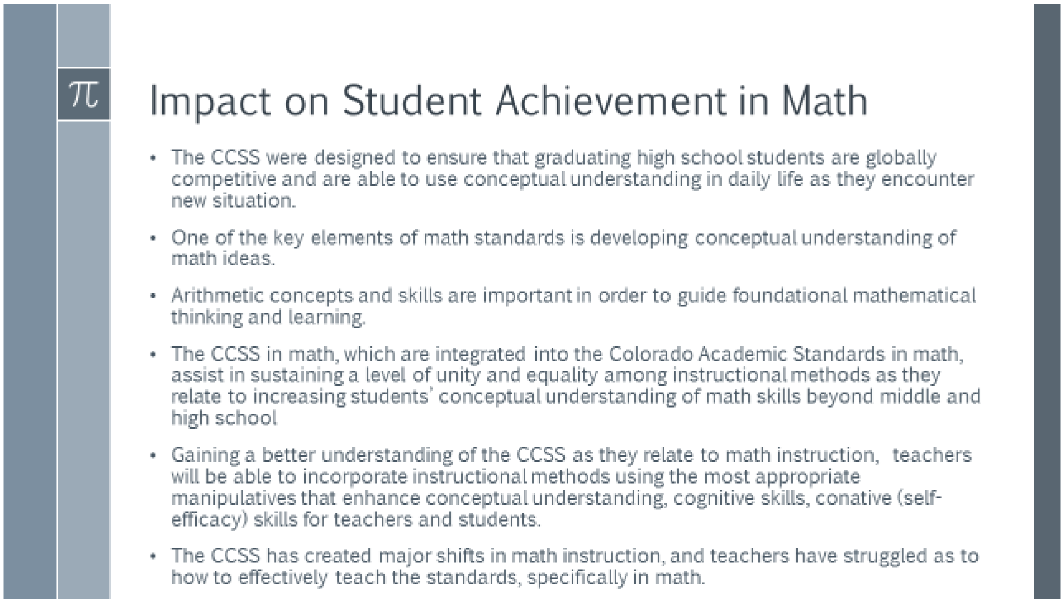
Ask participants, “What do focused, coherent, and rigorous mean in relation to the CCSS for math?”

- Focus means that important topics are covered in depth, not a “mile wide and an inch deep”.
- Coherent means concepts are developed over time (across grade levels). Development of the standards began with research-based Learning Progressions about how students’ math knowledge, skills and understandings develop over time.
- Rigor refers to the degree to which sets of standards address key content that prepares students for success beyond high school.

National Governors Association Center for Best Practices & Council of Chief State School Officers. (2010). *Common core state standards initiative.* Retrieved from www.corestandards.org

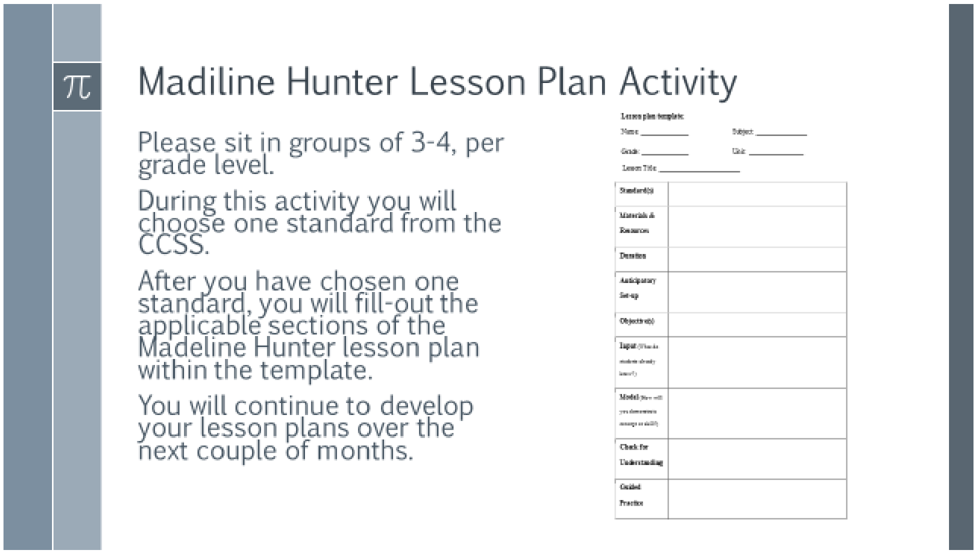

Colorado already developed a set of State standards for math. However, in 2009 decided to align CCSS into the already established Colorado Academic Standards. Colorado’s primary goal was creating a set of standards that will promote success of teachers and students in Colorado.

Colorado Department of Education. (2014). Colorado academic standards history and development. Retrieved from http://www.cde.state.co.us/communications/cashistoryanddevelopment

