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No more worksheets: a pre-service teacher's look at manipulatives

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NO MORE WORKSHEETS: A PRE-SERVICE TEACHER'S LOOK AT MANIPULATIVES

by
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ABSTRACT

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The purpose of this study is to explore the use of manipulatives during math. This is done by examining manipulatives in reference to student interest, diverse learners, student response, and student opinions. The study was conducted in an elementary school in the Winslow Township school district located in the Camden County region of South Jersey. All seventeen participants were taken from a collaboratively taught first grade classroom. Collection of data was done through the use of video tape, student journals, tests and my personal observations. Data was triangulated through the examination of multi-sources (video, journals, tests, observations), and themes, scores and interesting remarks were analyzed. In conclusion to the study one unifying pattern was found during the exploration of manipulatives was student eagerness. Their eagerness to use and explore manipulatives provided them with the openness to learn thus increasing their knowledge of the subject at hand.

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Lastly, I would like to thank all of you who are reading this document. Education is an ever changing field, and by your choice of literature, it shows that you place value on this field. Thank you readers and educators who are striving to make a difference in education.

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Chapter One: Introduction

Worksheets, worksheets, worksheets, are the students as bored as I am? Slowly a slight buzz of conversation filters throughout the room.

"You watch Sponge Bob yesterday?" Johnny asks Suzzie.

She whispers back: "No. I had cheerleading practice right after school. I'm gonna watch it today."

John laughs to himself, "It was so funny! Sponge Bob..."

John's voice is drowned out by Tim's voice in the next row who is talking to Frank. "Do ya think your mom will let you come over today? I want you to play against me in this cool new Game Cube game I just got! It's called..."

As I look around the room, I notice the same bored look on many faces

A few students finish early and quietly talk with their friends, while others sit quietly and share my bored look. In the same small room, a handful of students display a completely different look. With lips pressed tightly together, these students wrinkle their noises, squint, and stare hard at the worksheet in front of them. Until finally, on- by-one they raise their hand and utter "I don't get this!"

Welcome to many typical classrooms where worksheets seem to be an everyday event during math. What would happen if we took a break from constant worksheets and started making our math lessons engaging? What if we used manipulatives instead of worksheets to reinforce our math lessons? Would our students still have that board or even frustrated look on their face? Would student conversation turn away from television

and video games and steer towards the subject at hand? In this study I, a pre-service teacher in Winslow Township, will explore manipulative use during first grade math.

Background Information

Classrooms that are constantly evolving and meeting the needs of every child can not only be demanding but thought provoking as well. As a pre-service teacher, I am constantly envisioning my future classroom. A classroom different from that described above. This classroom would use manipulatives instead of purely worksheets to enforce math concepts. I want learning to be a fun and enjoyable experience. I feel that students will be more opened to learn if they are engaged in the process.

In 2002, George W. Bush signed the *No Child Left Behind Act* into law. The United States Department of Education (2004) describes providing educational instruction to all students in their Least Restrictive Environment (LRE) and closing the achievement gap as two major goals of the *No Child Left Behind Act.* In achieving these goals, this Act holds educators accountable for the education and success of all children (U.S Department of Education, 2004).

A survey conducted by the United States Department of Education in 2000 found that "70% of students with disabilities received special education and related services in a general education classroom (King, 2003)." This is a 56.25% increase from 1995 when the number of disabled students receiving services in a general education setting was 44.8 % (King, 2003). After reviewing the *No Child Left Behind Act* and the above percentages, it is reasonable to assume that the percentage of disabled students receiving services in a general education setting is still increasing. For this reason, it is important

for educators, to find ways to meet the diverse learning needs within the general education classroom.

In 2003, the fourth grade reading proficiency test exhibits that most students were below math proficiency levels (U.S Department of Education, 2004). This test also showed students with disabilities and minorities, excluding Pacific Islander, to fall well below proficiency with only 10%-17% of this group being at the proficiency level (U.S. Department of Education, 2004). The math proficiency test in 2000 shows, upon graduating from high school, proficiency levels among all groups decreases drastically (see Appendix A). Math proficiency, as shown through these percentages, is an area that presently has a performance gap.

As discussed earlier, the *No Child Left Behind Act* holds educators accountable to raise all students' proficiency levels (U.S Department of Education, 2004). "With the push for placing special needs students [learning disabled, English as a second language, etc.] in inclusion classrooms, it is reasonable to assume a need to understand contextually relevant teacher practices that benefit a diverse population of students" (King, 2003, ¶ 2). According to S. Boren and R. Hartshorn (1990, ¶ 4) research indicates that manipulative use during math is a contextually relevant teacher practice that is "particularly useful in helping children move from the concrete to the abstract level." Having proficiency levels low in math, particularly with minorities and students with disabilities, the use of manipulatives offers an opportunity to meet the students' needs.

Research Questions

Throughout this ethnographic study, the focal question which this study attempted to answer was this one: What happens when teachers use a manipulative approach to teaching math? In evaluating this focal question, many sub-questions surfaced:

1. Is there an increase in participation when manipulatives relate to students' interests?
2. How does the use of manipulatives meet the needs of diverse learners?
3. How do students respond to manipulative use?
4. What are students' opinions on manipulative use?

Overview of Related Research

Previous studies have been conducted that relate to the use of manipulatives. These studies can be divided into four intertwining areas: (a) experiential learning, (b) implementation, (c) increasing knowledge, and (d) previous case studies. These previous studies provide a foundation for my current examination of the manipulative approach to learning math

Manipulatives are often referred to as an experiential learning approach (Diem, 2004; Boren & Hartshorn, 1990; Stevens & Richards, 1992). A study conducted by Silberman (1996) discusses why active learning, another name for experiential learning, is beneficial to learners. His study focuses on active learning in respect to auditory processing, how the brain works, and direct involvement.

Many researchers have discussed the process of manipulative implementation (Burns, 2004; Clements & McMillen, 1996; Hynes, 1986; Bright, 1986; Kennedy, 1986; Boren & Hartshorn, 1990; Schultz, 1986). Researchers seem to agree that the most

important aspect of manipulative implementation is objects should only be used if they are able to bridge the gap between the student's concrete environment and the abstractness found in mathematics (Clements & McMillen, 1996; Hynes, 1986; Bright, 1986; Kennedy, 1986; Boren & Hartshorn, 1990; Schultz, 1986).

Many previous case studies relating to the topic of manipulatives focus primarily on the general topic of experiential learning in the form of project based studies. Studies such as those conducted by Baker & Mabie (1996) and Boaler (1999) reveal positive results, but are project based case studies. Jones & Moyer (2004) conduct a case study that directly studies the uses of manipulatives in relation to mathematics. This study, though it focuses on teacher control provides information directly relating to how students reactions to free access of manipulatives (Jones & Moyer, 2004). Though I found material directly relating to the study of manipulative uses within mathematical instruction to be wanting, the related studies provide a contextual framework for my study.

Increases in student knowledge are related by many researchers to manipulatives and a hands-on approach to learning (Baker & Mabie, 1996; Boaler, 1999; and Jones & Moyer, 2004). Case studies such preformed by Boaler (1999) and Baker & Mabie (1996) provide specific results of increase knowledge and comparisons provided through test scores. Though their studies focus on a project approach to learning, the case studies can be related to manipulative use, because they both employ active based learning techniques. Researchers such as Moser, Kennedy, and Thornton & Wilmot, who were published separately in the *Arithmetic Teacher* February 1986 edition, also provide feedback on the knowledge students' gain through the proper use of manipulatives.

Definitions and Limitations

The term manipulative is frequently used throughout this study, thus because of its importance to the study, the term needs to be precisely stated.

manipulative(s): objects (not pictures) "that can be touched, moved about, rearranged, and other wise handled by children" (Kennedy, 1986, p.6). These objects can take any form as long as they are physical items which represent mathematical ideas (Kennedy, 1986).

In reference to the use of manipulatives for this study, only two types of usage are defined under this term: active manipulative and passive manipulative (not nonmanipulative).

active manipulative: students actively partake in manipulating objects creating a hands-on approach to learning math (Schultz, 1986, p.54).

passive manipulation: students take a passive role and watch as the teacher manipulates the object so as to demonstrate or model a concept (Schultz, 1986, p.54).

The term experiential learning, which will be described later in more depth, is often an ambiguous word; hence its definition needs to be clearly defined.

experiential learning: students learn-by-doing often with minimal direct guidance from an educator and the focus is often on making a connection between the task and life skills (Diem, 2004).

There are several limitations to this study due to its boundaries related to sample size, time period, and the unique setting being observed. Only one classroom is being

considered in this study. All information received throughout the study relates to this classroom. Each student is unique, but all twenty-seven students live in the same town and have similar economic settings. Twenty-seven students is only a minute number of first graders, and can not adequately express all the feelings and ideas of every first grader in America. This limits the studies ability for generalization, and it also impacts the amount of diversity present in the study. Math is consistently presented to the class at the same time everyday, right before lunch. Physiological factors may thus influence and limit the study. Factors such as alertness, hunger, lightning, etc. may affect the students ultimately affecting the outcome of the study. Finally, the Winslow Township first grade class, which will be the subject of the ethnographic study, is a collaboratively taught inclusion classroom. This uniqueness combined with the other limitations limits the generalization of the study.

