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EFFECTS ON STUDENT PERFORMANCE OF USING HANDS-ON ACTIVITIES TO
TEACH SEVENTH GRADE STUDENTS MEASUREMENT CONCEPTS

by

DARLENE M. HOKE
B.S. Nova Southeastern University, 1998

A thesis submitted in partial fulfillment of the requirements
for the degree of Master of Education in Mathematics and Science
in the Department of Teaching and Learning Principles
in the College of Education
at the University of Central Florida
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Major Professor: Juli K. Dixon

ABSTRACT

Student performance on measurement concepts in mathematics was the basis for this action research study. This study summarizes research conducted in a seventh grade classroom at an urban middle school during fall of 2005. The study investigated the practice of using hands-on activities in addition to the standard mathematics curriculum to improve student performance in measurement tasks. Students were asked to respond to questions posed by both teacher and other students in the classroom. Data were collected using measurement survey, focus group discussions, math journals, and teacher observations. Results of this study showed that student performance on measurement tasks increased throughout the course of the study. Student gains were recorded and analyzed throughout the eight-week study period. Twenty-one out of 26 students that participated in the study showed performance growth in measurement concepts.

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Gratitude cannot begin to explain the emotions I have towards Juli Dixon for her continued belief that I could finish this task. Without her guidance and support, I would have never made it. I also owe a debt of gratitude to my husband for taking care of the girls while I worked to meet my deadlines. Lastly, I have my lovely daughter to thank for believing with her whole heart in me.

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CHAPTER ONE: INTRODUCTION

Rationale for the Study

Students entering their first year of school begin eager to learn; however, something happens when they approach their middle school years. Eccles and Wigfield (as cited in Palincsar, Anderson, & David, 1993) reported considerable developmental declines in academic achievement in grades 6, 7, and 8, as well as declines in intrinsic motivation. Fewer students elect to take higher-level mathematics and science courses as they progress from middle school onward into their high school years. Do students lose this motivation due to lack of focus on relevance of mathematics to the real world? Does the focus change due to wondering ‘when will I ever use this?’ Or have students lost motivation due to rushing them into using higher levels of thinking than they are capable? Do they lack the skills and comprehension needed for higher thinking?

In many cases, we as a population are expecting more and more from today’s students often without providing them the resources they need. It begins with kindergarten, where we are reducing play time for children. Play or recess is crucial for students for their developmental needs. Students begin testing on higher level thinking at younger ages such as 3rd and 4th grades. Students are expected to achieve higher developmental stages earlier in their lives, with increased knowledge of mathematics both taught and retained.

Yet, what methods are affective in supporting students’ retention of mathematics? “Numerous scientific studies have shown that traditional methods of teaching mathematics not only are ineffective but also seriously stunt the growth of students’

mathematical reasoning and problem-solving skills” (Battista, 1999, p. 426). In the traditional mathematics classroom, strategies are the same every day. Examples of several problems are shown followed by students practicing similar types of problems in class and at home. Resorting to the methods of the past does not provide the desired effects on student performance.

Research shows that there are benefits to students exploring mathematics using alternative methods such as collaborative groups, manipulatives, journaling, and hands-on activities (Curtain-Phillips, 2000; Harper & Daane, 1998; Wolodko, Willson, & Johnson, 2003). Students then build confidence in their abilities to do mathematics and develop skills in higher order thinking, while making connections to “real world” applications.

In the process of learning mathematics using alternative methods, skills in questioning the meanings and purpose of mathematics develop. Teachers learn that questioning students is imperative through college methods courses to developing higher order thinking skills; however, teachers do not always implement this technique in the study of mathematics (Inman, 2005; Mason, 2000, Nichol, 1999). Neither are student questioning addressed in the sense of trying to increase their understanding and comprehension of mathematics (Mason, 2000). Using alternative methods and opportunities to explore higher-order thinking skills, teachers place value for students to learn mathematics.

Similar to many states, Florida requires students in grades 3 through 10 to take state assessment tests; students take the Florida Comprehensive Assessment Test (FCAT). The purpose of FCAT is to increase student achievement by implementing

higher standards and improve educational effectiveness. According to the Assessment and Accountability Briefing Book (Florida Department of Education, 2004), the FCAT is divided into two components: criterion-referenced tests (CRT) measuring selected benchmarks in Mathematics, Reading, Science, and Writing from the Sunshine State Standards (SSS) and norm-referenced tests (NRT) in Reading and Mathematics measuring individual student performance against national norms. The mathematics portion of the test is broken down into subtests that measure how well students apply concepts in five strands of mathematics. These strands, algebraic thinking, geometry, data analysis, number sense, and measurement, have specific content correlated with grade level expectations designed for all teachers to follow in the state of Florida.

Based on the Florida Department of Education Web site, data indicate that students in all grade levels have difficulties successfully completing problems in the measurement strand (<http://www.firn.edu/doe/sas/fcat.htm>). For grades six through eight, average percentages in this subtest during 2004-2005 indicated a drop in measurement from the previous year representing the need for improvement in this area. In the county where this study was conducted, average percentage scores for students in the same grades indicated that the students across the county scored equal to or slightly above the state mean in measurement during the 2004-2005 school year. The decline in measurement and low percentage in the measurement strand drove my desire to conduct this action research study.

Purpose of the Study

The purpose of this study was to examine how changing my teaching methods to include hands-on activities affected student performance through data sources using qualitative and quantitative methods. Specifically, this research examined the effects of using hands-on activities to teach middle school students strategies involving measurement. Within the scope of this study, I considered the following research questions:

Research Question #1

Does teaching measurement using a hands-on approach affect student performance on tasks related to measurement?

Research Question #2

In what ways do hands-on activities enhance students' independent question posing and attitudes related to measurement?

Significance of the Study

Throughout history, humans always found ways to measure. We used scratch marks carved on rocks or pebbles next to gates to count how many animals in a herd. Deep marks in boulders were used to indicate length for buying fabric. Since the beginnings of humanity, some semblances of numbers and measurement have existed. The fabric of our lives still revolves around our abilities and desires to measure everything using many different methods, including financial worth.

Measurement is an important piece of our mathematical knowledge as it not only integrates every academic subject, but also has applications to every other mathematical

strand developed by National Council of Teachers of Mathematics (NCTM). According to the NCTM (2000) *Principles and Standards for School Mathematics*,

Instructional programs should enable all students to-

- understand measurable attributes of objects and the units, systems, and processes of measurement;
- apply appropriate techniques, tools, and formulas to determine measurements (p.240).

Learning to measure requires students to manipulate, explore, and question how measuring tools are used and what happens when an objects dimensions change.