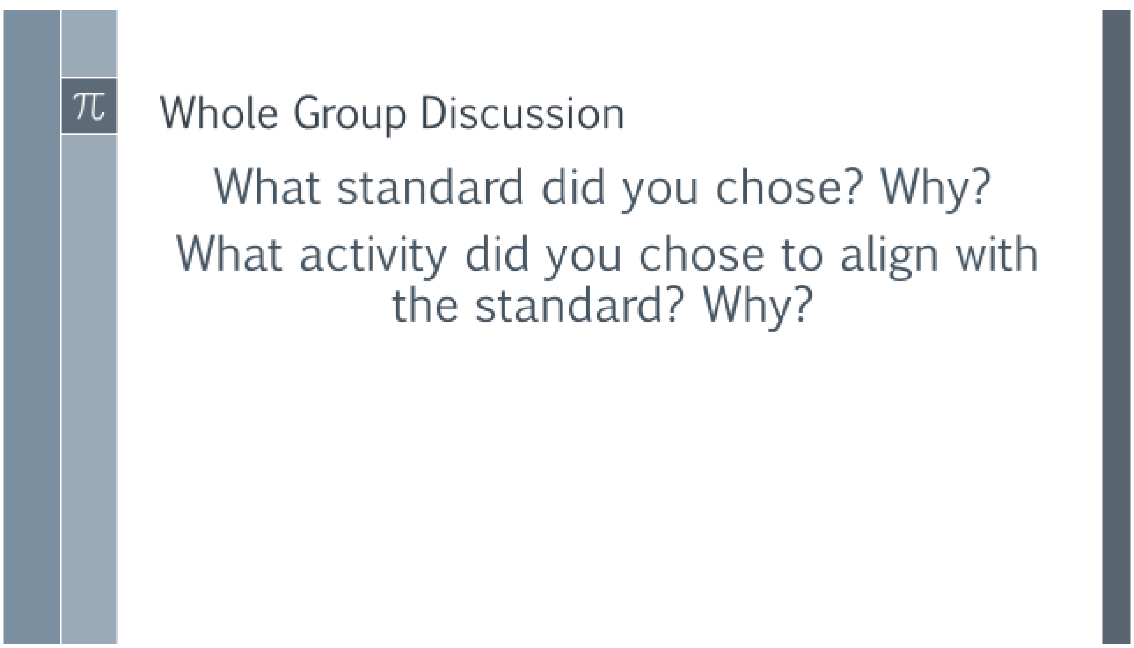



Clements, D. H., & Sarama, J. (2011). Early childhood teacher education: The case of geometry. *Journal of Mathematics, 14*(2), 133-148. doi:10.1007/510857-011-9173-0

Confer, C., & Ramirez, M. (2012). *Small steps, big changes: Eight essential practices for transforming schools through mathematics.* Portland, ME: Stenhouse Publishers.




Please sit in groups of 3-4, per grade level. During this activity you will choose one standard from the CCSS. After you have chosen one standard, you will fill-out the applicable sections of the Madeline Hunter lesson plan within the template. You will continue to develop your lesson plans over the next couple of months.