The Story of the Question

Learning can be very challenging. For me, the challenge was not in memorizing facts; I could do that. The challenge was in taking a concept and making it practical. I could memorize the value of a coin, but hand me a bunch of coins and that was a different story. I will always remember the feelings of frustration and even shame due to the lack of understanding. The comments from parents, teachers and peers constantly asking, why *don't you get this? It's easy.* When at the point of frustration, these comments are not taking as concern but become a haunting within your head that constantly questions your intelligence. Until finally, I heard the sweet soft voice of a teacher say, *let's try this*. That instant manipulatives became the magical key that

unlocked the mysteries of math. Though math never became my favorite subject then nor today, I began to understand it and even appreciate. Manipulatives became an important part of my educational process. For me, learning did not occur without the use of manipulatives to make concepts concrete. As a pre-service teacher, I want to be that soft spoken person that unlocks the mysteries of math and squashes the fears and frustrations which occur during math.

Throughout the last four years while working towards my bachelor degree in Collaborative Education at Rowan University, I was required to visit and observe many different classrooms throughout southern New Jersey. During these visits, I observed, among other things, the lack of manipulative use in many classrooms. Over the years it became disheartening to watch as worksheets seem to take over seatwork, homework, and even instructional lessons. As a student at Rowan, my teachers always encouraged and sometimes even demanded that we use manipulatives, so I have always questioned why teachers choose not to use manipulatives.

Though many teachers I observed did not use manipulatives, I do not want the reader to believe that all did not. Several teachers used manipulatives sparingly, some even used them frequently, and it was through their usage that I became intrigued by the topic of manipulative use. If it were not for observing both manipulative and worksheet centered learning within various classrooms, I might not have realized the importance of manipulatives.

As a pre-service teacher, I try daily to absorb all that I can about creating an environment which is conducive to learning. I am constantly searching for a way to reach all the students in a classroom. I want the students in my future classroom to not

only memorize the information presented but to be able to see the practical uses of that information. I want to take an experiential approach to teaching and the education of my students so that my students will always be engaged. I feel that through the use of manipulatives I can achieve that goal.

The point in which this question of manipulative use truly emerged was during my 2004 fall practicum one placement. I taught a lesson on coins to a class of third graders. This classroom did not use manipulatives on a regular basis; in fact over the eight weeks I observed, they never used manipulatives. When I had the opportunity to teach math, I of course decided to use manipulatives. I gave the students a set of coins, and I also let them participate in using over head coins. The lesson was a success, and the students all participated. This turn of events was different from the normal math class.

Wanting feed back, I engaged in conversation with the teachers after the lesson. The conversation with the teachers lead to how they feel it is not practical to do interactive lessons on a regular basis. They stated that they feel it takes too much planning and too much time. They also went on to say *when you are a "real" teacher you just won't have time for it.* This conversation sparked my interest to look deeper into manipulative use. My hopes are that, through this study, teachers and other pre-service teachers will be encouraged to use manipulatives during math lessons because of the positive effects such as increased knowledge, participation and the willingness to learn.

Organization of Thesis

This ethnographical study will strive to answer the questions proved throughout this chapter. Though this study harbors its own uniqueness, there are many articles which discuss manipulative use in the realm of mathematics. These studies and articles previously written by researchers, educators, and theorists help provide the frame work for this study. In the following chapter, the research of other individuals will be examined in the hopes of enriching the present study of manipulative use in math.

Chapter Two: Literature Review

Overview of Organization

In examining what happens when a teacher uses a manipulative approach to teaching math, the present study attempts to build upon and expand preexisting studies of manipulative use. Many studies have been done in the recent and even distant past, which detail different aspects of manipulatives. Consequently, it might be advantageous to review literature of previous studies so as to better understand the current study.

Upon examination, previously written research can be divided into four areas: (a) experiential learning, (b) implementation, (c) increasing knowledge, and (d) previous case studies. The present review includes the examination of postdated articles due to their significance in the field of manipulative use.

Experiential Learning

The experiential learning approach, often referred to as the "active learning," is identified as an instructional approach that allows students to take a hands-on approach to learning (Diem, 2004; Boren & Hartshorn, 1990; Stevens & Richards, 1992). Manipulative use itself is a hands-on process that encourages students to "manipulate" objects during the presentation or reinforcement of mathematical concepts (Boren & Hartshorn, 1990). The linking of manipulative use to experiential learning is noted by researchers such as Diem (2004), Boren & Hartshorn (1990), Stevens & Richards (1992),

and Silberman (1996). However, Silberman's (1996) study generates several elements that might be helpful to note here.

Silberman (1996) discusses active learning, which as aforementioned is another name for experiential learning. Active learning focuses on learning through doing as an approach to education. In his explanation of why this type of approach is necessary and beneficial to learners, Silberman (1996) describes (a) auditory processing, (b) how the brain works, and (c) direct involvement.

"Over 2400 years ago, Confucius declared: What I hear, I forget. What I see, I remember. What I do, I understand" (Silberman, 1996, p.1)." Confucius' declaration is still true today. Much of what is heard is forgotten. Silberman (1996) notes that even when a student is fully concentrating on what a teacher is saying the student only absorbs about half of the words spoken. This rate usually declines after several minutes of lecture (Silberman, 1996). This decline typically occurs due to boredom, difficulty concentrating, or a combination of the two (Silberman, 1996). For this reason, active learning embodies much more than just auditory processing to engage students.

In his study of active learning, Silberman (1996) views the working process of the brain as similar to a computer. Through his analogy Silberman (1996) states that passive learning is like an ill working computer. In Silberman's view when learning is passive our brain is unable to properly process information for several reasons. One reason suggested is that the brain needs to be engaged to process information; without engagement, our brain just absorbs without actually turning itself on (Silberman, 1996). Another reason suggested is that engagement helps link previous information to present study. This linking allows the brain to process and store the information given

(Silberman, 1996). As Silberman (1996) sees it, learning does not actually occur if the brain is unable to fully process the information given.

Silberman (1996) is one of many researchers who have noted the importance of active learning. Often teaches demonstrate activities to students instead of directly involving them (Silberman, 1996). According to the Myers-Briggs type Indicator (MBTI), a test helpful in understanding roles within the learning process, given in 1993 college freshman indicated that they prefer to learn through direct experiences before discussing basic concepts (Silberman, 1996). Silberman (1996) noted that "[i]f it happens *to* the learner, there will be little mental engagement *by* the learner" (Silberman, 1996, p.4). Direct involvement of a student through active experience provides mental stimulation; hence, the learning process can occur (Silberman, 1996).

Confucius statement that one must do to understand holds true to the ideas represented in experiential (active) learning. The main focus of experiential learning is that students must experience, question, explore, and ultimately do (Diem, 2004; Boren & Hartshorn, 1990; Stevens & Richards, 1992, Silberman, 1996). Experiential learning provides the brain with the processing tools it needs, and it also provides the necessary support for auditory processing (Silberman, 1996).

Implementation

In order for manipulatives, a type of experiential learning, to be an effective learning tool within a classroom, teachers need to use proper implementation (Burns, 2004; Clements & McMillen, 1996; Hynes, 1986; Bright, 1986; Kennedy, 1986; Boren & Hartshorn, 1990; Schultz, 1986). Many researchers agree that one major requirement of

manipulative implementation is that the objects can be used to bridge the gap between the student's concrete environment and the abstractness found in mathematics (Clements & McMillen, 1996; Hynes, 1986; Bright, 1986; Kennedy, 1986; Boren & Hartshorn, 1990; Schultz, 1986). Though many researchers agree on this fundamental principle, several researchers such as Hynes (1986), Clements & McMillen (1996), and Burns (2004) have created other criteria for manipulatives and their implementation.

The *Arithmetic Teacher* shows its devotion to the use of manipulatives by dedicating the entire February 1986 issue to its discussion. Though dated, this journal is presently an employed source for manipulative research. Other researchers such as Boren & Hartshorn (1990) and Clements & McMillen (1996) have referenced this issue of *Arithmetic Teacher* to aid their study due to the precise language of manipulative implementation found within the articles. Hynes (1986) in this addition writes about the selection criteria for manipulatives which current day researches, some who are mentioned in the above paragraph, find important to site. First Haynes discusses the pedagogical criteria for selecting manipulatives: clear representation, appropriateness, interest, and versatility. Then Hynes (1986) discusses the physical criteria for manipulative selection: durability, simplicity, attractiveness, manageability of storage, reasonableness of cost.

When discussing the pedagogical criteria for manipulatives, Hynes (1986) emphasizes that clarity is important. He explains that students need to clearly see and understand what the manipulative represents in relation to the mathematic idea presented (Hynes, 1986). Without this form of clarity the manipulative will not support mathematical concept (Hynes, 1986). Next, Hynes (1986) noted that choosing

manipulatives that relate to students' developmental level and learning style is also important. If a student is unable to correctly manipulate an object, the object should not be chosen for use (Hynes, 1986). Then, Hynes (1986) stressed the importance of using manipulatives to elicit interest and motivation to learn. When students are interested in what they are doing, they are more open to learning because it is not looked upon as work. Finally, the importance of versatile manipulatives was noted (Hynes, 1986). Objects that incorporate more than one sense at the same time can be very useful in the process of learning mathematical concepts (Hynes, 1986).

Manipulative criterion in reference to physical concerns should also be considered in addition to pedagogical concerns (Hynes, 1986). The focus of using manipulatives is that the objects can be manipulated by students, so it is necessary to use durable objects (Hynes, 1986). Simplicity is also listed as a criterion by Hynes (1986). Objects which are too complex detract from the mathematical idea represented (Hynes, 1986). As previously mentioned, student interest is important, so manipulative attractiveness increases student interest especially in the younger grades (Hynes, 1986). Hynes (1986) offers practical considerations for manipulative use and accessible to all students. This factor is important because both time and space are precious commodities within a classroom (Hynes, 1986). Hynes (1986) concludes his criterion with the subject of cost. He explains that manipulatives can be expensive, so when purchasing them, teachers should buy items that are versatile (Hynes, 1986). Another suggestion is for teacher to use hand-made manipulatives (Hynes, 1986).