With the knowledge that measurement requires manipulating, exploring, and questioning teachers need to provide students opportunities to do this (Burns, 2000; Chapin & Johnson, 2000; Johnsen, 2001; Kamii & Clark, 1997; Piaget, Inhelder, & Szeminska, 1960/1981). Teaching in measurement begins with students learning to partition objects into equal objects and later use transitivity to find the measure of the objects. Transitivity in this study refers to the student's ability to figure out relationships between two or more other relationships that may or may not be equal (Stephan & Clements, 2003; Kamii & Clark, 1997; Piaget et al., 1960). Students typically receive nonstandard items to use as measuring tools such as bears, paper clips, or blocks. Then they compare the objects to determine or approximate length. Measurement becomes procedural. For example, students receive a ruler and must measure objects with it. Next, formulas for area and perimeter are introduced with demonstrations of how to use the formulas. Plug numbers into the function and the result will be the answer needed. This continues through the students learning about volume of three-dimensional figures

Conceptual understanding related to perimeter, area, and volume does not receive the emphasis needed (Boston & Smith, 2003). How do students develop necessary conceptual understanding? Various strategies such as using hands-on activities and journaling about learning experiences build communication skills through peer and teacher discussions. Consequently, students develop conceptual understanding needed in mathematics (Daniels, Hyde, & Zemelman, 2005). Using journals as a learning strategy builds communication between teacher and students, which allows every student opportunities to share their opinions and feelings regarding their learning of mathematics (Raffini, 1996). Additionally, with opportunities to reflect on hands-on experiences in journals, students develop a deeper understanding of mathematics skills, leading to increased performance on state assessment tests (Wolodko, Willson, & Johnson, 2003). Using journal writing as a means of communication, students develop deeper understanding of mathematics concepts, including measurement, increasing their mathematical reasoning and comprehension.

In order to promote the development of student conceptual understanding of measurement, I decided to change my teaching strategies to include the use of hands-on activities in conjunction with journal writing as a means of student reflection. To explore more mathematics and teach students to have a deeper understanding of measurement became my drive. I distinctly remember my learning experiences in mathematics, from viewing problems on an overhead to imitating how problems were worked through homework assignments and tests. “If students are asked to spend most of their time learning and practicing procedures that they see as having no connection to real life, they will think mathematics is something that cannot be understood” (Steele & Arth, 1998, p.

45). My personal development of a deeper understanding of mathematics failed to exist. Through this project I focused on my teaching practice while investigating techniques in teaching measurement to middle school students with the hopes of improving my own knowledge related to teaching measurement in more effective ways.

In the next chapter, I examined literature related to reform in student and teacher perceptions in mathematics from traditionalism to learning through using hands-on techniques. I discussed stages of development for learning measurement. I explored how students learn mathematics; specifically focusing on how students learn measurement. I discussed differing views on how students learn mathematics. Finally, I examined students learning using various teaching techniques, such as hands-on strategies, journaling, and collaborative groups

CHAPTER TWO: REVIEW OF LITERATURE

Introduction

The need for skill in measurement exists in all areas of our daily lives. Waking up in the morning or evening, being “on time” to work, knowing what day of the week it is, and knowing the day of year require knowledge about measurement of time. Keeping track of the amount of gas needed to drive to work, knowing the distance to work or school, and figuring the amount of work needed to pay the bills measure fluid, length, and wealth are examples of how measurement affects a small portion of our daily lives, leading to the need to develop proficient skills in measuring. Yet, “in spite of how regularly we use measurement, results of national and international assessments indicate that U.S. students of all ages are significantly deficient in their knowledge of measurement concepts and skills” (Chapin & Johnson, 2000, p. 177).

With the rise in career fields requiring more mathematics and science, emphasis on mathematics and science education continues to grow with the pressure to improve student performance increases. This is not a recent phenomenon. According to Assessment and Accountability Briefing Book (2004), the Florida Department of Education has been working to “improve educational effectiveness” since 1968. The resulting action to “improve education effectiveness” is the Florida Comprehensive Assessment Test (FCAT). As stated previously, it is divided into four main components focusing on Writing, Reading, Science, and Mathematics. Tests exist for all grades levels in Reading and Mathematics.

Most school districts now rely on state assessment tests to determine student achievement of learning goals as well as teacher performance, so teachers are under pressure to cover all material, in essence “teaching to the test” (Battista, 1999). Battista mentioned that this is particularly evident in mathematics, where teachers “cover” the standards. Pressures to achieve well on state assessment tests also stem from the media, principals, district administrators, and parents who evaluate teachers and schools on the basis of a state assessment test score that may assess procedural knowledge alone (Resnick & Resnick, 1992). Yet, many teachers believe that they can teach students operational procedures first and later develop concepts related to these procedures. This viewpoint is often fueled by a perceived need to “get children ready” for state assessment tests and bottom-line efficiency (Schliemann & Magalhaes, 1990).

Data retrieved from the Florida Department of Education Web site indicate that students in all grade levels have difficulties successfully completing problems in the measurement strand on the Florida Comprehensive Assessment Test (FCAT). Data also indicate between the years 2002 and 2005; students’ scores in measurement have gradually shown a decline in the subtest for measurement. My area of interest and focus is on measurement because of the continued decline in measurement and low percentages in the measurement strand.

Measurement has application to every other mathematical strand developed. According to the National Council of Teachers of Mathematics (2000) *Principles and Standards for School Mathematics*, teachers need to instruct students to understand how to measure, what to measure, what tools to use for measuring, and how to use various formulas when measuring. This includes understanding metric and customary systems

and converting within each system and selecting appropriate units and size to measure various objects. It also encompasses a students' ability to use and derive formulas for finding perimeter, area, and volume to name a few. When students are learning to measure they need to manipulate, explore, and question how measuring tools are used and what happens when an object's dimensions change (Burns, 2000; Chapin et al., 2000; Johnsen, 2001; Kamii & Clark, 1997; Piaget, Inhelder, & Szeminska, 1960/1981).

In my review of the literature several themes emerged surrounding measurement. How students and teachers perceive mathematics impacts how well students learn and will perform. Different strategies such as journaling and hands-on methodologies affect student learning and perceptions of mathematics. Lastly, I will consider how students learn measurement.

Student Perceptions in Mathematics

When children begin their educational experiences, most start with enthusiasm and a love for learning. Between fourth grade and eighth grade they branch in different directions. Based on Raffini's study (1996), a portion of these students are driven to work hard to please their parents and will take whatever measures are necessary to make good grades and be successful in everything they do. Another portion and probably the largest portion choose to take an easier route and decide to take courses that are less demanding and challenging to them so they can get out of school. They have decided that education has no value and do not want to learn more than required. At some point these students lost interest in education and its value to their future. The last group of students began with little value in education and considers school a waste of time.

What happened to the students in the last two groups? Research indicates that by the time students reach middle school they know what classes they want to take and do not want to take. Larger percentages of students are opting to take fewer higher mathematics and science courses deciding that careers with less mathematics are more desirable (Eccles et al., 1993; Palincsar, Anderson, & David, 1993). Beginning in the fourth grade, mathematics becomes more abstract requiring students to have a good foundation in what they have already learned. It is at this time that more investigation and explorations need to occur with less frequent learning through rote memorization techniques to connect concrete concepts to the abstract.

Students fear being embarrassed in front of their peers if they give the “wrong” answer. They develop a lack of confidence early in their academics and in their own abilities, avoiding mathematics whenever possible, thus affecting their academic performance. Student self-efficacy, their belief in their own capabilities, is important to their development in mathematical abilities (Maier & Curtin, 2005). This can be impacted by communication of the teacher’s expectations, having high or low expectations of students and their performance on mathematics tasks and assessments (Brookhart & DeVoge, 2000).