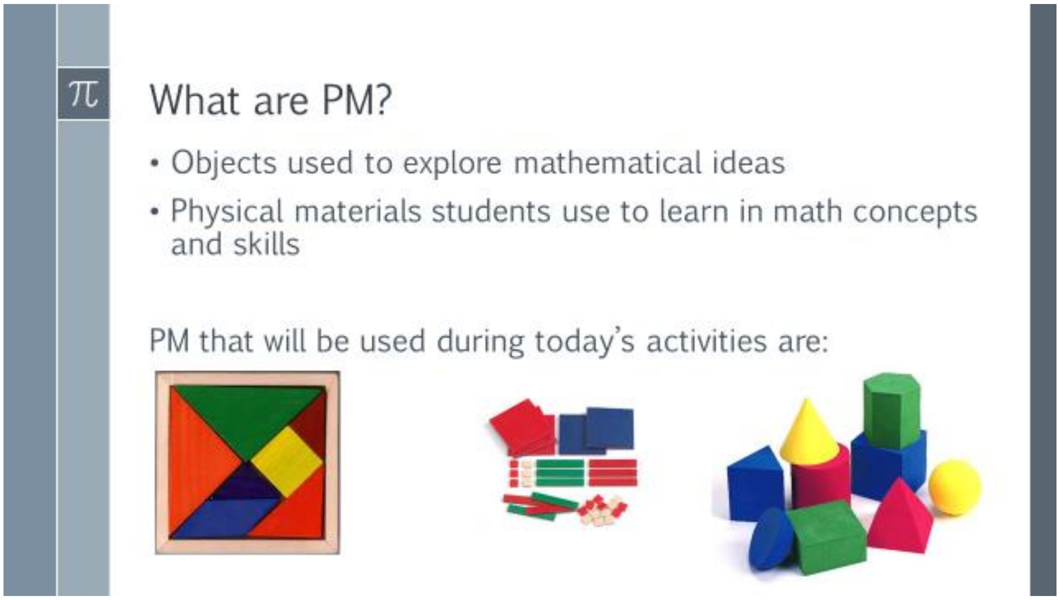


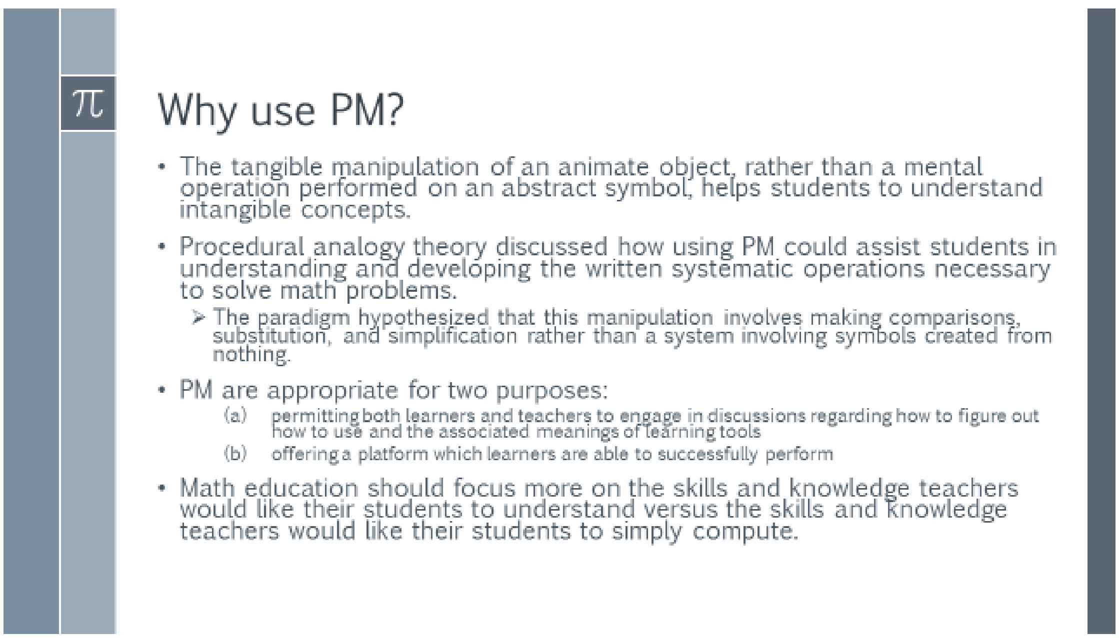
*15 minute break.*

π

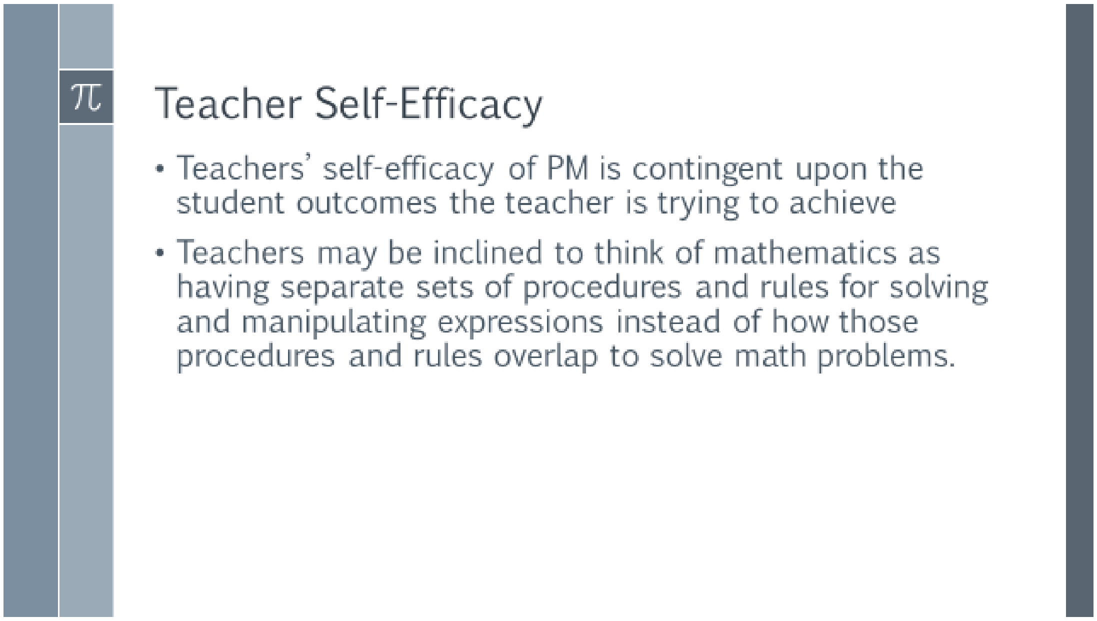
Best Practices using
Physical Manipulatives (PM)

π



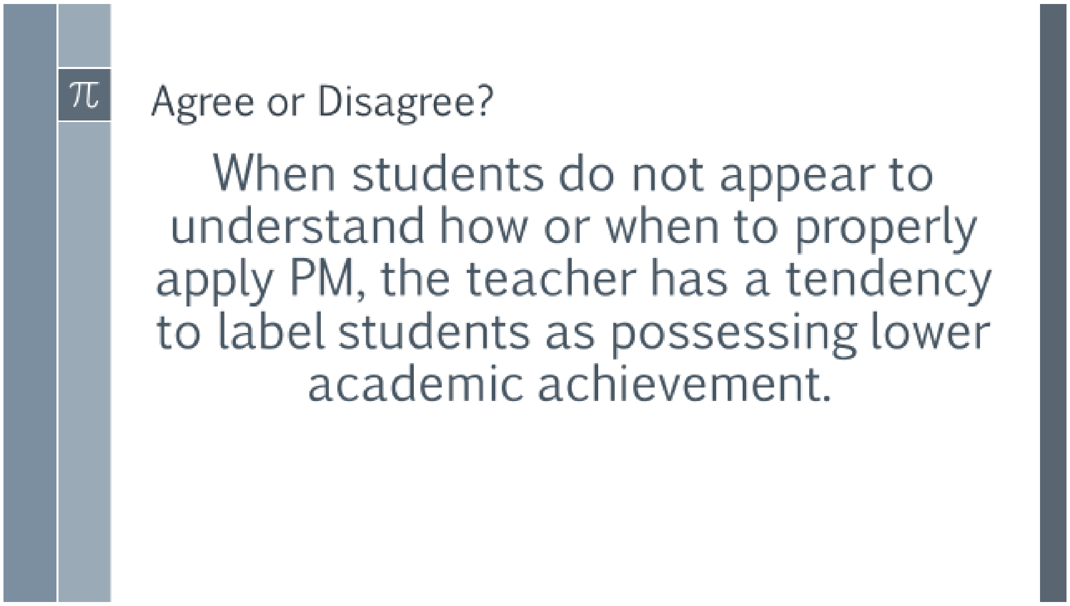




Goldsby, D. (2009). *Research summary: Manipulatives in middle grades mathematics*. Retrieved from http://www.nmsa.org/Research/ResearchSummaries/Mathematics/tabid/1832/Default.aspx