Clements & McMillen (1996) offer suggestion on how manipulatives should be used within a classroom to create successful learning. Their first suggestion is to use

manipulatives frequently (Clements & McMillen, 1996). As Clements & McMillen (1996) see it manipulatives are often not used as frequently as they should, specifically in relation to mathematics. Clements & McMillen (1996) suggest allowing students to choose what manipulative to use for problems. They recognize that each student processes information differently, so by choosing their own manipulative, they are better able to meet their own individual learning needs (Clements & McMillen, 1996). Similarly, Clements & McMillen (1996) suggest that teachers "[e]ncourage students to use manipulatives to solve a variety of problems and then to reflect on and justify their solutions" (How Should Manipulatives be used, ¶ 4). By analyzing their results, students will be reinforcing the understanding achieved through manipulative use (Clements & McMillen, 1996). The last suggestion Clements & McMillen (1996) make is in reference to teacher attitudes. Often the success of manipulatives is based on the teacher's understanding of the manipulative, so they encourage teachers to become knowledgeable on the manipulative before presenting it to the students (Clements & McMillen, 1996).

Burns (2004) suggests several general instructions for the successful use of manipulatives. Her first suggestion is to introduce first time manipulative users to manipulatives (Burns, 2004). During this process the teacher should explain what manipulatives are, why they use them, and show physical examples for them to explore (Burns, 2004). Burns (2004) recommends that the teacher establishes rules for using manipulatives on the first day. Students need to particularly understand that manipulates are not toys, and they also need to be advised not to impede each other's exploration (Burns, 2004). Allowing time for free exploration of manipulatives is another proposition Burns (2004) makes, which allows the students to satisfy their curiosity.

"Teacher demonstrations alone are like eating papaya in front of the room and expecting children to know how it tastes" (Burns, 2004, ¶ 4). Another suggestion Burns (2004) makes is to involve parents. Parents may be unfamiliar with manipulatives; subsequently it is important to gain parental support by helping them understand why and how their child is using manipulatives in math class (Burns, 2004).

Previous Case Studies

One of the limitations to the study of manipulatives in a classroom math setting is the lack of previous case studies pertaining to manipulatives in a mathematical setting. Throughout my research on the topic of manipulative use, I found that the overwhelming majority of case studies which referenced manipulatives were based on studies done in relationship to project based learning and experiential learning. Studies such as those conducted by Baker & Mabie (1996) and Boaler (1999) did not specifically address manipulative use; rather these studies focused on the whole active learning approach.

One article that solely focused on manipulative use was "Controlling Choice: Teachers, Students, and Manipulatives in Mathematics Classrooms" (Jones & Moyer, 2004). Jones & Moyer (2004) took both a quantitative and qualitative approach to their research. The study was conducted in middle school classroom settings and focused on the amount of control/lack of control teachers have in regards to manipulative use in their classroom. The researchers, Jones & Moyer (2004), stated that they researched the practice of using manipulatives during their study, though details on this research were not actively discussed. Throughout this study, the primary focus was on the teachers

negation of control over manipulatives and then secondly on student participation (Jones & Moyer, 2004).

Part of the study focused on what occurred when students were given free access to manipulatives during math class (Jones & Moyer, 2004). This free access implied that manipulatives were made available to students, and the students were informed that they were freely able to use manipulatives of their choice throughout the lesson (Jones & Moyer, 2004). Jones & Moyer (2004) reported that students were skeptical at first, but as time passed most students became active in this process. "Observations and interviews with the teachers revealed that as the weeks passed students began to understand the purpose of manipulatives in the containers and, consequently, became more selective about the tools they obtained" (Jones & Moyer, 2004, The New "Script" ¶ 2). This free access period allowed students to take an active role in their own learning of mathematics.

In conclusion to their study, Jones & Moyer (2004) found that teachers attitudes toward manipulative use affects how students use and view manipulatives. Jones & Moyer (2004) found that when teachers display a negative view of manipulatives it inadvertently resulted in the students' improper use of manipulatives. Conversely, teachers who supported the use of manipulatives inadvertently had students who used the manipulatives to build a higher level of mathematical understanding. Ultimately, Jones & Moyer (2004) found that "[c]ommunicating representational systems, including manipulatives, visual images, and abstract symbols, helps students develop a deeper understanding of mathematics" (Conclusion ¶ 3).

Increased Knowledge

Several researchers have examined and discussed the issue of how manipulative use increases student knowledge. The results of the studies mentioned above all point to increased knowledge as a result of manipulatives and a hands-on approach to learning (Baker & Mabie, 1996; Boaler, 1999; and Jones & Moyer, 2004). Other researchers from the February, 1986 edition of *Arithmetic Teacher* such as Thornton & Wilmot, Moser, and Kennedy also conclude that manipulatives, if implemented properly in mathematics, will increase student knowledge.

Case studies conducted by Baker & Mabie (1996) and Boaler (1999) yield similar results. Both studies focused on the general topic of experiential/active learning and compared results of students who participated in activity based learning to those who only received teacher directed instruction (Boaler, 1999) and those who received no instruction (Baker & Mabie, 1996). The results of the Boaler's (1999) project based learning case study, showed that three times as many students, who were instructed through project based learning, received the highest possible grade on the national examination compared to the students who only received teacher-directed instruction. Boaler (1999) also reported that the students who participated in active learning produced higher test grades and retained more information then the students who only received teacher-directed instruction.

Baker & Mabie (1996) produced similar results. Before participating in a ten week program on agriculture, students where questioned on the food and fiber system. After the ten week period students were retested to see how active learning affected student outcomes. The results of the test displayed significant increases in knowledge

gained by the active learners, while the control group's test results displayed only slight increases if any (Baker & Mabie, 1996).

Researchers such as Moser and Kennedy who were published in separate articles throughout the *Arithmetic Teacher*, February 1986 edition, provide similar commentary on the increase of knowledge achieved through manipulative use during mathematics class. Moser and Kennedy note that manipulatives, when implemented correctly, help students to take the abstract ideas which are presented in math and make them concrete. Once the abstract ideas are concrete, students are able to use these mathematical concepts in a variety of situations; thus students are continually reinforcing what they have learned (Moser, 1986; and Kennedy, 1986).

Thornton & Wilmot (1986), who also were published in the *Arithmetic Teacher*, focus on the increased knowledge of gifted students. They explain that manipulatives increase knowledge of gifted students in at least six ways: "1. build concepts and related vocabulary; 2. improve spatial visualization; 3. allow discovery of patterns and relationships; 4. provide problem-solving experiences; 5. teach the essence of verification or proof; and 6. promote creativity" (Thornton & Wilmot, 1986, p.40). Gifted students, just like other students, can use manipulatives to develop a concrete level of mathematical understanding (Thornton & Wilmot, 1986).

Synthesis of Research

Experiential learning is the foundation for manipulative use. It is the type of learning environment in which manipulatives can be found if implemented properly. As noted, manipulative use should actively engage students in the manipulation of objects,

which should relate to mathematical concepts. Ultimately, manipulative implementation is only a success if it can be categorized as experiential learning.

Experiential learning also harbors a majority of the case studies which mention manipulative use. These studies, though they do not focus on manipulative use specifically, do however provide a strong context, in which I can ground my research. The results of project based learning display positive outcomes and detail accounts of increased knowledge.

Authors such as those found in the *Arithmetic Teacher* express how manipulative use produces increased knowledge, but they neglect to present case studies that support their claims. Instead they present their information in conversational format. I believe that their claims about manipulatives are valid, and I hope that through this case study I can present data that proves their theory and provides examples of how they work in an actually classroom setting. I have hopes that the data found will support the claims made by authors such as Thornton & Wilmot, Moser, and Kennedy in the *Arithmetic Teacher* that manipulative use increases knowledge.

Relationship to This Study

From these related studies already conducted, I will expand my research. These previous studies provide a framework for the background knowledge and implementation of manipulatives into classrooms. Through the models and suggestions that have been pre-established, the process of incorporating manipulatives into a classroom has been clearly stated. It is my goal to broaden the subject of manipulative use during math, by providing a study that contains detailed observations of classroom interactions during

manipulative use. The study will also incorporate direct feedback from the students in the classroom of study. The new information gathered in my study will not subtract from this pre established research; rather it will provide a new prospective to an existing practice.

Chapter Three: Methodology

Context and Setting

The study was conducted within the Winslow Township school district which is located in the Camden County region of South Jersey. Centrally located between Philadelphia and Atlantic City, this district of 58 square miles includes Albion, Ancora, Atco, Blue Anchor, Braddock, Cedarbrook, Elm, Rosedale, Sicklerville, Tansboro, West Atco, and Winslow (Winslow Township, 2005). Winslow Township is a Pre-Kindergarten through Grade 12 district, with four Elementary Schools, two Upper Elementary Schools, one Middle School, and one High School. The elementary school was chosen to house the study due to convenience, since I was student teaching there at the time of the data collection. The participants were not random, because all seventeen were taken from Mrs. K and Mrs. A's first grade collaboratively taught classroom where I student taught.

According to Census 2000 data obtained from its website, Winslow Township is 65.5% white, 29.3% black, 4.3% Hispanic or Latino, 0.3% American Indian, 1.3% Asian, 0% Pacific Islander, 1.6% some other race and 2.0% two or more races. The people of this community, according to Census 2000 data, have backgrounds of more than twenty seven different nationalities.