An educational environment that allows students to evaluate their own learning and accept responsibility for that learning is necessary (Curtain-Phillips, 2000; Steele & Arth, 1998). Teachers need to provide an atmosphere that encourages questioning and exploring without judgment. Most every student when given opportunities to express their thoughts and ideas increase their achievement levels. Through these opportunities

students share understanding and similar experiences which are helpful to other students having difficulties (Fotoples, 2000).

Unfortunately, teachers do not always prepare students for abstract thinking in mathematics, making learning mathematics seem out of reach and too difficult for students to achieve. Many mathematics teachers rely on using traditional methods: “explain-practice-memorize” (Martinez & Martinez, 2003). Since this is how we learned mathematics, this is how we teach it. However, teachers unknowingly create an atmosphere devoid of learning with their treatment of mathematics due to their own perceptions of mathematics.

Teacher Perceptions in Mathematics

Teacher perceptions of mathematics greatly effect how students will learn and develop their own mathematical abilities. Teachers need to create an environment where students grasp how mathematics fits into the world around everyone, thus creating an environment of learning and exploration. Ball’s study stated “teachers, equipped with vivid images to guide their actions, are inclined to teach just as they were taught” (Ball, 1989, p. 5). Teachers need to reframe their experiences of the traditional mathematics class and break free from the mindset that they “hate math.” To unlearn or gain a better understanding of the math that is being taught requires teachers to create some dissonance in their own way of thinking and become comfortable with allowing exploration to occur. This is necessary to foster change in student perceptions that negatively influence their desire to learn mathematics.

The affects of continuing to teach using traditional methods are monumental. To compete with technological advances, more students need encouragement to pursue and explore the career fields in mathematics. This requires change in classroom design and teaching to meet the needs of all students. It requires a revolution in how mathematics is perceived as an academic course. Rarely will you hear individuals admit that they cannot read, but there exists no hesitation to admit when they are not doing well in mathematics. Comments such as “I was never good in math” or “I hated math when I was in school” are expressed with little regard to the perception of others.

The problem lies in that many teachers are not adequately prepared to investigate mathematics through any type of problem solving with their students. Professional development for teaching mathematics using alternative methods is limited to the number of teachers able to attend workshops and share ideas collaboratively with colleagues. Implementation and follow up also create road blocks for teachers (Wenglinsky, 2000). Learning new techniques and strategies to teach mathematics requires learning to facilitate and allow discourse in the classroom. Teachers often revert back to traditional teaching methods because they are more comfortable with it and find it easiest to do, regardless of research stating that students learn, comprehend, and retain information better when actively engaged in learning using alternative teaching methods such as journals, manipulatives, collaborative groups, and hands-on activities (Rose, 1999).

Strategies for Learning and Teaching Mathematics

The traditional method of teaching mathematics stresses learning algorithms with lack of focus on inquiry for students to develop deeper understandings of concepts

involving mathematics. “If students are asked to spend most of their time learning and practicing procedures that they see as having no connection to real life, they will think mathematics is something that cannot be understood” (Steele & Arth, 1998, p. 45). This standard method of teaching often begins in intermediate grades (grades 4 and 5) and carries them through middle school, to high school and into college mathematics courses. These teaching methods do not lend themselves to increasing student motivation to do mathematics. Instead, students fail to make connections with real world applications opting for careers requiring fewer technical skills and limited problem solving ability.

Sadly, teachers continue to teach using the methods from past learning experience, thus providing students with the same algorithms and no explanations with any connection to every day applications of mathematics. This occurs mainly because reform in mathematics education is often slow to occur. “It is much easier to present students with ‘rules’ to be accepted without question than more helpfully, to explain that the architecture of mathematics is based on accepted axioms and on theorems obtained by logic” (Salvadori, 1991, p. 43). What further motivation do teachers have to change their current method from traditional teaching to teaching using hands-on activities when what they have always used produces the short-term results in a test? One thought could be that “teachers are unaware of the importance of restructuring their teaching in terms of students’ conceptual development in the various sub-strands of measurement” (Groves, Mousley, & Forgasz, 2004, p. 12), which is necessary to teaching measurement concepts.

Piaget noted that in order for children to develop understanding in mathematics it could not come from a perceived notation of physical properties; it needed to come from reflecting on the actions they performed on objects (Piaget et al., 1960/1981). Students

given opportunities to work collaboratively share their background knowledge and experiences with their peers. This enhances student learning. In addition, when students work collaboratively during hands-on activities, students develop skills in communicating mathematically and explore problem solving with increased proficiency and understanding (Burns, 2000; Chapin & Johnson, 2000; Daniels, et al., 2005; McClain, Cobb, Gravemeijer, & Estes, 1999; Raffini, 1996). Supplementing hands-on activities with reflective journal writing increases students' abilities to develop connections of abstract concepts with tangible meanings. Connections help students understand abstract concepts and performance on tasks such as class work and state assessment tests related to measurement increase (Piaget et al., 1960/1981). Teachers facilitate this process by using alternative methods in conjunction with traditional teaching methods.

Additional research in learning measurement indicates students need to more opportunities to explore mathematical concepts using alternative methods such as collaborative groups, manipulatives, journaling, and hands-on activities (Daniels et al., 2005; Curtain-Phillips, 2000; Harper & Daane, 1998; Johnsen, 2001; Wolodko, Willson, & Johnson, 2003). Using these methods, students learn to explore mathematics and develop communication skills necessary for building connections to "real world" applications. In turn, this creates an appreciation and understanding for mathematics. This is vital as the world embraces the information age and continues to increase the need for experts with higher mathematics knowledge, sustaining a competitive edge in technical careers. Ultimately, students develop a better understanding, appreciation, and desire to learn and achieve in mathematics (Burns, 2000; Fotoples, 2000; Palincsar et al., 1993; Wolodko et al., 2003).

“For students to learn how to measure accurately and be able to use measurement concepts effectively, instructional sequences must focus on [conservation, transitivity, and units and unit iteration] and must ask students to perform real measurements” (Chapin & Johnson, 2000, p. 177). This is best accomplished through hands-on teaching. In Wenglinsky’s study with eighth grader students, students that were taught mathematics using hands-on activities performed 70% better than their peers (Wenglinsky, 2000). “Children need direct and concrete interaction with mathematical ideas; ideas are not accessible solely from abstraction” (Burns, 2000, p. 24).

By using hands-on activities to teach measurement, students have opportunities to ask questions and look for alternatives methods for understanding concepts with mathematics. Developing skills in asking questions are crucial in mathematics because students must understand what is communicated correctly (Inman, 2005; Mason, 2000; Nichol, 1999). They place more value on learning to use formulas by attaching their personal understanding to each and are able to internalize their meaning. This helps the reasoning abilities of students which have not fully developed enough to picture the array in an area problem and know to multiply numbers together and do not fully understand what area means.

Learning Measurement

“Students bring to the middle grades many years of diverse experiences with measurement from prior classroom instruction and from using measurement in their everyday lives” (NCTM, 2000, p. 241). This includes knowing what different measuring tools are as well as how to use different formulas to find the area of an irregular figure.