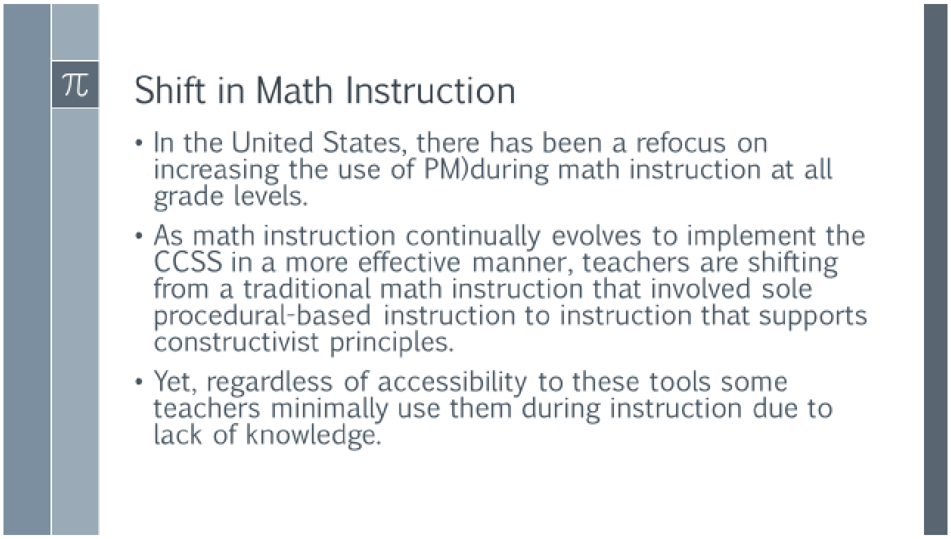

Ask participants to silently reflect about their perceived self-efficacy regarding incorporating PM into daily lesson plans and using PM during math instruction.

Akkan, Y. (2012). Virtual or physical: In-service and pre-service teacher's beliefs and preferences on manipulatives. *Turkish Online Journal of Distance Education, 13*(4), 167-192. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=83144753&scope=site




Ask participants whether they agree or disagree with the statement. Ask participants to briefly share why they either agree or disagree with the statement.

Akkan, Y. (2012). Virtual or physical: In-service and pre-service teacher's beliefs and preferences on manipulatives. *Turkish Online Journal of Distance Education, 13*(4), 167-192. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=ehh&AN=83144753&scope=site

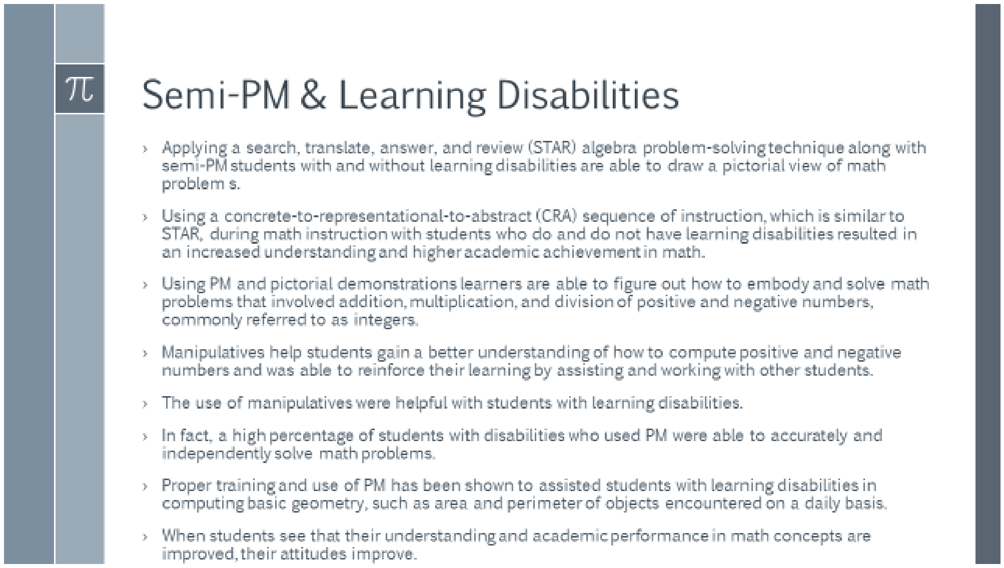



Briefly explain constructivism.
Constructivism is the theory that individuals construct knowledge for themselves. People construct meaning both individually and socially as he or she learns new concepts and skills. Constructing meaning is learning!

Grady, M., Watkins, S., & Montalvo, G. (2012). The effect of constructivist mathematics on achievement in rural schools. *Rural Educator*, *33*(3), 37-46. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=eric&AN=EJ987623&scope=site

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal, 42*(2), 371-406. doi:10.3102/00028312042002371

National Council of Supervisors of Mathematics. (2013). *Improving student achievement in mathematics by using manipulatives with classroom instruction.* Retrieved from http://www.borenson.com/Portals/25/ncsm_positionpaper%20Manipulatives.pdf




Teachers are faced with inclusive classrooms, so more learning needs have entered into regular education classrooms. Using PM during math instruction allows teachers to address learning needs while promoting student achievement in math.