The socio-economic levels vary with a family income ranging from less than $10,000 a year to more than $200,000 a year. The majority of families in this area earn an income between $35,000 and $149,000 a year. The basic employment of the people

living in Winslow Township ranges from blue-collar jobs such as construction, transportation, and maintenance to white-collar jobs such as office positions, management, and sales. A small majority of the members of this community have farming, fishing, and forestry occupations (US Census Bureau, 2000).

To gain an understanding of the basic employment/socioeconomic levels of the district, the following information was gained through the US Census Bureau 2000 website. The labor force consists of 68.4% of the people in Winslow Township; this compares to the national average of 63.9%. $55,990 is the median household income in Winslow Township compared to $41,994 nationally. The median value of a single family home in Winslow Township is $112,800 while nationally the median is $119,600. In Winslow Township 4.5% of families are below the poverty line, verses a national average of 9.2%.

Participants

Demographic information was gathered regarding the participants, including birth date, race, gender, socio-economic status, academic level, number of parents at home. The students in this study are all first graders in a collaboratively taught classroom. The students ranged in age from seven years of age to eight. There are a wide variety of achievement levels within the participants. Three students participate in gifted and talented, while three students are identified as needing special education services. Other students are functioning on grade level, above grade level, and below grade level. Presently, a student is in the process of receiving testing, and it is believed that the student will qualify as emotionally disturbed.

There are seventeen participating students; seven are males and 10 females. Caucasian students hold the majority with thirteen students and only four African American students. Most students come from two parent homes. Together with their own interests and abilities they form the participants in the study (see Appendix B).

The number of subjects involved was determined by the number of permission slips returned and those that received parental permission. All students in Mrs. K and Mrs. A's first grade class were asked to participate. Because of the students' age, the students' parents were to make the decision of participation through filling out a permission slip. Out of the twenty seven permission slips sent home, twenty two were returned and completed, and five parents chose not to have their child participate. This calculates to an 81% return rate and participation rate within the class was a rate of 62%. Two students expressed that their parents did not want them to be video taped, thus they did not agree to the student's participation.

Mrs. K and Mrs. A have been teaching together for about six years. Mrs. K is the special education teacher in the room and Mrs. A is the general education teacher. Collaborative teaching involves the teaching of special and general education students together and having the support of both types of teachers all day in one classroom. Mrs. K and Mrs. A do not teach separate children, they both teach the whole class and often times they teach at the same time. They in essence perform the same tasks within the classroom. Their roles are only distinguished when students are placed in academically homogenous groups. When this occurs, Mrs. K works with the lower level group, though the levels of the groups are never discussed openly with the students. Though, Mrs. K

and Mrs. A are not included in the study it is important to understand the type of classroom presented in the study.

Instruments

The implementation process of the manipulatives into the classroom occurred prior to my arrival. Mrs. K and Mrs. A established a manipulative rich environment during the first weeks of school. Upon my arrival, the students were already instructed on the proper way to handle manipulatives or math tools as the students called them. On several occasions, I witnessed their implementation by Mrs. K and Mrs. A during math lessons. Within the classroom students, with teacher permission, had access to bins full of manipulatives. Though free access was rare, the students did have a strong familiarity prior to the study on how to use manipulatives during math.

A survey of the students' was taken in order together direct information about the students' interests (see Appendix C). This survey consisted of two parts. The first part asked the students to list their favorite and least favorite things. The students were given topics to reply to in order to keep there answers organized. For organizational reasons, the survey was made into two columns, one side for the students' favorites and one for their least favorite. Due to the study's length and the attention span of the students, only the favorite's side of the survey was used and completed in this study. The second part of the study was in the form of short answer questions. These four questions related to their home life, interests and preferences.

We Can See Geometry!, the self created unit based on the Harcourt Math: Teacher's Edition first grade curriculum, was used as the focal implementation of

manipulatives. The lessons taught in this geometry unit focused on the implementation of various manipulatives. Teacher observations were thus gathered during every lesson and recorded. These observations include whole group and individual student reactions. The observations also include particular strong or weak points in the use and implementation of manipulatives during each lesson. During one lesson, a video was used to directly capture students' reactions to the manipulatives.

Two tests were given to the students during this lesson (see Appendix D). Both were taken from the Harcourt Math: Assessment Guide. The tests covered information which they had been taught in the prior lessons while using manipulatives. The first test, which covered solid and plain shapes, was in the form of multiple choice. The second test covered symmetry, congruency and direction and was in the form of free response.

Incorporated into the unit plan was a math journal. This journal was used after several lessons to record students' feelings about the lessons and the use of manipulatives. The math journal gave the students fill in the blanks and prompts on which to write. Each student had their own journal, and they were collected after each entry.

Methods

Before beginning the study, Human Participant Protections Education for Research Teams certification was gained through the completion of an online course. Permission was then gained from the Institutional Research Board at the University of Rowan by submitting the necessary paperwork for approval. Then I obtained permission from the building principal to conduct research on the premises.

Permission slips were distributed to all the students in Mrs. K and Mrs. A's classroom (Appendix E). The students were instructed to give them to their parents. As recommended by Mrs. K and Mrs. A to ensure return of the permission slip, students were informed that upon return they would receive a brightly colored pencil. It was emphasized to the students that it did not matter which box their parents checked, just as long as it was signed and returned.

Before lunch five students were ask if the would like to stay in the classroom during lunch to complete the survey. Those who did not want to stay in for lunch completed the survey during writing class. Students were given the survey apart from their classmates, but due to the student's early reading and writing stage, I read the questions to the students and recorded their answers. If students were unable to think of an answer or did not want to answer a question, the space was left blank. All participants were asked to answer honestly and informed that there was no right or wrong answer. I explained that this survey was a way for me to learn more about what they like and dislike.

Data Analysis

Observational data from each lesson was analyzed by comparing normal levels of student participation and reactions to those gained during the use of manipulatives. Lessons were also compared to other lessons within the unit conducted differently to see if the way manipulatives are used changes effectiveness. The observations also allowed for the examination of diverse learners participation during the lessons.

The data obtained from the surveys was used in the video taped lesson, Solid Figures. Students were placed in groups according to their interests recorded on the survey. I then collected items relating to their interests in the form of different solid shapes. At least three items per student found on the survey sheet were incorporated into the manipulatives. Particular parts of the video taped lesson were transcribed to directly determine student feedback to the use of manipulatives and the relation to their interests. The video was also used to visually see the students' use of the manipulatives and their physical interactions.

Students' journals were analyzed to see each student's personal opinions on the use of manipulatives. The journals are examined to see common themes, such as the liking or disliking of a lesson due to manipulative use, subject matter and reasons outside the lesson. Then a few responses to why a student felt a particular way were chosen for dissection due to the interesting insights they shared.

The tests given were used in examining the effectiveness of manipulative implementation and the effects on students learning. The tests were graded and scored to find the class average. The accuracy of students' answers for each question was determined. This information was then used to determine a common theme as to why the students answered the question incorrectly. The tests also added in examining how diverse learners reacted to manipulative use by examining their test scores.

Summary

This study was conducted in an elementary school in the Winslow Township school district located in the Camden County region of South Jersey. Out of the twenty

seven students in Mrs. K and Mrs. A's classroom, only seventeen students returned the permission slip with parental approval so that they could be a part in the study. With help, the participants completed a survey which gathered information about their interests. This information was then incorporated into the unit, *We Can See Geometry!*, through the use of manipulatives. Information was collected throughout the teaching of this unit which focused on manipulative use. Collection of data was done through the use of video tape, student journals, tests and my personal observations. Data was triangulated through the examination of multi-sources (video, journals, tests, observations), and themes, scores and interesting remarks were analyzed.

Chapter Four: Data Analysis

Introduction

Throughout this chapter, I will focus on the results of my study dealing with manipulative use during math. I will attempt to answer the focal question: what happens when teachers use a manipulative approach to learning math? In accomplishing this, I will discuss manipulatives in relation to students' interests, opinions, and responses as well as the relationship to diverse learners.

Is there an increase in participation when manipulatives relate to students' interests?

After the students interests were surveyed, I used the information gathered to divide the students into three groups. My goal was to make teams who had similar interests as well as give equal team members on each team. Students' interests were then incorporated through manipulatives that related to solid geometric figures. For example, a box of instant mashed potatoes was used to represent a rectangular prism and a party hat was used to represent a cone. These physical items, which relate to students interests, were used as representatives of mathematical ideas (Kennedy, 1986). As soon as the bags were distributed to the groups, the students had trouble containing their excitement. Their chatter rose louder. I reminded them that if they were too loud they would not hear the queue word (detective):

Class: *Quiet, quiet, be quiet!* Slowly, they quieted each other.

T: *Detective*

There was a slight delay as the students possessed the word, then eager to explore all the items, the students emptied their bag and began.

Sitting in a circle, the blue team began to take their objects from the bag. Nina passed out the shape cards indicating which shapes each student got to sort. Danny faced the camera smiled widely and showed his three shape cards.

During this lesson, explicit directions were not given. Students were simply informed that they were to work together, and they were reminded not to grab from others. The blue team, eager to begin the task, made sure all team members could equally participate in the lesson by dividing the sorting process among the teammates. This decision to divide the sorting process was impressive. During previous group work projects within and outside of math lessons, students needed teacher prompting and explicit directions to complete a task. In this case, students independently devised their own plan of implementation so as to provide equal participation among all group members.

The actions of the students in conjunction with the normal levels of participation show that because the students were eager to begin using and looking at the manipulatives, they were able to participate fully in the process. As Hynes (1986) states, when students are interested in the manipulatives their motivation is increased, which is exactly what is seen here. The eagerness to begin is also shown through the huge smile that Danny displayed on his face once he was given shape cards to investigate.