The challenge lies in individualizing needs and making connections to what students may or may not know about measuring. Little dispute exists in Piaget's studies on how children learn mathematics or measurement as well. Yet, measurement still creates much turmoil.

Research on learning measurement involves three general concepts: conservation, transitivity, and unit iteration (Hiebert, 1981; Kamii & Clark, 1997; Piaget et al., 1960/1981; Stephan & Clements, 2003; Stephan & Petty, 1997). In the first stage of learning to measure students must be able to compare objects to determine if they are the same length when the objects are next to each other and when one item is moved. This is the concept of conservation in measurement.

Next students learn the concept of transitivity by comparing several items with each other indirectly when it may not be feasible to compare them side by side. To fully understand this concept, students need to understand the concept if object one is equal to object two, and object two is equal to object three. Subsequently, object one is equal to object three.

Unit iteration has two parts; one involves understanding how something is to be measured and the other involves dividing objects into single units that are repeated. These three concepts are not necessarily learned in a specific order and change as students learn to apply each of these concepts to higher order thinking questions involving area and volume (Clements, 1999; Kamii & Clark, 1997; Piaget et al., 1960/1981). Some researchers have added estimation, precision, and accuracy as additional stages in student learning of mathematics (Chapin & Johnson, 2000; Stephan, Bowers, & Cobb, 2003). All three of these concepts, are to what degree measurement occurs. Estimating is necessary

for checking if measures are accurate. Accuracy refers to how correctly a measure is made. And finally, precision includes to what unit a measurement can be made using various measuring tools (Chapin & Johnson, 2000; Cobb, Stephan, McClain, & Gravemeijer, 2001; Stephan et al., 2003).

Learning measurement for children in the classroom begins with comparing objects like which student is tallest in the class while standing side by side. Using nonstandard methods of measuring take place with parts of the human body or other objects to compare unit measures and are valuable to student's development of measurement (Van de Walle, 2004). While this method proves acceptable for estimating measures, consistency between people does not exist as our dimensions often vary. And thus, children are lead to the misconception that a standard measurement is not necessary, without regard to measuring using precision (Burns, 2000; Chapin & Johnson, 2000; Kamii & Clark, 1997; Piaget et al., 1960/1981; Stephan et al., 2003).

Beyond using nonstandard units for measuring, such as body parts or other objects within the classroom, children are next introduced to measurement with the use of rulers. They begin by exploring the idea of transitivity and unit iteration while also learning correct alignment of a ruler to measure objects. Teaching measurement should not focus on the numbers on the ruler and relations between size and number until the second and third grades (Clements, 1999; Stephan & Clements, 2003). Once children have had experiences with rulers and selecting appropriate measurement units and tools, students learn the distance around regions, or perimeter. Generally, at this point more abstract concepts are introduced with formulas for finding the perimeter followed by

area, both without concrete representation. Students confuse area and perimeter and do not develop a complete understanding of area and its applications.

Students in middle school are expected to have developed the basic measurement concepts of selecting appropriate measuring devices including the use of these tools. In addition, students must comprehend the meaning of perimeter with relative fluency. By the end of middle school, students must develop proficiency with circumference, area, surface area, and volume and make connections with understanding concepts in scale measurements as well as the affects that changing dimensions has on the area and volume of two- and/or three-dimensional figures. They also must develop proficiency with customary and metric conversions. Research, however, on how measurement is learned is limited mainly to how younger students learn and develop these concepts.

To explore and apply the concepts of area and volume students need an environment rich with problem solving using alternative teaching methods. As previously mentioned, traditional teaching methods are prevalent in secondary schools. While this teaching method has its place in teaching students, it continues to be the primary method utilized by teachers, which stifles continued student development of measurement concepts. Students need to understand the concrete meanings of area and volume along with how to derive and use formulas for finding the area and volume; however, this is where disconnect occurs as students lack abilities to apply measurement concepts with problem solving.

How do middle school students learn measurement concepts? Little research exists on this topic other than to state that students continue to need more exposure to opportunities for investigation in measurement through problem solving. “Students lack

experiences with attributes and units of measurement before embarking on the use of standard measuring devices and formulas” (Kinney, Martin, & Strutchens, 2003, p. 206). Students in middle school need opportunities to investigate measurement concepts through hands-on activities and reflective journaling which enhances students’ conceptual understanding and increases their abilities to justify their answers mathematically (Daniels et al., 2005).

Conclusion

Despite research supporting the use of alternative methods to teach mathematics, traditional teaching methods continue to dominate current secondary mathematics classrooms (Daniels et al., 2005). Research focuses primarily on development of basic measuring skills in elementary students. Students in middle school are expected to have developed proficiency in basic measurement concepts and to apply them to solving problems involving perimeter, area, and volume. Using hands-on experiences and opportunities to communicate through journaling, including reflections on past experiences, students develop understanding of perimeter, area, and volume, leading to increased performance on state assessment tests (Wenglinsky, 2000). This action research study and the review of literature indicate learning through hands-on activities increases student performance in measurement.

This action research study explores how changing teaching strategies to include hands-on activities and journaling affect student performance on measurement tasks. In the next chapter, I discuss the procedures and methodology of this action research study.

CHAPTER THREE: METHODOLOGY

Problem Statement

Each of the five years I have taught, students in my school perform poorly on the state assessment test. In this study, I changed my practice of teaching measurement to include more use of hands-on activities and open-ended questioning to determine the effects on student performance. The purpose of this action research study was to determine if using hands-on activities to teach measurement influenced performance in measurement as well as how journaling influenced my students' attitudes in measurement.

Design of Study

Through action research, teachers influence change. "Action research is research done *by* teachers *for* themselves; it is not imposed by someone else" (Mills, 2003, p. 5). Teachers validate or refute teaching strategies and techniques, leading the way to change in teaching. Action research has gained popularity since teachers must demonstrate higher student achievement on state assessment tests, specifically in reading and mathematics. However, with a decline in student achievement on these state assessment tests, reform in teaching reading and mathematics has heightened the need for teachers to conduct additional and more focused research. Teachers must find ways to affect a deeper understanding in mathematics.

This action research study primarily relied on qualitative methods; however, quantitative methods were also incorporated using a pre and post measurement survey

(Appendix A) to determine students' attitudes towards measurement. The qualitative data were collected through journal entries, focus groups, and teacher observations.

Pre and post measurement surveys were administered to measure students' attitudes on their abilities to measure using different tools and their comfort estimating and using formulas, and to determine student perceptions of measurement. Differences between the pre and post surveys were compared to measure changes in students' attitudes in measurement. Student scores on the Comprehensive Mathematics Ability Test (CMAT) (Appendix B) and the state assessment test, the Florida Comprehensive Assessment Test (FCAT), were used to determine students' skill levels and select students for the focus group.

Various hands-on activities were selected to investigate different measurement concepts (Appendix C). Primary focus of the activities were relating to areas of weaknesses which were determined through the FCAT and teacher observations. Each activity spanned over two to four days to complete. I recorded my observations through field notes, audiotapes and videotapes of students completing activities. Students reflected on activities in student-created mathematics journals.