Bouck, E., Satsangi, R., Doughty, T., & Courtney, W. (2014). Virtual and concrete manipulatives: A comparison of approaches for solving mathematics problems for students with autism spectrum disorder. *Journal of Autism & Developmental Disorders*, *44*(1), 180-193. doi:10.1007/s10803-013-1863-2

Cass, M., Cates, D., Smith, M., & Jackson, C. (2003). Effects of manipulative instruction on the solving of area and perimeter problems by students with learning disabilities. *Learning Disabilities Research & Practice, 18*(1): 112–160. doi:10.1111/1540-5826.00067

Lorraine, S. (2006). *The impact of virtual and concrete manipulatives on algebraic understanding* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Thesis database. (Order No. 3208964)

Maccini, P., & Hughes, C. A. (2000). Effects of a problem-solving strategy on the introductory algebra performance of secondary students with learning disabilities. *Learning Disabilities Research & Practices, 15*(2): 10–21. doi:10.1207/SLDRP1501_2

Re, A. M., Pedron, M., Tressoldi, P. E., & Lucangeli, D. (2014). Response to specific training for students with different levels of mathematical difficulties. *Exceptional Children*, *80*(3), 337-352. doi:10.1177/0014402914522424

Witzel, B., Mercer, C., & Miller, M. (2003). Teaching algebra to students with learning difficulties: An investigation of an explicit instruction model. *Learning Disabilities Research & Practices, 18*(2), 121–131. doi:10.1111/1540-5826.00068

Appendix B: Participant Invitation to Participate Letter

Middle School Math Teacher:

I am conducting a research study as part of the requirements of my degree, and I would like to invite you to participate. In addition to being a doctoral candidate at Walden University, I am also a parent of a student enrolled within CSD1. However, my role as a researcher is separate from my role as a parent. I believe that the results from this study may benefit your current instructional practices as they relate to math.

The purpose of exploring the perceptions of teachers is to better understand teachers' perceptions of professional development and self-efficacy in the use of manipulatives as it relates to CBAM. This study may be essential to find ways to support teachers' perceived sense of self-efficacy as it relates to manipulatives, which, in turn, may yield positive outcomes related to student math achievement. If you decide to participate, you will be asked to: (a) allow me to become a nonparticipatory observer within your classroom during one class period; (b) participate in a one-on-one interview, lasting no longer than 60-minutes, with me about your perceptions regarding various topics, such as your instructional practices and professional development; (c) provide current school year's lesson plans and a list of current school year's completed professional development/training whether formal or informal; (d) review the transcription of the interview and recorded observation to provide feedback for change or clarify any misconceptions. Review of the final study results will be to ensure accurate representation of your experiences.

You may feel uncomfortable answering some of the questions. You do not have to answer any questions that you do not wish to answer. Participation is voluntary and confidential. Your identity will not be revealed. You may withdraw from the study at any time. Taking part in this study is your decision. Only I will know whether you choose to participate.

If you would like to participate, please go to the link, https://eSurv.org?u=angelavizzistudy, and complete the online consent form and demographic survey. Completion of the demographic survey will indicate your consent to participate, should you choose to participate in the study. I will send a follow-up email within a week if I do not hear back from you. You may also contact me at any time to answer questions or to address concerns by email at angela.vizzi@waldenu.edu or by phone at (850) 313-1504.

Thank you for your time and consideration.

Angela Vizzi, principal researcher

## Appendix C: Letter of Cooperation

Dear Angela Vizzi,

Based on my review of your research proposal, I give permission for you to conduct the study entitled *Teachers' Perceptions of Manipulatives during Middle School Math Instruction* within CSD1. As part of this study, I authorize you (referred to as 'the researcher' within this letter) to:

- Participate in a one-on-one interview with the volunteering math teachers about their perceptions regarding various topics, such as their instructional practices and professional development. The interview will not take place during classroom instructional time. Rather, the interview will be conducted during a time and at a location that the researcher and the math teacher have both agreed upon, and will last no longer than 60-minutes. The interview will be allowed to be audio recorded so that the researcher can accurately record, transcribe, and reflect upon the discussion. Only the researcher will review the audio to accurately transcribe and analyze the audio file. Following the researcher's transcription, the audio recording will be destroyed leaving only a digital recording and transcription, which will be stored electronically in a password-protected file for 5-years per Walden University protocol.
- Become a nonparticipatory observer within the math teachers' classrooms for one class. The observation will occur during an agreed upon date and

time. The descriptive and reflective fieldnotes written during the observation will be electronically recorded and analyzed. Electronic data will be kept secure by being stored in password-protected files on the researcher's home computer and all non-electronic data will be stored securely in the researcher's home desk. Data will be stored for 5-years per Walden University protocol.

- Receive two documents from each volunteering math teacher: (a) current school year's lesson plans and (b) a list of current school years completed professional development/training whether formal or informal. These data will be triangulated with the interview and observational data. All identifiable data, such as names of teachers and schools, will be removed from the documents. The documents will be kept secure by being stored securely in the researcher's home desk for 5-years per Walden University protocol.
- Request each volunteering math teacher to review the transcription of the interview and recorded observation to provide feedback for change or clarify any misconceptions. You review of these data will be to ensure accurate representation of each volunteering math teacher's experiences.
- Request each volunteering math teacher to review the final study results to ensure accurate representation of each volunteering math teacher's experiences.

Individuals’ participation will be voluntary and at their own discretion.

We understand that our organization’s responsibilities include: math teacher participants who have volunteered to participate in this study, a classroom with minimal distractions and interruptions to conduct interviews, allowing the researcher to become a nonparticipatory observer within the math teachers’ classrooms for one class, and provide the researcher with requested archival documents. We reserve the right to withdraw from the study at any time if our circumstances change.