The camera then pans to the green team. Tightly pressed against the bag, each member of the green team plunged their hand into the bag. Camie successfully pulled out the box of instant mashed potatoes. Her jaw dropped and her mouth formed the shape of

an "o." She smiled enthusiastically (this box was chosen specifically with her in mind due to it being her favorite food). Nicole reached toward the box, but quickly withdrew her hand undoubtedly realizing that efforts to take the box would be fruitless. Bea picked the pink wooden cube out of the bag. She flipped it around to see all the different pictures of birds (her favorite animal) displayed on its sides. Then she placed it in the pile marked with the pyramid shape card.

This team's process of participation was different, though their level of participation was just as high as the blue team. Students did not divide up the tasks, instead they all lunged their hand deep into the bag, eager to pull out an object. This group of students did not want to spend time dividing the tasks. Instead they choose to immediately begin. The members of this group were immediately actively engaged in the process of sorting the solid shapes.

All students on the green team were able to view all the objects, but some of the students took a particular interest in certain objects. Camie with her potatoes and Bea with the pyramid, these students took more time with particular objects. Clements & McMillen (1996) suggest that students investigate manipulatives in this way. They discuss that each student processes information differently, so by choosing their own manipulatives, they are better able to meet their own individual learning needs (Clements & McMillen, 1996).

Finished sorting their objects the yellow team sat beside their objects. Jon proudly told Mrs. K, the camera holder, that he has the movie *Godzilla*, an object in his team's bag. The team discussed the objects they sorted and double checked to make sure

they are sorted correctly. Rachell realized that a blue cube was mistakenly put with the rectangular prisms and moved it to the proper place.

I was impressed by the way the yellow team self corrected and checked their work. Students in this class are always encouraged to check their work after tasks and assignments. Normally, the students state that their answers are just fine and neglect to check their work. In this case, students were not asked to check their work, but they independently chose to self correct their answers. In contrast to normal levels of class work, this showed the high level of participation and willingness to be engaged in using the manipulatives. If this had been a regular pen and paper assignment, the students would have finished the task and then impatiently waited for the text task or in the case of math, lunch. Hynes (1986) stressed that manipulatives, which elicit interest, motivate students to learn. This is due to students being more open to learning because it is not looked upon as work when students are interested in what they are doing (Hynes, 1986). The initiative taken in this group shows the students desire to remain engaged in the same activity as well as their desire to learn.

This lesson went very well. The students were actively engaged throughout the entire lesson. It was interesting to see their reactions to the items in the bags. Comments could be heard throughout the room such as "cool dinosaurs," "hey that's my favorite movie," or "umm pizza." The students seemed very intrigued by the items in the bag; they also enjoyed looking at each others items. As Hynes (1986) stated when discussing the criteria for manipulative implementation, it is important to relate to students' interests. He suggested that students will be more motivated to learn because they are not viewing learning as work. I believe this is true and can be seen through the level of class

participation. As a whole there were no participation problems. Though they were intrigued by the items, the students still were able to properly sort them. All students had an active part in the sorting process.

According to the survey on students' interests, more than 50% of the students enjoyed working in groups. This lesson met the students' choice of working style by placing them in pre-selected teams. Watching the video was very helpful because it allowed me to see and understand things about student participation within the teams that I was unable to observe during the lesson. For example, I was very impressed by the way the blue team passed out their shape cards to each member, especially because it was not stated for them to organize in that manner. Similarly, it was interesting to see the green team eagerly grabbing items at the same time. Though they were less organized, all their team members examined the items and helped sort them by shape. The way in which participation was conducted in the groups varied, but the main focus still existed. All members of each team actively participated in the process of sorting shapes.

While teaching the lesson and during the guided practice stage, the students seemed very noisy. Through the video, I was able to hear the conversations more precisely, and found them to be constructive and on task. Normally, when these students are placed in groups they tend to discuss things outside of the classroom. A frequent discussion among these participants is what they did over the weekend and stories about their family life. During this lesson which focused heavily on manipulative use, only a few comments were off task. Most students focused their discussions on the manipulatives being used and the task at hand. For example, students from the blue team discussed the positioning of items. Kate questioned the placement of an item and Nina

helped her decided it was a sphere by going over the properties of the item. Students from the yellow team verbally named all the items in each group to make sure all were in the right place. Student conversational on task participation was increased during this lesson particularly in comparison with normal group work. Having students work together during math fostered an environment conductive of learning and using manipulatives.

How does the use of manipulatives meet the needs of diverse learners?

Out of the seventeen students who participated in this study three students are classified as eligible for special services and three students are offered accelerated classes. Together this yields a percentage of 35% of the participants are eligible for extended services either to help with current curriculum understanding or advanced curriculum. The participants which remain are a mixture of high and low level learners. This provides the context of diverse learners within the study. The following shows an observation taken during the lesson *Solid Figures* (see Appendix F), which use manipulatives relating to students interests:

One student at first did not want to participate. Antonio had his head down for the beginning of the lesson. When the teams were being given out, he did not raise his head, but slid it across his desk to watch.

Mrs. A – *Antonio [are] you going to do it buddy? Come on sit up hun.*

Antonio shook his head no without raising it.

Mrs. A - *Antonio even if you're not going to do it you need to listen to the directions.*

Antonio ignores her until his name is called to go into a team. As the other students assembled into their groups to begin, Antonio clung to Mrs. A and whispered in her ear *I don't want to work on a team.* Mrs. A gently coached him over to the bag by encouraging him to give it a try. As she walked over to his team, he crept slowly behind her. She peaked into his team's bag and exclaimed *Wow look at all the cool stuff.* Antonito moved closer and his eyes widened. As the other students began to empty the bag, Antonio moved closer and closer until finally his original statement was forgotten. Engulfed in the excitement, Antonito could be heard saying *Look at this! Cool! I have one of these! Let me see!* Original fears completely forgotten, he worked and participated in his group throughout the entire lesson.

The behavior observed above is completely outside of the student's normal behavior. Antonio, a student in the process of testing for special services, spends most classes with his head down unwilling to participate even when coached. Often times he pretended he was sleeping and had to constantly be asked to put his head up. This was seen in the beginning of the lesson before the manipulatives were introduced. Then on other occasions, he would be removed from the classroom due to aggressive behavior.

His behavior during the lesson was astonishing to me. He was not only interacting with the other members of the team, but he was answering questions and seemed eager to learn. I believe it can be stated that due to the use of manipulatives within this lesson Antonio was able to fully function as a learner within the classroom.

Two test scores were calculated during the unit plan *We Can See Geometry!* These test scores provide evidence that within a diverse classroom, such as this, all needs are being met through the use of manipulatives. Aside from the test scores, I was able to

evaluate the questions to determine why students might have gotten particular answers wrong. A pattern emerged which provided more evidence that manipulatives do enable abstract concepts to become concrete even when dealing with diverse learners. In this study I will examine one of these tests.

The first assessment which covered solid figures and plane shapes was completed with an average of 90.7% accuracy. The students answered questions number 1, 2, 8, and 9 with 100% accuracy. Question number 4 only received one wrong response. Out of the entire class, three students answered number 3 wrong as well as number 6, and four students answered number 5 wrong. The two questions, which received the most wrong answers, were numbers 7 and 10. Number 10 received five wrong answers while number 7 received nine wrong answers.

Question number 7 relates to the lesson *Plane Shapes on Solid Figures*. I believe this low score correlates to the students being unable to use all manipulatives. Due to time constraints, the students during this lesson were only able to examine two different solid shapes. In previous lessons, the students were able to use and investigate all manipulatives to make determinations. Many students indicated that they believed the answer was a rectangle. During the lesson, the students were told that the plane shape is hidden on the flat surface of a solid. After finding the flat surface(s), the students were to trace it/them to reveal the hidden shape. I feel that if all students were able to trace the cylinder they might have understood that the circle was the plane shape. Also, I found it to be surprising that on the previous question, which asks about the number of flat surfaces on a cylinder, only three students marked an incorrect answer. Then interestingly in question number eight, when students have to identify a circle, they are

all able to do so with 100% accuracy. I believe this means that the students understood and did not know the number of flat sides on a cylinder and the shape of a circle, but not how to find a hidden plane shape.

Five wrong on number 10 shows that I was correct in my feeling that the material on the lesson *Sides and Corners* was rushed. Students were able to identify the shape that corresponds to the amount of sides and corners in number 9 with 100% accuracy. The shape in number 10 was not a learned shape. The students needed to take what they knew about sides and corners and apply their learned knowledge. I believe that if the students had more time working with familiar and unfamiliar shapes they would have had a better understanding.

The students' attitude during the test was different then tests in the past. I did not hear any complaints; nor did I see any worried faces. Also, no students needed to be pulled aside for individual testing. The students for the most part took this test with ease. One student, who usually doubts himself started to in the beginning, but after the first two questions, gained confidence in himself. All students passed the objective of 70% or higher. Seven students completed their test with 100% accuracy, while eight students completed their test with 90% accuracy. That left only one student with an 80% and one with 70% accuracy.

As noted in the evaluation of the questions, students can recall information more clearly when they have ample time to use manipulatives prior to the test. I believe this is due to manipulatives enabling abstract concepts to become concrete even when dealing with diverse learners. This can be seen through the fact that all students were able to answer numbers 1 and 2 with 100% accuracy. These questions related to the lesson

where students used manipulates that were everyday objects and related them to solid shapes. All students were given the opportunity to use and apply the manipulatives, thus making the concept taught more concrete as noted on the test.