Assumptions and Limitations

Research on how students learn measurement is limited primarily to elementary grade levels. Students enter into middle school with some prior knowledge of measurement. It was assumed that students knew how to partition items into equal parts and use transitivity to measure items using various measuring tools. Transitivity is defined as the ability to figure out relationships between two or more other relationships

that may or may not be equal (Kamii & Clark, 1997; Piaget, Inhelder, & Szeminska, 1960/1981; Stephan & Clements, 2003). It was assumed each student would do their best on the measurement activities and their reflective mathematics journals.

The sample size was limited to one class of seventh grade students. This particular class size was twenty-six students. Unique to the class was the time of day this class was held. This class was directly after lunch with the assumption that each student ate a healthy lunch and was refreshed for the second half of their day. Due to rapid population growth movement in and out of the urban city, class size often fluctuated. To overcome this limitation, I requested that no students were added to this class period for the duration of the study.

Other limitations were student skill levels and student participation in the hands-on activities. Each student entered with a different knowledge set of what measurement meant and how to measure. Students were not accustomed to using hands-on activities as a learning strategy. The assignments and activities were not recreated for students that were absent. Students were also not required to make up these activities.

The research was conducted over the course of eight weeks. Change in each class period was new to our middle school this year by reducing fifty-five minute classes to forty-five minute classes. This change limited extended variations and required teaching closely to county curriculum guides. Measurement was not an item taught in the curriculum during this time frame. For this class period, the school added thirty minutes defined as “study hall,” where students were expected to read or work on homework. Permission to conduct this study was granted during this thirty minute time frame.

Setting

This study took place in a central Florida middle school located on the outskirts of an urban city. Students in grades six through eight attend this middle school. As of May 2005, six elementary schools track students to this middle school. One of three middle schools in the vicinity, it was the only secondary school to achieve a school grade of “A” in the 2004-2005 school year. In January 2006, the school had 1430 students, with 741 male students and 689 females. The school ethnicity is comprised of 3% Asians, 3% Indian/Multiracial, 8% Blacks, 23% Hispanics, and 63% Caucasians.

The class in this study contained a variety of ethnicity. There were two Asian students (8%), one Indian student (4%), four Black students (15%), eight Hispanic students (31%), and eleven Caucasian students (42%). I anticipated problems with student comprehension due to language barriers because several of my students were English Language Learners. The overall average skill level of the class was below average as measured by the state test. There were an equal number of male and female students in the class. The ages of the students varied from eleven to fourteen. Two of the students in the class were retained prior to seventh grade; one in the sixth grade and one in elementary school.

The class selected for this study was chosen for two reasons: convenience and performance on the state assessment test. Thirty minutes were added to this class period for the use of study hall, where students were expected to read or do homework. Permission was granted to utilize the thirty extra minutes of this class period for this study. The standard class times were forty-five minutes, reduction in class time from the previous year; therefore, every available minute of class time was devoted to teaching the

curriculum. During general class time, I conducted the lesson as outlined by the county curriculum guides. Measurement was not part of the curriculum guide at the time of the study and was taught during “study hall.” Secondly, on the state assessment test, the students in this class performed below average on each of the five subsets of the test; algebraic thinking, geometry, data analysis, number sense, and measurement. The lowest subset average was measurement, with algebraic thinking next.

All twenty-six students in the class voluntarily participated in the study; however, two students had frequent absences during the eight-week action research study. No students left the class to be assigned to another room during the study and no new students were added to this class during the study.

Hands-on activities were selected to suit the needs of students in this class from several different sources such as professional development workshops and teacher resources available through the school mathematics department (Appendix C). Each activity required students to work in collaborative groups or with partners to achieve the desired tasks. The first activity involved students working together to measure various items using both nonstandard and standard tools. Subsequent activities involved students investigating area, perimeter, surface area and volume using manipulatives such as Geoboards, snap cubes, Cuisenaire Rods, and Pattern Blocks. Additionally, students investigated changing units of measure during various activities involving perimeter, area, and volume.

Data Collection Procedures

Prior to the beginning of the 2005-2006 school year, permission was sought and obtained from the principal of my school and the University of Central Florida Institutional Review Board (IRB). Permission was granted by Pro-Ed to use the Comprehensive Mathematics Abilities Test (CMAT). The principal of the school granted permission for the study to take place, and parent consent was obtained for each student that participated. The permission notifications are provided in Appendix D-F, respectively. I read the student assent script (Appendix G) after all permissions were received. All students agreed verbally to participate in the study. For the sake of confidentiality, student numbers were used through this study.

The quantitative data consisted of a pre and post measurement survey (Appendix A) to determine student attitudes of measurement and the CMAT to determine preliminary areas of students' strengths and weaknesses. The qualitative data collection included student journals, teacher observations, and focus group discussions. The methods of data collection are discussed further in the following sections.

Instruments

Two instruments were utilized for this study; a measurement survey and an abilities assessment. A brief description and their uses follow.

Measurement Survey

The measurement survey was written to determine students' comfort using various measurement tools and formulas and comfort with measurement in general. The survey was divided into two categories: student perception of measurement and comfort level using measuring tools. The survey used a scale of one to four with four representing

strongly agree. Prior to administering the survey, it was reviewed by my colleagues for validity and pilot tested in 2005 prior to this action research study. It was structured similar to several math anxiety surveys from student textbooks. Data from the pilot test were used to ensure that the questions were clear as well as to test for sentence structure.

The measurement survey (Appendix A) considered student attitudes in measuring and were separated into two sections; one for how students felt about measuring and one for how comfortable they were with using measurement tools. The survey contained six indicators for student feelings and comfort regarding measurement and six for identifying student knowledge of measuring tools. Statements 3, 5, and 11 were written to generate a strongly disagree response. Statements 1, 2, 4, 5, 7, and 8 indicated student attitudes on measurement while statements 3, 6, and 9-12 indicated students' basic knowledge of measurement.

Students were instructed to respond honestly to the twelve statements in the survey. The survey was read aloud for the benefit of students with low reading levels. Students then were to define what measurement meant to them. It took approximately fifteen minutes to administer the survey. Student answers were arranged on a spreadsheet using Microsoft Excel to investigate changes in student perceptions of measurement. Pre and post answers to the free response question on measurement are discussed in the following chapter. The pre and post measurement surveys were used to triangulate student attitudes in measurement. After collecting the pre surveys, I administered the Comprehensive Mathematics Abilities Test (CMAT) to determine student mathematical abilities and select students for the focus group.

Comprehensive Mathematics Abilities Test (CMAT)

The Comprehensive Mathematics Abilities Test (CMAT) was selected as an instrument to assess student mathematical abilities. The CMAT design allowed for students to demonstrate their mathematical ability as they answered questions that increase in difficulty starting with basic operations in mathematics continuing through various problem solving tasks.

The test was divided into two main components, core subtests and supplemental subtests. The core tests included addition, subtraction, multiplication, division, problem solving, charts, tables and graphs. The supplemental subtests included algebra, geometry, rational numbers, time, money, and measurement. For the purpose of selecting a focus group, I administered the subtests involving general knowledge, core subtests, along with the supplemental subtest in measurement.