I confirm that I am authorized to approve research in this setting and that this plan complies with the organization’s policies.

I understand that the data collected will remain entirely confidential and may not be provided to anyone outside of the student’s supervising faculty/staff without permission from the Walden University IRB.

Sincerely,

________________________________________________

Contact Phone Number: ___________________________

Contact Email Address: ___________________________

**Walden University policy on electronic signatures: An electronic signature is just as valid as a written signature as long as both parties have agreed to conduct the transaction electronically. Electronic signatures are regulated by the Uniform Electronic Transactions Act. Electronic signatures are only valid when the signer is either (a) the sender of the email, or (b) copied on the email containing the signed document. Legally an "electronic signature" can be the person’s typed name, their email address, or any other identifying marker. Walden University staff verify any electronic signatures that do not originate from a password-protected source (i.e., an email address officially on file with Walden).

Appendix D: Participant Consent Form and Demographic Survey

Dear Middle School Math Teacher:

You are invited to take part in a research study to gain a deeper understanding of teachers' perceived feelings of PD and self-efficacy in the implementation of manipulatives to teach math in middle school. The researcher is inviting middle school math teachers in CSD1 to be in this study. This form is part of a process called "informed consent" to allow you to understand this study before deciding whether to take part.

A researcher named Angela Vizzi, who is a doctoral student at Walden University, is conducting this study. You may already know the researcher as a parent of a student within the CSD1, but this study is separate from that role.

**Background Information:**

The purpose of exploring the perceptions of teachers is to better understand teachers' perceptions of professional development and self-efficacy in the implementation of manipulatives. This study may be essential to find ways to support teachers' perceived sense of self-efficacy as it relates to manipulatives, which, in turn, may yield positive outcomes related to student math achievement.

**Procedures:**

If you agree to be in this study, you will be asked to:

- Allow the researcher to become a nonparticipatory observer within your classroom for one class. The observation will occur during an agreed upon date and time. The descriptive and reflective fieldnotes written during the observation will be electronically recorded and analyzed. Electronic data will be kept secure by being stored in password-protected files on the researcher's home computer and all non-electronic data will be stored securely in the researcher's home desk. Data will be stored for 5-years per Walden University protocol.

- Participate in a one-on-one interview with the researcher about your perceptions regarding various topics, such as your instructional practices and professional development. The interview will not take place during classroom instructional time. Rather, the interview will be conducted during a time and at a location that we have both agreed upon, and will last no longer than 60-minutes. The interview will be audio recorded so that the researcher can accurately record, transcribe, and reflect upon the discussion. Only the researcher will review the audio to accurately transcribe and analyze the audio file. Following the researcher's transcription, the audio recording will be destroyed leaving only a digital recording and transcription, which will be stored electronically in a password protected file for 5-years per Walden University protocol.
- Provide two documents to the researcher: (a) current school year's lesson plans and (b) a list of current school years completed professional development/training whether formal or informal. These data will be triangulated with the interview and observational data. All identifiable data, such as names of teachers and schools, will be removed from the documents. The documents will

be kept secure by being stored securely in the researcher’s home desk for 5-years per Walden University protocol.

- Review the transcription of the interview and recorded observation to provide feedback for change or clarify any misconceptions. Your review of these data will be to ensure accurate representation of your experiences.
- Review the final study results to ensure accurate representation of your experiences.

Here are some sample questions:

- What experiences have influenced (formal and informal) your decisions to use or not to use manipulatives?
- How does teacher collaboration influence instructional practices, specifically when manipulatives are used?
- How does professional development influence instructional practices, specifically when manipulatives are used?

**Voluntary Nature of the Study:**

This study is voluntary. Everyone will respect your decision of whether or not you choose to be in the study. No one at CSD1 or Walden University will treat you differently if you decide not to be in the study. If you decide to join the study now, you can still change your mind later. You may stop at any time without any consequences.

**Risks and Benefits of Being in the Study:**

Being in this type of study involves some risk of minor discomforts that can be encountered in daily life, such as fatigue from responding to interview questions, or stress from reflecting on your practice. Being in this study would not pose risk to your safety or wellbeing. The benefits of being in this study is that your insights could suggest ways in which school administrators within the school district might be able to offer ways to increasing math teachers' perceived sense of self-efficacy as it relates to manipulatives, which, in turn, may yield positive outcomes on student academic achievement and assessment scores in math.

**Payment:** There is none.

**Privacy:**

Any information you provide will be kept confidential. The researcher will not use your personal information for any purposes outside of this research project. In addition, the researcher will not include your name or anything else that could identify you in the study reports.

**Contacts and Questions:**

You may ask any questions you have at any time. If you have questions, you may contact the researcher via email at angela.vizzi@waldenu.edu. If you want to talk privately about your rights as a participant, you may call Dr. Leilani Endicott. She is the Walden University representative who can discuss this with you. Her phone number is

(612) 312-1210. Walden University's approval number for this study is **04-16-150338986** and it expires on **April 15, 2016.** The researcher will give you a copy of this form to keep prior to conducting the scheduled interview.

**Statement of Consent:**

To protect privacy, no signatures are being collected. Completion of the online survey indicates consent, should you choose to participate in the study.

○ Yes, I consent to participate.

○ No, I do not consent to participate.

**Contact Information**

Please provide the following contact information so that we can schedule an interview and observation date, time, and location. In addition, a copy of the consent form will be emailed to you so that you may print or keep a copy of this consent form for your records.