These findings are consistent with those found by Baker & Mabie (1996) and Boaler (1999). When students use active based learning, in this case manipulatives, they on average score higher and retain more information. Unlike their case studies, this study did not involve a separate test on students not using manipulatives, but the test did show that the amount of interaction with manipulatives affects the retention and understanding of material. Moser (1986) and Kennedy (1986) separately concluded similar finding. They both stated that manipulatives, which in this were actually solid shapes, help students to make abstract ideas, such as real objects being solid shapes, and make them concrete. This was seen through the students' ability to apply what they learned in the form of a standard pen and paper test.

How do students respond to manipulative use?

As mentioned earlier when discussing the effects of manipulatives relating to students interests and the effects on student participation, it was shown that manipulatives do increase students' participation. The following is a reflection of how the students responded to the use of manipulatives in the lesson *Symmetry*.

Using the cutout shapes helped the students to determine the line of symmetry in a concrete way. The students at first felt the need to fold the shapes, but by the end they were able to identify the line first and then fold to check. The first time the students received a shape that did not have a line of symmetry; one student raised his hand after a

few minutes. He said, "I don't understand...I can't fold it to make two sides the same." This student often struggled with math and later he mentioned, he thought it was just him not being able to do math. He was very happy when I told him that he was right about not being able to find a line of symmetry. He smiled and said, "Can I share it with the class?"

Throughout the lesson the students were very eager to share their answers with the class; they also were very fascinated by the shapes given to them which included fish, dinosaurs, shapes, and letters. When receiving their homework, I heard many students say how easy it looked. This was also portrayed in the results of their homework that showed that the students were fully capable of finding the line of symmetry.

The students were able to initially use the manipulatives as a means of physically finding symmetry by dividing objects, in this case paper shapes. This use of manipulatives helped to make the abstract idea of symmetry concrete by going through the division process. After using the manipulatives several times, the students were ultimately able to find the line of symmetry without physically dividing manipulatives. As seen by the one student's eagerness to share his answer, there is a sense of pride when they are able to successfully understand a concept. This student was not alone, all students were eager to participate not only in the use of the manipulatives but also in the answering of questions and the display of work.

What are students' opinions on manipulative use?

I began a writing journal that enabled the students to express their opinions about the lesson being taught in reference to the manipulatives used. Due to the age of the

students, I provided fill in the blank, fill in the circle and free writing. The students were asked on five different occasions to write about how they felt during the math lesson. Some students responded with discussion outside of what happened during the math lesson while others wrote one word answers. The students were only asked to write their opinions. They were not prodded nor were they penalized for lack of an opinion. The following are examples of student opinions (spelling was changed to provide ease in reading) on the lesson *Solid Figures*.

Nicole: Today in math I felt *excited! Today I was excited because the math escapade was great. It was fun too because I liked looking at everyone's shapes and being on a team and having shapes.*

Nina: Today in math I felt *happy. I wish we can do it again and the thing I did today that I felt happy about was sorting with all of my friends. It was so so so so so so fun and the people that I did...*

Jon: Today in math I felt *so happy! Math was fun today! I had fun at Math.*

Trish: Today in math I felt *happy. Because we did something new and it was fun organizing the shapes.*

The students' opinion of using manipulatives during math was very positive. They all mentioned their feeling of happiness during math. This lesson used multiple manipulatives in the form of real objects being compared to pictures of solid shapes. Because the whole lesson revolved around this, the mention of math being fun today in turn means using the manipulatives was fun. After evaluating the journals, I feel that the overall opinion of the students was that using manipulatives was fun, which then makes math enjoyable.

Bea, a gifted student, usually complains of boredom during class. Most times she already knows the information given in class, or she learns it within the first day of a new lesson. It can be challenging to get her to participate or pay attention during class for this reason. The following are several entries that she made in her journal (spelling was changed to provide ease in reading):

Entry #1: Today in Math I felt *board. Because everything we do I know and [it] makes me feel left out.*

Entry #2: Today in math I *felt happy and excited! Because I knew that we were going to do something fun and we did. And because we looked at other people's work.*

Entry #3: I would feel *board/sad* if I could not use solid shapes today. *Because it looks like a lot of fun!!*

In the first entry, the lesson did not involve manipulatives for the students to use. Bea as mentioned before found the lesson to be boring because it did not stimulate her. The following two lessons heavily relied on the use of manipulatives. Bea's attitude drastically changes from entry #1. In entry #2, she discusses that the lesson made her happy and excited and she states that she had fun. Bea states in entry #3 that she would again feel bored, like she did in entry #1, if she could not use manipulatives, in this case solid wooden shapes. Reading Bea's journal gives a clear statement of opinions towards manipulatives. Students, like Bea find the use of them fun and they give a nice break from the boring routine usually found during math lessons. Thornton & Wilmot (1986) explain six ways that manipulatives increase knowledge in gifted students. One way that I believe affected Bea was through the promotion on creativity. The promotion of creativity in turn provided a positive view on learning.

Conclusion

One unifying pattern found during the exploration of manipulatives is student eagerness to participate. I never heard "oh that's what we're doing" or "do we have to do that?" stated derogatively. Students began to look forward to math. I would have conversations most morning like this one:

Mindy: *Are we doing math today?*

T: *Yes.*

Mindy: *Cool! What are we going to do?*

T: *It is a surprise!* (This was always my answer)

Students also took initiative during activities that they did not occur on a regular basis. Students checked their work and divide tasks during group activities. Conversation on outside factors decreased about 15% during activities which focused on the use of manipulatives. During the lesson on *Symmetry*, students were so engaged in the lesson they did not want to stop for lunch. They asked if we could use our last manipulative before heading to lunch. This eagerness to participate was only present when the full use of manipulatives was present.

Their eagerness to use and explore manipulatives provides them with the openness to learn. Hynes (1986) stress the importance of interesting students through the use of manipulatives. He states that when this occurs, students are more open to learning because it is not looked upon as work. The goal of using manipulatives is to make abstract items concrete, but as Silberman (1996) states this can only happen if students can become actively engaged. In this study active engagement did occur as seen through

the levels of participation, and reinforced through the analysis of test scores, the average test score being at 90.7%.

Hynes' (1986) discussion is similar to what Silberman (1996) found in his study on active learners. When engaging students in active experience, such as the use of manipulatives, he found that active engagement stimulates the brain thus causing learning to occur. In this study, students' high level of participation can be seen not only through their interactions but through their test scores.

The students were never able to freely use the manipulatives, but they still enjoyed the process due to the stimulation. The work given them to investigate using manipulatives could have been just pen and paper worksheets as suggested by the Harcourt Math series. Students had a more enjoyable experience during math lessons using manipulatives instead of worksheets. About 75% of the students made direct comments, through their journals, that manipulatives are fun and/or exciting. Hence as Hynes (1986) discussed, the use of manipulatives fostered students' independent desire to learn.

Chapter Five: Summary

Summary of Study

Since the time of childhood, manipulatives have not only fascinated me but have helped me as well. As a pre-service teacher, I envision that my future classroom will incorporate the principles found in experiential learning. Providing students with a manipulative rich environment goes hand in hand with this image. Due to my strong desire to incorporate them into my own classroom, I chose to focus my study on manipulatives.

Throughout the study, I focused what happens when teachers use a manipulative approach to teaching math? In the quest to answer this question, four sub-questions emerged: 1. Is there an increase in participation when manipulatives relate to students' interests? 2. How does the use of manipulatives meet the needs of diverse learners? 3. How do students respond to manipulative use? 4. What are students' opinions on manipulative use? The evaluation of these sub-questions lead to a focused answer of my main topic question.

To better answer these questions, I examined related literature in order to gather prior knowledge relating to my study. Four areas emerged within the related research: (a) experiential learning, (b) implementation, (c) increasing knowledge, and (d) previous case studies. Current literature and case studies were examined as well as postdated articles due to their significance in the field of manipulative use.

Researchers and writers such as Diem (2004), Boren & Hartshorn (1990), Stevens & Richards (1992), and Silberman (1996) acknowledged the connection between manipulatives and experiential learning. Silberman (1996) discussed active learning, another name for experiential learning, by focusing on why it is beneficial to all learners. Throughout his study, Silberman (1996) repeatedly stated that active engagement provides stimulation to the brain causing learning to occur. Silberman (1996) emphasized that for complete processing within the brain the students must be actively engaged. As Boren & Hartshorn (1990) stated, manipulative use is a hands-on process in which the learner is "manipulating" objects. As in this definition, manipulatives provide necessary stimulation of the brain which in turn aides the learning process.

Burns (2004), Clements & McMillen (1996), Hynes (1986), Bright (1986), Kennedy (1986), Boren & Hartshorn (1990), and Schultz (1986) agree that manipulatives, a type of experiential learning, need to be implemented properly in order to be an effective tool. Hynes (1986) focused his discussion on the importance of clarity, physical properties, and cost when choosing and implementing manipulatives. Clements & McMillen (1996) suggested that manipulatives should be used often and be encouraged positively by teachers. Burns (2004) went into detail of the step by step process of implementation.

One previous case study that specifically focused on manipulatives in a math setting was conducted by Jones & Moyer (2004). Their study's concentration was on the effects of teacher control of manipulatives. Included in their study, student participation was addressed. In the conclusion of their study, Jones & Moyer (2004) found that student participation had a direct effect on student use of manipulatives. When teachers

viewed manipulatives positively, students used manipulatives to build a higher level of mathematical understanding.

Moser and Kennedy who were published in separate articles throughout the *Arithmetic Teacher*, February 1986 edition, provided similar commentary on manipulatives in relation to increased knowledge. Both stated that manipulatives help students take abstract ideas, presented in math and make them concrete. Once concrete, the mathematical concepts can be used in a variety of situations, ultimately reinforcing what they have learned. Thornton & Wilmot (1986) focused their discussion of increased knowledge on ways manipulatives affect gifted students. They felt that gifted students can gain from manipulative use just like any other student.