Administration of the CMAT was recommended approximately 45 minutes to 1 hour, with flexibility for student progress. For administration during this study, I allotted four days with thirty minutes each day and divided the subtests accordingly to avoid starting and stopping in the middle of a subtest. The testing script and scoring rubric was provided for each subtests in the Profile/Examiner Record Booklet, Students were not penalized for guessing. The use of calculators was not permitted on subtests for addition, subtraction, multiplication, and division; however, calculators were permitted on the remaining subtests.

The CMAT reported “evidence of a high degree of reliability across three types of reliability [content, time, and scorer differences]” (Hresko, Schlieve, Herron, Swain,

Sherbenou, 2003, p. 60). Additionally, validity as a measure of student mathematics abilities was established through various measures.

Focus Groups

“Focus groups are a particularly useful technique when the interaction between individuals will lead to a shared understanding of the questions being posed by the teacher researcher” (Mills, 2003, p. 63). Following completion and scoring of the CMAT, groups were selected based on their mathematical performance on addition, subtraction, multiplication, division, problem solving, charts, tables and graphs, and measurement subtests. A group of six students were selected with the following criteria; two students with above grade level abilities in all tested areas stated, two students on grade level abilities in over 90% of the tested areas, two students with below grade level abilities in all tested areas. With the group variation, students helped each other to understand questions asked by the teacher and offer the teacher insight on student attitudes in mathematics particular to measurement. I elected to have a focus group with varying student abilities to observe changes in students’ performance and observe interactions between students with varying mathematical abilities.

I first interviewed students recording responses on audiotape and taking notes of student reactions to questions. Each student was asked to respond the following questions:

1. What is a “measuring tool?”
2. Give an example of a “measuring tool” and where it is most appropriately used.
3. How do you measure an object if you don’t have a “measuring tool?”
4. Compare the objects in the pictures and determine if they are the same or different sizes.
5. What does it mean to be precise in measuring?

6. What do perimeter, area, and volume mean? Give some examples.

Responses to these questions are discussed in a later chapter. The focus group met following each activity to discuss thoughts, problems, ideas, and solutions to questions they had regarding the activities and how each related to measurement. Students were instructed that within the focus group that each student was to respond before a new question would be asked. The focus group data were used to triangulate effects on student performance in measurement and student attitudes as related to measurement.

Mathematics Journals

At the beginning of the school year, students created a journal using notebook paper and scissors. I began with students identifying what they considered their strength in mathematics to be. Following each activity, students were asked to reflect on thoughts, ideas, confusions, and “ah-has” they had during the activities. Students were informed that the journals were not going to be taken as a grade. Students were encouraged to share their journal entries so that I could ascertain student confidence in questioning and abilities to measure. Comments made by the students helped to guide discussion for future activities. Journals were collected each day as students left the classroom. I wrote comments to the students to encourage their ideas and inquire when I was not certain some of their comments. Mathematics journals were used to triangulate student questioning and student attitudes.

Teacher Observations

Teacher observations were recorded through the use of teacher field notes and video and audiotape throughout the study for the hands-on activities. I observed students interacting in groups during various activities and recorded questions posed in the groups

and during whole class discussions. I also observed and recorded student work on individual hands-on activities to observe student abilities to use measuring tools appropriately. Additionally, I allowed time after each activity for students to pose questions for discussion and recorded responses to determine how student questioning changed with the involvement of hands-on activities. These observations were used in conjunction with student mathematics journals and in class assignments to assess student performance and to guide further activities in measurement.

Data Analysis Procedures

Data were analyzed using several methods. During the course of this action research study, two measurement instruments were utilized. The procedures of how they were utilized are listed below.

Instruments

Measurement Survey

At the beginning and end of the research period students completed a measurement survey. The measurement survey was written to determine students' comfort using various measurement tools and formulas and comfort with measurement in general. The percentage outcomes for each student response to the survey were compared to the percentage outcomes of the post survey to determine changes in students' perceptions of measurement and their measurement knowledge. The survey was administered at the beginning of the eight week study and re-administered at the end of the action research study.

The responses were placed in a spreadsheet and percentages for each response were calculated. Data were separated on the spreadsheet into the two categories being measured, student perceptions and measurement knowledge. The change in the pre and post measurement survey was calculated to determine any differences in student feelings or knowledge.

Comprehensive Mathematics Abilities Test (CMAT)

The CMAT was designed to determine student ability levels at the beginning of the study and was used for purposes of developing a focus group during the study. Students began at the appropriate entry levels as stated in the examiner's manual and were to complete as many of the problems as they could for each section. If a student finished early and enough time was available I allowed them to complete the next section.

Once students completed sections, I scored them using the rubric provided in the Profile/Examiner Record Booklet. Students received a 1 for correct responses and a 0 for incorrect responses. If students received three incorrect responses in a row, instructions were that this marked the ceiling for the student and I was to count the correct responses above that point to develop a raw score. The raw score was used to identify age-based norms, using the appendix to locate the student's age/grade equivalent, percentiles, and standard score. I used age/grade equivalent and percentiles to determine which students to select for the focus group. Students were informed they would not receive a grade for this test.

Mathematics Journals

Mathematics journals were used for students to reflect on the activities and how they perceived their understanding of the concepts taught. Students' responded in their journals to hands-on activities involving using different measuring tools and determining the appropriate tool to measure at the end of each activity. Students were then permitted five minutes to share their entries and asked questions when they were confused about an activity.

Responses were not graded; however, I read and responded to each journal following each activity. As each entry was read, I kept track of student communication using a check sheet for each activity. Communication that was unrelated or did not provide information received a minus. Communication that recapped the activity received a checkmark. Communication that elaborated on the activity and the student's learning for the activity received a plus and their comments were recorded in a composition notebook.

Focus Group

A focus group was selected using the results of the Comprehensive Mathematical Abilities Test (CMAT) based on the criteria previously stated. Individual members of the focus group met with the teacher prior to beginning the hands-on activities to discuss their thoughts on measurement and respond to interview questions discussed in a later chapter. In the focus group meetings, students were instructed that each person's thoughts, ideas, and confusions were all valid and open for discussion. The focus group met periodically throughout the action research study to demonstrate their understanding

of various measurement tasks and to determine their self perception and comfort with measurement.

Times varied in each meeting dependent on the length of time each activity required to complete. Audiotapes were the primary method for recording the interactions of the focus group. Tapes were reviewed after students were released from school so that the information was not lost. From the audiotapes, student comments were recorded that demonstrated independent questioning and change in their perceptions of tasks related to measurement. When the focus group met, the remaining students were required to read or work on other homework assignments.

Teacher Observations

I recorded overall observations of the class during hands-on activities including student questioning of peers and teacher. I circulated around the room during activities making observations of student interactions as well as posing questions and comments to clarify student work such as “show me how you arrived at your conclusions,” and “can you demonstrate what you were thinking?” All students actively participated in the activities in collaborative groups and partners. Students led discussion following the hands-on activities where each student was given the opportunity to share their experience, confusion, and learning.