Name ____________________

School ____________________

Email ____________________

**Demographic Information**

* What is your gender?

- Male
- Female

* What is your highest level of education?

- Bachelor's Degree
- Master's Degree
- Doctorate Degree

* How many years have you taught middle school math?

* What grade level do you currently teach?

- 6
- 7
- 8

Thank you for choosing to participate.

Please remember to bring two documents to your scheduled interview:

(a) current school year’s lesson plans and

(b) a list of current years completed professional development/training whether formal or informal.

You have completed the consent form and demographic survey.

<< Back < Finish Survey>

# Appendix E: Interview Protocol

To maintain alignment with the central research question and sub questions, the following interview questions will guide the study.

**Central Research Question:**

What are teachers' perceptions of professional development and self-efficacy in the use of manipulatives as it relates to math instruction in urban middle schools?

*Interview questions*:

- How do you feel student learning and math achievement relates to math instruction?
- During my observation, I noticed that you (did/did not) use manipulatives.
    - Which types of math activities or lessons would you plan using manipulatives?
    - Which types of math activities or lessons would you plan not to use manipulatives?
- What experiences have influenced (formal and informal) your decisions to use or not to use manipulatives?
- How does teacher collaboration influence your instructional practices, specifically when manipulatives are used?
- How does professional development influence your instructional practices, specifically when manipulatives are used?

- Following a professional development session on the use of manipulatives, how did the session affect how you planned and wrote your lesson plans?
- Other than teacher collaboration and professional development…
    - What other instructional supports influence your instructional practices, specifically when manipulatives are used?
    - What other instructional supports do not influence your instructional practices, specifically when manipulatives are used?
- What are some strengths of using manipulatives to teach algebra and algebraic reasoning?
- What are some barriers of using manipulatives to teach algebra and algebraic reasoning?

**Potential Interview Probes:**

- Please give me an example.
- Please tell me more about…
- Please describe your process.

**Conclusion:**

*Interview question:*

- Is there anything you would like to add?

**Final Comments to Participant:**

Thank you for your time. I will prepare a transcript of your interview and send it to you to review for accuracy within one week of (interview date) __________________.

In addition, an executive summary of the full report, which would emphasize the research question, purpose, and findings and merely touch on the participants, data collection, and data analysis will be emailed to you at the conclusion and approval of my final study. In the event you may be interested in reading the full report, one will be sent to the Chief Academic Officer for the district. Again, please feel free to contact me if you have any further questions or concerns.

Appendix F: Observation Protocol

Project: Teachers' Perceptions of Manipulatives during Middle School Math Instruction

Teacher#: ________ School: ____________ Grade Level: 6 7 8

Date of Observation: ____________________ Length of Observation: _______________

Start Time: _____ End Time: ____

- **<u>Brief description of the observed lesson:</u>**

- Are manipulatives being used during the lesson? YES NO
    - If so, what kind of manipulatives?

      ______________________________________________

    - Did the teacher explain the manipulatives? Describe.

      ______________________________________________________________________

      ______________________________________________________________________

      ______________________________________________________________________

| TIME | DESCRIPTION OF EVENTS/ACTIVITIES | REFLECTIVE NOTES |
|---|---|---|
| | | |

# Appendix G: Curriculum Calendars

## Grade 6 Math

| Unit Title | Properties of Numbers | Rational Number Computation and Modeling | Ratios and Rates | Symbols, Tables and Graphs | Data and Statistics | Geometry |
|---|---|---|---|---|---|---|
| Sample Learning Topics | Formulate and Model Number Relationships; Factors and Multiples; Least Common Multiple & Greatest Common Factor; Order of Operations and the Distributive Property; Positive and Negative Number Locations on a Number Line; Positive and Negative Number Locations and Relationships in the Coordinate Plane; Order and Compare Values Including Absolute Values | Model and Apply Addition and Subtraction of Decimals; Model and Apply Addition and Subtraction of Fractions and Mixed Numbers; Model and Apply Multiplication and Division of Decimals; Model and Apply Multiplication and Division of Fractions and Whole Numbers; | Express Comparisons Between Quantities as Ratios and Unit Rates and use to Solve Problems in Context; Make Tables of Equivalent Ratios to Find Missing Values and to Plot in the Coordinate Plane; Use Common Fractions and Percents to Calculate Parts of Whole Numbers; Relate Part to Part Comparisons with Part to Whole Comparisons; | Read, Write, and Evaluate Numeric & Algebraic Expressions; Identify When Two Expressions are Equivalent; Represent Relationships Between Independent and Dependent Variables in Context; Analyze Relationships Between Two Variables using Equations, Tables & Graphs; Solve One Variable Equations | Anticipate and Account for Variability in a Data Set; Describe Data Sets Based on Center, Spread & Shape, Interpret Center and Spread in terms of a Data Set in Context; Display Data Sets using Line Plots, Dot Plots, Histograms and Box Plots | Develop and Apply Polygon Area Formulas to Real World Problems; Develop and Apply Surface Area and Volume Formulas for Prisms to Real World Problems; |
| Suggested Time Frame* | 7 Weeks | 6 Weeks | 4 Weeks | 6 Weeks | 3 Weeks | 5 Weeks |
| Assessment Opportunities | Sixth grade assessments will be developed using district Frameworks & Item Banks that provide students the opportunity to work with unit content in: Routine situations, conceptual or applied contexts, familiar and unfamiliar situations. | | | | | |

* Time frames are approximate.