This study broadens the subject of manipulative use during math by providing detailed observations of classroom interactions during manipulative use as well as direct feedback from the students in the classroom. This data was gathered during the self created unit *We Can See Geometry!* Seventeen students from Mrs. K and Mrs. A's first grade class, located in Winslow Township, participated in this study. Video tape, student journals, tests and daily observations were ways in which the data was collected. Data was then triangulated through the analysis of these sources to find reoccurring themes and patterns.

After analysis, one unifying pattern emerged. Students became eager to participate in math lessons due to manipulative use. Math, which falls directly before lunch, is a time where normally about 30% of the conversation is discussion and complaints by the students of physiological factors such as tiredness and hunger. During the lessons which relied heavily on manipulative use, this percentage decrease to about

5%. In the lesson *Symmetry*, student complaints of physiological factors even became nonexistent. During this lesson, students were so engaged that several asked to do one more exercise with manipulatives before heading to lunch. This eagerness to participate did not occur to this extent when manipulatives were not present within the study. Through the use of manipulatives students, students became engrossed in their learning process.

Through observations of student conversation and journal writings, students found using manipulatives to be fun and exciting. About 75% of the students made direct comments, through their journals, that manipulatives are fun and/or exciting. There eagerness to use the manipulatives during math made them more open to the learning process. As Silberman (1996) discussed, the stimulation, in this case the manipulatives, caused their brain to retain and apply the information. This could be seen through student tests scores, the average score being completed with 90.7% accuracy. Students did better on questions when lessons were reinforced through the use of manipulatives such as questions number 1 and 2 which were completed with 100% accuracy. Hence, in this study it can be said that manipulatives aided in increasing student knowledge.

Implications

As previously mentioned, the U.S. Department of Education (2004) has determined there is a proficiency gap in the area of math. As educators, we should try to close that gap by exhausting all measures available. The process of using manipulatives during math to increase learning is one measure that is always readily available.

This study affects the field of teaching by showing that manipulatives work within a classroom setting. Through the examination of student test scores, it was found that when students used manipulatives to explore during math lessons they were able to retain more information. I have hopes that this study encourages teachers to implement manipulatives into their math lessons, ultimately moving closer to closing the gap on math proficiency.

Implementing manipulatives into the classroom is important, but teachers need to achieve a comfort level for using the manipulatives within their classroom. As Clements & McMillen (1996) suggest teachers attitudes toward manipulatives can affect their success within the classroom. It is important for teachers to become knowledgeable on the process of manipulatives, before presenting them to the students (Clements & McMillen, 1996). If teachers become eager to use manipulatives, their eagerness transposes onto their students, and the same can be said about negative feelings toward them (Jones & Moyer, 2004).

Manipulatives can be as complex or simplistic as the implementing teacher chooses. Some districts, such as Winslow Township, not only encourage the use of manipulatives, but they provide teachers with manipulatives to use within the classroom. Manipulatives can also be found in kitchen cabinets, closets, and even in a backyard. The key is for teachers to use objects that are easy to access and are comfortable to them. As seen by the literature in this study, teachers can find a multitude of support in their quest to understand and feel comfortable with using manipulatives. With the achievement gap ever present, it is important for teachers to feel comfortable enough to support and implement the process of manipulative use within their classroom.

The use of manipulatives in this study effects student learning in several ways. Students, as just mentioned, scored higher on questions when given the opportunity to use manipulatives. They also were more at ease when answering questions on the test. All students, gifted and special needs, were able to take the test together; no one needed individual attention during testing.

Beyond test taking, students became eager to learn. They began to look forward to math lessons. Their attitude toward math for the most part became positive. Their desire to explore during the lessons caused participation to soar. Through this excitement, they were able to learn more because it was interesting to them. Students who had found math boring, now found it enjoyable. Learning was no longer considered work, instead it was considered fun.

As mentioned in the beginning of this document, there were many limitations to the generalization of the study. This leaves room for a multitude of future research. I think a comparison study would be interesting to see the effects on student test scores with and without using manipulatives. The study could be conducted on two separate classes to see, if one class scores higher than the other when taking the same test but being taught differently.

Another way to expand the study of manipulative use would be to repeat this study with another group of students. Instead of taking students from the same class and school, randomly sample students from different first grade classrooms across the county. The absence of familiarity may cause a different occurrence. It would be interesting to see if participation levels still remained high.

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Appendices

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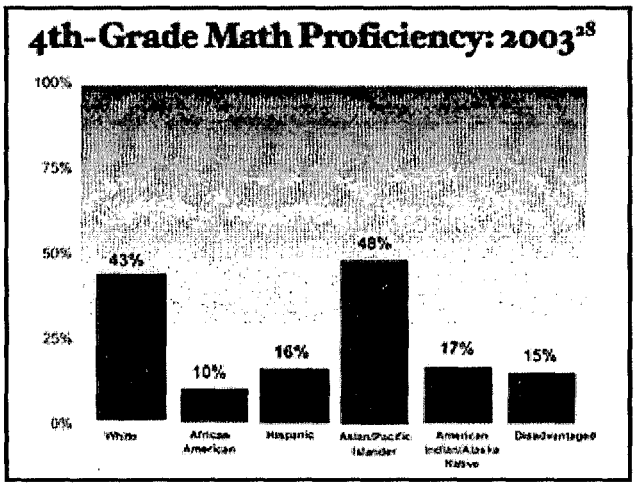

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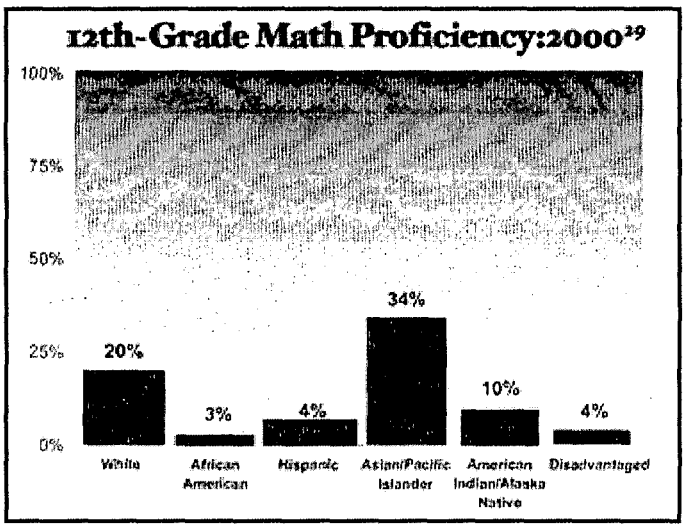


U.S. Department of Education, National Center for Education Statistics. National Assessment of Educational Progress, 2000 Mathematics Assessments. Disadvantaged defined by eligibility for free/reduced-price lunch.

Student Demographic Chart

Name **	Date of Birth	Gender	Race	Socio-economic Status	Academic
Antonio	2/12/1998	Male	Caucasian		Low
Brittney	5/31/1997	Female	African American	free lunch	Low/Average
Nicole	8/17/1998	Female	Caucasian		Average
Trish	1/7/1998	Female	African American		High
James	11/14/1997	Male	Caucasian		Average
Nina	11/4/1997	Female	Caucasian		High
Jon	12/2/1996	Male	Caucasian	free lunch	Special Needs
Nicholas	7/21/1997	Male	African American	free lunch	Low/Average
Mindy	8/20/1998	Female	African American		Average/High
Jack	7/14/1998	Male	Caucasian		Average
Kilee	9/9/1997	Female	Caucasian		Average/High
Michelle	6/23/1998	Female	Caucasian		High
Rachell	5/4/1998	Female	Caucasian		Average
Danny	8/15/1998	Male	Caucasian	free lunch	Special Needs
Bea	2/23/1998	Female	Caucasian		High
Jeremy	6/17/1997	Male	Caucasian		Average/High
Camie	6/18/1998	Female	Caucasian	free lunch	Special Needs

** All names have been changed to protect individuals privacy rights

My favorite…	**My least favorite…**
color:_____	color:_____
food:_____	food:_____
drink:_____	drink:_____
TV show:_____	TV show:_____
movie:_____	movie:_____
song:_____	song:_____
book:_____	book:_____

favorite (cont'd)	least favorite (cont'd)
sport:_____	sport:_____
game:_____	game:_____
toy:_____	toy:_____
season:_____	season:_____
subject:_____	subject:_____
special:_____	special:_____
animal:_____	animal:_____

Do you have any pets?

What are they?

Do you like working by yourself or as a team? Why?

Other interests:

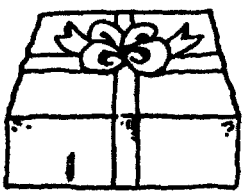
Name _____

Choose the correct answer.

1. Which solid matches this hat?

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

2. Which solid matches this box?



Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

3. Mark the solid that will stack and roll.

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

4. Mark the solid that will **not** slide.

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

5. How many flat surfaces are on a  ?

Ⓐ 1
Ⓒ 5
Ⓑ 4
Ⓓ 6

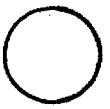
6. Which solid has only 2 flat surfaces?

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

Go On

Name _____

7. Which flat surface is on a cylinder?

Ⓐ 
Ⓒ 
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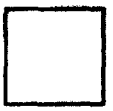
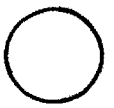
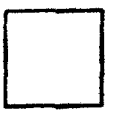
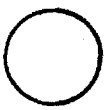
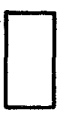
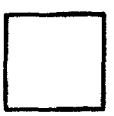
Ⓓ 

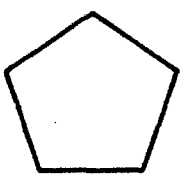
8. Which shape is a circle?