I listened and recorded observations of student interactions during the activities and discussions in a composition notebook making note of differences in student behavior and conversations. Observations were also recorded using video and audio tape and reviewed at the conclusion of the day. Unique responses and questions were noted as students were interacting with one another during the activities.

Credibility/Trustworthiness

Triangulation of the data results was necessary to improve credibility and trustworthiness. “The *credibility* of a study refers to the researcher’s ability to take into account all of the complexities that present themselves in a study and to deal with patterns that are not easily explained” (Mills, 2003, p. 78). This included the use of the data from student mathematics journals, teacher recorded observations, focus groups and pre and post measurement surveys. Together the data were used to determine the effects of hands-on activities on student performance in measurement and attitudes in measuring through journaling.

Summary

Using sources above, data were triangulated and analyzed to show the effects of using hands-on teaching methods on student attitudes and performance in measurement. Analysis of data identified changes in questioning, attitudes, and performance. These findings are discussed in the next chapter.

CHAPTER FOUR: DATA ANALYSIS

Introduction

This action research study investigated how the use of hands-on activities to teach measurement affected seventh grade students' performance on measurement tasks. An action research design was selected because it created opportunities through personal reflections and data analysis to enhance the educational experience of the students (Mills, 2003). My interest in this topic developed over the years as I noticed a decrease in student performance in measurement on the state assessment test. This chapter discusses the effects that hands-on activities had on middle school students' performance on class work and tests focused on measurement as well as their confidence in measuring and posing questions. Twenty-six seventh grade students voluntarily participated in this study during the fall of 2005. Data revealed that students' attitudes increased regarding measurement during the period they used hands-on activities to explore concepts in measurement. Data showed a small increase in student performance with measurement. Data also showed that the frequency of students' questioning increased during the action research study.

Data for this study were gathered through the use of student journals, focus group, pre and post surveys, and teacher field notes. According to Mills (2003), to validate research and add to the credibility of the research, action researchers must not rely on a single data source. Using multiple data sources allowed for triangulation of data across research methods (see Table 1).

Table 1: Research Questions and Triangulations

Questions	D.S. 1	D.S. 2	D.S. 3
Performance	Focus Group	Teacher field notes	Student Journals
Questioning and Attitudes	Pre- and post survey	Teacher field notes	Student Journals

The research questions for this study were:

Research Question #1

Does teaching measurement using a hands-on approach affect student performance on tasks related to measurement?

Research Question #2

In what ways do hands-on activities enhance students' independent question posing and attitudes related to measurement?

Data were collected using several different sources that related students' performance, questioning and attitudes in measurement. Data were analyzed from pre and post measurement surveys, student journals, student work, focus group, and teacher field notes. As I began analyzing the pre and post survey, students' journal entries, and notes from the focus group and teacher field notes, several pertinent themes emerged from the data.

One theme that emerged during the study was that the use of hands-on activities seemed to correlate with an increase in students' performance on tasks related to measurement. Analyzing teacher field notes and focus group comments provided evidence that students demonstrated increased knowledge and understanding of

measurement. In one example, during the focus group interview Jenny stated that she understood the meaning of perimeter as the distance around the outside of any figure and volume as how much would fit inside of a three-dimensional figure, but she did not understand what it meant to find the area of figures and could not explain it. She demonstrated this by pointing around the room when describing perimeter and placing her hand in a box when describing volume. During the course of the study, I noted in my field notes that she demonstrated a better understanding of area when she stated in her journal that she “discovered that area was like wrapping something up to cover it, instead of going around the outside like perimeter.” Combined with student work, teacher field notes and focus groups indicated that student performance increased related to measurement.

Another theme emerged to include improved question posing and attitudes in measurement. Through student journals and in class discussions, student questions and comments were more detailed and specific to measurement. For example, Bobby, in his first journal, stated only that he “didn’t understand how to do it [the activity].” His fourth journal entry indicated that he had improved his communication when he stated “I learned how to use different rulers that didn’t start at zero.” In addition, I observed his interactions during group activities increase as well as questions related to the topic.

With regards to student attitudes in measurement, students developed increased confidence in their abilities to measure and answer questions involving measurement. At the beginning and completion of the action research study, students completed a pre and post survey focused on student attitudes in measurement which was separated into two sections; one for how students felt about measuring and one for how comfortable they

were with using measurement tools. Student definitions for measurement and terms involving measurement became more elaborate and detailed as their understanding of measurement was evident from measuring the width to using tools to find length, width, and height for perimeter, area, and volume. Student comments in the focus group indicated that hands-on activities helped them to become more confident in asking questions and offering their responses.

These data indicated that the use of hands-on activities and journaling were associated with change in student performance, questioning, and attitudes related to measurement. The following section presents an overview of a typical mathematics class period and data analysis aligned according to research questions.

A Typical Mathematics Class

Maintaining county guidelines throughout the course of the action research study was an expectation verbally addressed prior to beginning the study. In order to do this, class began with the traditional mathematics lesson for the first forty-five minutes of class. The remaining thirty minutes of class, referred to as “study hall,” was designated as my action research time.

Within this time frame, a typical mathematics learning session involved students working in collaborative groups, with partners, or working independently. Students used manipulatives such as Geoboards, square tiles, and Pattern Blocks to support the lesson. Students were placed into groups or partners at the beginning of the activity. For each activity students were placed in groups of two to four with person in the group responsible for doing the tasks assigned. Groups were selected based on previous

performance tasks for other units of curriculum. Performance tasks in this instance refer to class assignments, projects, quizzes, and tests for the units. Most groups consisted of one student performed above average on most performance tasks and another performing below average. Based on the activity, the additional students in the group performed average to below average on task.

Typically, seating in the room was arranged prior to students entering the room depending on the necessary configuration for the activity. Once students received the needed supplies for the hands-on activities, it was then explained to them, and they were released to begin the activity. Each activity utilized hands-on activities to learn measurement to support the knowledge being constructed by the students. After each activity, students were given five minutes to reflect on what they learned during the activity and to discuss the activity and ask any questions they had during the activity. At the end of the eight-week research study, students were given a unit test covering topics in measurement such as converting within customary and metric system, finding perimeter, area and volume, and using appropriate tools for measuring to gauge the effectiveness of hands-on activities.

While hands-on activities in mathematics are becoming more prevalent in teaching mathematics, these seventh grade students had very little previous experience using hands-on activities to learn mathematics, especially related to measurement, as was discovered through class discussion. Typical mathematics classes for these particular students were taught showing examples of how to solve problems followed by students mimicking how they were shown. Every student in the class stated that they learned best using hands-on activities but they had never used these strategies in mathematics class. I

was particularly interested in students' initial levels of performance and attitudes towards measuring and the changes as the study progressed.

Student Performance

Student mathematics abilities were first evaluated using the Comprehensive Mathematical Abilities Test (CMAT). The CMAT was used for two purposes; to first determine student ability levels in several areas and second to identify students for the focus groups by testing students on basic mathematics skills, such as operation with addition, subtraction, multiplication and division. Based on student scores on the CMAT, I selected six students of varying mathematical abilities. I also gathered information from the Florida Comprehensive Assessment Test to determine which of the five mathematics strands tested had the greatest need for improvement. As with the previous three years, the year 2004-2005 showed that students were still lowest in the area of measurement.