## Grade 7 Math

| Unit Title | Positive and Negative Number Operations | Proportional Reasoning and Similarity | Linear and Proportional Reasoning | Sampling and Probability | Geometry |
|---|---|---|---|---|---|
| Sample Learning Topics | Apply Addition and Subtraction to Positive and Negative Rational Numbers; Demonstrate Properties of Addition and Subtraction of Positive and Negative Numbers on a Number Line; Apply Multiplication and Division to Positive and Negative Rational Numbers; Solve Real World Multi-Step Problems Using the Four Operations with Rational Numbers; Convert Between Equivalent Names for a Number Including Repeating Decimals | Analyze Proportional Relationships; Draw, Construct and Describe Geometric Figures in a Proportional Relationship; Determine When Two Geometric Figures are in a Proportional Relationship; Use proportions to Solve Real world Problems; Compute Unit Rates and Use to Solve Problems and Estimate Costs; Solve Multi-Step Problems Involving Percents. | Identify, Represent, Analyze and Compare Proportional ($y=px$) and Non-Proportional ($y = px + q$) Linear Relationships; Describe Properties of Proportional Relations in the Coordinate Plane; Use Properties of Operations to Generate equivalent Expressions and Equations; Use Variables to Represent Real-World Problems, Write Equations and Solve; | Draw informal Comparative Inferences about a Population Using a Random Sample; Use Measures of Center and Variability from Random Samples to Draw Comparative Inferences About Two Populations; Investigate Develop and Evaluate Probability Models; Approximate the Probability of a Chance Event by Collecting Data; Find and Explain Probabilities for Compound Events; | Construct Triangles and Determine Conditions that Determine a Unique Triangle; Write and Solve Equations Related to Supplementary and Complementary Angles; Apply Area Concepts, Volume Concepts and Formulas to the Solution of Real-World 2-D and 3-D problems; Solve Problems Involving a Scale Factor for 2-D and 3-D Objects |
| Suggested Time Frame* | 5 Weeks | 9 Weeks | 7 Weeks | 5 Weeks | 6 Weeks |
| Assessment Opportunities | Seventh grade assessments will be developed using district Frameworks & Item Banks that provide students the opportunity to work with unit content in: Routine situations, conceptual or applied contexts, familiar and unfamiliar situations. | | | | |

* Time frames are approximate.

Grade 8 Math

| Unit Title | Data Analysis and Modeling | Coordinate Models and Geometry | Exponential Growth and Decay | Geometric Patterning | Linear Equations and Systems | Quadratics |
|---|---|---|---|---|---|---|
| Sample Learning Topics | Use Tables, Graphs and Equations to Describe and Model Linear Relationships; Use Tables, Graphs and Equations to Distinguish between Linear and Non-Linear Relationships; Define Function in Terms Of Tables Graphs and Rules; Construct and Interpret Scatter-Plots for Bivariate Data and Interpret Patterns of Association; Interpret Slope and Intercept in Context for Linear Models; | Apply the Pythagorean Theorem to Real World Situations and Coordinate Models to Find Distances; Interpret Real Numbers in Both Exact (Radical) and Approximate (Decimal) Forms; Convert Repeating Decimals into Fractions; Evaluate the Square Roots of Perfect Squares and Cube Roots of Perfect Cubes; | Apply Properties of Exponents to Generate Equivalent Expressions; Interpret Values in Scientific Notation; Multiply and Divide Numbers in Scientific Notation; Determine the Multiplicative Pattern of Change from a Table; Interpret, Evaluate and Compare Exponential Functions Represented by Tables Graphs and Equations; | Verify Properties of Rotations, Reflections and Translations Experimentally; Describe the Effect of a Dilation, Translation, Rotation or Reflection on an Object in a Plane; Demonstrate that Congruence is the Result of a Sequence, Rotations, Reflections and Translations; Demonstrate that Similarity is the Result of a Sequence of *Dilation*, Rotations, Reflections and Translations; State and use Volume Formulas for Cylinders, Cones and Spheres | Solve Linear Equations and Inequalities in One Variable; Estimate the Solution to a Linear System Graphically; Solve Systems of Linear Equations Algebraically; Solve Real –World Problems Leading to Two Linear Equations | Compare Properties of Quadratic Functions Defined by Tables Graphs or Rules; Use Quadratic Functions to Model Relationships Between Quantities |
| Suggested Time Frame* | 8 Weeks | 5 Weeks | 5 Weeks | 6 Weeks | 5 Weeks | 4 Weeks |
| Assessment Opportunities | Eighth grade assessments will be developed using district Frameworks & Item Banks that provide students the opportunity to work with unit content in: Routine situations, conceptual or applied contexts, familiar and unfamiliar situations. | | | | | |

* Time frames are approximate.

Appendix H: Affective Domain Permission to Reprint

## Permission to use Affective Domain table...

5 messages

---

**Angela Vizzi** <angela.vizzi@waldenu.edu> Sat, Aug 15, 2015 at 7:37 AM
To: journals@phcog.net

To Whom It May Concern:

My name is Angela Vizzi. I am a doctoral candidate at Walden Univeristy. I would like your permission to use (within my project study) the Affective Domain table from “Assessment of Learning Domains to Improve Student’s Learning in Higher Education,” 2014, Journal of Young Pharmacists, 6, p. 30 (DOI: 10.5530/jyp.2014.1.5). All information and tables used within my study will be properly cited/referenced per APA 6th edition.

Thank you for your time and consideration.

Angela Vizzi

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**Phcog. Net** <journals@phcog.net> Mon, Aug 17, 2015 at 12:07 AM
To: Angela Vizzi <angela.vizzi@waldenu.edu>

Permission is granted,with proper citation

Mueen
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