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

9. Mark the shape with 3 corners and 3 sides.

Ⓐ 
Ⓒ 
Ⓑ 
Ⓓ 

10. How many sides does this shape have?



Ⓐ 3
Ⓒ 5
Ⓑ 4
Ⓓ 6

Stop

Dear Parent/Guardian:

As you know, I am a graduate student in the Education Department at Rowan University. Part of my requirement is to conduct a research project. Under the supervision of Dr. Susan Browne, I will be conducting my master's thesis concerning the use of manipulatives (math tools) during math. I am requesting permission for your child to participate in this research. The goal of the study is to observe how students use manipulatives during math and how they feel about using them.

Manipulatives, known to your child as math tools, are a part of the preexisting math curriculum. They provide your child with visual representations of math problems. I will be observing your child's daily interactions with the manipulatives during math. To collect this data, I will take written observations as well as videotape a lesson. I will retain the videotapes at the conclusion of the study. To preserve each child's confidentiality only first names will be used to identify individuals when on film and the video will be used research purposes only. The students will be asked to answer a survey about their feelings toward using manipulatives and their interests. The students will also be asked to write in their journals about their feelings toward manipulatives. Students will be identified by surnames when included in the thesis.

Your decision whether or not to allow your child to participate in this study will have absolutely no effect on your child's standing in his/her class nor will it change their daily routine. If you have any questions or concerns please contact me at (609)922-9809 or you may contact Dr. Susan Browne at (856) 256-4500 ext 3748. Thank you.

Sincerely,

Kathren Barraclough

Please indicate whether or not you wish to have your child participate in this study by checking the appropriate statement below and returning this letter to your child's teacher as soon as possible.

____ I grant permission for my child _____to participate in this study.

____ I do not grant permission for my child _____to participate in this study.

_____ _____

(Parent/Guardian signature) (Date)

Preparation Prior to Lesson

Lesson Topic and Grade:

Geometry: Solid Figures; 1st grade TAM

Materials and Advanced Preparation:

Prior to the lesson, I surveyed, with parental permission (Ap.A), the students to determine students' interest (Ap.A). Following the survey, I acquired items related to the students' interest, which also correspond to the solid shapes being discussed, so this is how the items and teams (Ap.A) were divided.

Camcorder (not a requirement for lesson), practice 20.1 (Ap.B), word cards (sphere, cone, cube, cylinder, rectangular prism, pyramid) (Ap.A), tape, solid shape blocks, math journals (Ap.A), labels with a word card and picture (5 sphere, 5 cone, etc.), 5 bags labeled by team color with the following items:

Red –Granola Bars: S'mores box, The Black Cauldron video tape, orange, golf ball, Incredibles bouncy ball, party hat, orange top, coke can, can of mushrooms, sound wand, green Sponge Bob pyramid, white Snoopy basket ball cube, blue Disney cube

Yellow –basketball, tiger tennis ball, Incredibles bouncy ball, Godzilla video tape, Ellio's Pizza Box, blue Sponge Bob pyramid, Mountain Dew can, chicken noodle soup can, blue megaphone, party hat, green top

Orange –Triscuit Box, lemonade soda can, can of sauerkraut, pink lemonade can, cheetah tennis ball, golf ball, party hat, red top, green Sponge Bob pyramid, red dice, blue Disney cube, Pocahontas video tape

Blue –Bagel Bites box, Lion King video tape, pink cat pyramid, blue Sponge Bob cube, blue football Snoopy cube, party hat, purple megaphone, yellow top, baseball, Incredibles bouncy ball, can of beans, Canada Dry ginger ale can

Green –mashed potatoes box, 101 Dalmatians video tape, soccer ball, Dalmatian ball, Incredibles bouncy ball, orange megaphone, pink top, party hat, chicken noodle soup can, fruit punch soda can, blue Disney cube, orange Barbie cube, pink bird pyramid

Prior Specialized Knowledge:

How to sort, how to handle math tools, general knowledge of solid shapes

Lesson Performance Objective:

Students will be able to identify spheres, cones, cubes, cylinders, rectangular prisms, and pyramids and to relate them to everyday objects

NJ Standard/Indicator:

4.2.1st.A2- Use concrete objects, drawings, and computer graphics to identify, classify, and describe standard three-dimensional and two-dimensional shapes
4.5.1st.A1- Learn mathematics through problem solving, inquiry, and discovery.
4.5.1st.A4- Pose problems of various types and levels of difficulty.
4.5.1st.A5- Monitor their progress and reflect on the process of their problem solving activity.
4.5.1st.B1- Use communication to organize and clarify their mathematical thinking.
4.5.1st.B2- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others, both orally and in writing.
4.5.1st.B3- Analyze and evaluate the mathematical thinking and strategies of others.
4.5.1st.B4- Use the language of mathematics to express mathematical ideas precisely.
4.5.1st.C3- Recognize that mathematics is used in a variety of contexts outside of mathematics.
4.5.1st.C4- Apply mathematics in practical situations and in other disciplines.
4.5.1st.D4- Rely on reasoning, rather than answer keys, teachers, or peers, to check the correctness of their problem solutions.
4.5.1st.E1- Create and use representations to organize, record, and communicate mathematical ideas.

Actual Lesson

Anticipatory Set/Purpose:

Did you know shapes are all around us? In our classroom... In your desk...In your bedroom... Well today we are going to sort objects that we see everyday.

Input and Modeling:

Place the shape word cards on the board. Tell the students that first we are going to review the solid shapes we discussed yesterday. Hold up a wood block of a cylinder and model your thought process. Talk out loud about what the cylinder looks like then exclaim "this must be a cube, so I will place it in the cube under the word cube."

Checking for Understanding:

See if the students respond to the wrong answer. Ask if someone can come show me where the object should go. Then hold up a classroom item and have the students tell you where to put the item.

Input and Modeling:

Tell the class that they will be divided into teams. Explain that these teams are different from the ones you are in now. Each team will have a bag of items and an envelope with labels. As a team, they will sort the objects by shape. Emphasize that each team member should have at least two turns deciding where an object should go. Show them the solid shape pictures and words that are found in the envelope. Instruct them to wait until you

say the word "detective" to begin. Divide the students into pre-selected teams; move them to an area of the room. Give them the pre-selected bag, and an envelope.

Checking for Understanding:

Ask the students the following questions: When we are in our new teams should we fight? What about sharing and grabbing? What should we do?

Input and Modeling:

After all teams are ready, say the word "detective." The students will then begin. Float around the room to observe and monitor the students' transactions.

When finished have the students walk around the room to observe the objects their classmates sorted. When finished have the students return to their areas and sit on the floor.

Checking for Understanding:

Have the students volunteer what items they saw that correspond to the solid shapes. Point to the different shapes one at a time until all are completed. Ask if the solid shapes are still the same if they are upside-down, or on the side.

Independent Practice:

Have the class take out their math journals. Have them write at least two sentences about their feelings in math class today. Make writing suggestions before they begin such as: How did you feel today when you were working with the objects? Happy, sad, confused, excited, frustrated? Did using the objects help you remember the shapes? Did you know that these objects were solid shapes?

They will also do practice 20.1 for homework, which reemphasizes the activity done in class.

Differentiated Instruction:

The students will have solid shape cards, which contains the name and picture of the solid shape. This way the students who are unable to read the name of the word, have a picture prompt. Students are paired with other students of different abilities; this provides opportunities to challenge the accelerated students to assist those with special needs. It also provides students with disabilities a way to get the help they need.

Some students may need extra attention during the writing exercise. Some may have ideas but are unable to write them. Allow them to tell you the sentence. Write that sentence and then they rewrite it.

This class uses an auditory technology device. Each teacher wears a microphone around their neck that is connected to a speaker in the room. Though not specified in any students' IEP, this device aids in auditory processing by keeping a consistent level of the teachers' voice. This particular classroom has a very loud heater system, so the auditory device benefits all students.

Closure:

If the students are not finished with their journal, explain that they will have a small amount of time after lunch to finish. Have them clear their desks. Tell them that our detective work is not done. Explain that tomorrow we will get to investigate our shapes again.

Relevance/Making Connections

Curriculum Integration:

This lesson incorporates the subject areas of reading and writing. The students will be reading the names of the shapes as well as using picture cues to help them decode the words. Writing is incorporated through the students' math journal, when the students fill in sentences about their feelings towards the math activity.

Multiple Perspectives/Multicultural Content:

The students' perspectives will be shared by their thoughts on why an object should be placed with others. Also the writing process allows the students to share their own perspective of how the lesson went. There is no right or wrong answer all perspectives are appreciated.

Plan for Assessment

Your Teaching:

This lesson will be video taped, which will allow for a thorough evaluation of my pacing, helpfulness, questioning, etc. Students' participation in answering questions, as well as the answers they give will allow me to evaluate the clarity of my questions. Due to the nature of the classroom, I will also be able to discuss these issues and reflect with the cooperating teachers after the lesson.

Learners' Performance:

The students will be expected to participate within their group, show proper handling of their math tools, be respectful of others when they are speaking, help team members, and show attentiveness.

Evidence Objective Was Met:

Evidence will be seen through student participation and their ability to complete practice 20.1. I will be monitoring the room during the guided practice to observe the level of participation and to see if any students are struggling. The following morning I will evaluate the students' homework to see if they are able to independently apply the concepts learned.

If a majority of students do not meet the objective, I will re teach the lesson. Upon re teaching, I will focus more on a complete modeling and whole group approach. Also, I will focus more on describing how objects relate. If it is a few individuals who do not reach the objective, they will receive extra help during center activities as well as individual attention during the following math class.