Following administration of the pre-survey on measurement (Appendix A), I administered the CMAT. The subtests administered were addition, subtraction, multiplication, division, problem solving, charts, tables and graphs, and lastly, measurement. Within the subtests, all students except four were at or slightly below grade level equivalence in the areas of addition, subtraction, multiplication, and charts, tables and graphs. Four students were above grade level on all areas of the CMAT that were tested. As stated previously, I utilized this data to formulate the focus groups.

“Focus groups are a particularly useful technique when the interaction between individuals will lead to a shared understanding of the questions being posed by the teacher researcher” (Mills, 2003, p. 62). Through the focus group, I observed the

interactions of a small group of students with varying abilities. The group consisted of six students. Two students scored above grade level on all areas that were tested; two students scored below grade level on all areas; and the remaining two students scored on grade level in all areas except one. The combination of students created an atmosphere of sharing and helping each other learn and discuss measurement without pressure and fear of getting the wrong answer.

The focus group met prior to beginning the first hands-on activity (Appendix C). The first question asked was “What is a “measuring tool?” Each of the focus group participants stated that a measuring tool was something that measured length like a ruler except Manny. Manny was hesitant to answer the questions because as she stated she was “not certain how to answer the question.” After each student had the opportunity to answer, I adjusted the next question slightly by asking students to give a different example of a “measuring tool” other than the one previous mentioned and where it is most appropriately used. Anton finally answered by stating “a protractor can be used to measure angles.” Ralph shook his head in agreement and then stated “what about those things in Science that we use to weigh things?” The group began to look around the room for any clues of what they could use to measure things. Kandi said “can’t we measure using that thing that makes the clicking noise [referring to a trundle wheel], doesn’t it measure like the road or something.” The remaining three students were not able to come up with items beyond a yardstick for measuring the distance around the room.

When the students in the focus group were asked “how do you measure an object if you don’t have a “measuring tool,” they each paused for a few moments until Kandi and Mitch demonstrated how they would measure using their finger because they had

previous knowledge stating that from one knuckle to the next was about one inch. Ralph and Jessica commented that they “would use whatever item that was smallest to compare the other items to.”

Students were then asked to compare the objects in different pictures and determine if they are the same or different sizes (see Appendix H). Each of the students agreed that in squares 1 and 3 both line segments were the same. When discussing the segments in squares 2 and 4, the students concluded that the segments were equal in length as long as the gaps were not removed and only represented different divisions of the items. In square 5 students were shown two line segments at a time to determine if they could compare lengths. Each student was able to compare segments to determine the longest. In square 6, students used the smallest segment to approximate how many would be needed to measure the longest. Ralph took the lead and decided that the measure was a little under three of the short segment. Each student afterwards came up with similar answers, each making attempts to be more precise stating that it was about two and four-fifths of the small one. This led well into the next question: “What does it mean to be precise in measuring?” The only response the students were able to come up with was measuring with a ruler.

When asked to respond to what perimeter, area, and volume meant and to give some examples, the responses were similar. Jenny stated that she understood what perimeter was and stated that “it is the distance around the outside and you find it by measuring the outside or adding up all the outside measures.” She continued by stating that she also knew what volume was but wasn’t certain how to find it out without something to measure it. Then, she stated that area was the part she didn’t understand.

She stated that she knew it was different than perimeter but didn't know how to explain it or find it out. Once she stated that, Ralph, John, Manny, and Jessica in the focus group tried to explain that area was the space contained within the figure, but Jenny was not convinced.

In my field notes from class discussion, student knowledge of measurement for the entire class was limited to the uses of various measuring tools and finding the perimeter of geometric figures. I documented 75% of the students were able to accurately recall formulas for finding the area of squares and rectangles; however, students were unable to recollect formulas for finding the area of triangles and circumference and area of circles. When students were asked to read orally measuring instruments to approximate the lengths of objects, 14 of the 26 were able to measure with 90% accuracy. Students accurately identified basic measuring tools and their uses, such as using a ruler to measure the length of objects and scales to measure weights. Beyond these concepts of measurements, all twenty-six students needed assistance with volume and proportions.

During activities for week one (Appendix C), students were expected to become comfortable with identifying various measuring tools and their use as well as to demonstrate estimating and measuring items using nonstandard and standard units. In the first activity, students were given different measuring tools and were instructed to work with their groups to determine the use of each item, create a chart stating how the item was used and describe how precisely the item would measure. Following the activity, the focus group met to discuss the activity. Kandi stated that the activity really helped to remind her about measuring tools that she never thought about. My field notes aligned with her response as several times during the activity I recorded that she mentioned

seeing most of the measuring tools and didn't realize they were actually measuring tools. I noted that for this activity every student commented that they learned a few different measuring tools that they didn't know before and learned how to use them in their journals.

In the second activity, students demonstrated their skills in estimating and measuring using nonstandard and standard measuring tools. All student groups selected a small paper clip as the nonstandard measuring tool with the exception of one group, which chose a piece of candy. I recorded in my field notes that student responses to why they chose the items to measure with *each* group responding that they chose the item that seemed closest to an inch. In one group, Martina and Jessica both demonstrated a comparison between the paper clip and a section on their finger that they were informed was close to an inch, demonstrating previous knowledge. When students were asked to approximate and measure the same items using a ruler using centimeters, I noticed the measurements students recorded were in whole or half centimeters with little precision to the nearest tenth of a centimeter. I inquired with each group if their measures were as precise as they could be and discovered no one in the class knew how to measure for precision.

Students continued their inquiries with measurement in week two by measuring with rulers that were altered by an inch being removed from each end. Skill levels in measuring surfaced as students learned to use these rulers. Conrad, Amy, Michelle, Jessica, and Kamica dominated the activities by demonstrating to the other members of their groups of five or six that measuring with these rulers were "not like normal because you cannot start at zero." Jessica demonstrated her understanding of how to use the ruler

by stating that she measured each side of the figure and subtracted one from her measurement because the ruler started at one instead of zero. In student journals, students indicated that the above students helped them understand what they needed to measure “more carefully.”

At the end of week two and beginning of week three of the study, students began investigations with perimeters and areas of figures. In both of the activities for the week, 85% of the students stated in their journals that they had difficulty following the directions provided and needed further instructional assistance in understanding “how to find different areas.” This was confirmed in teacher field notes where I noted that students requested teacher assistance numerous times asking for clarification during each step of the activity. After reviewing the directions, I noticed that the directions were easy to misinterpret for low-level readers; however, I also discovered that several students did not fully understand how to measure and calculate area.

I inquired of the students in the focus group about the difficulties they experienced. All six students stated that “it was difficult to locate different areas.” When asked why this was, each student shrugged their shoulders and was not able to elaborate on their answer. I then proceeded to ask the focus group if they knew how many rectangles they could create with a perimeter of 12. Ralph drew a rectangle with one unit by five units and demonstrated to the rest of the students that “five plus five is ten, and then you add one plus one which is two, two plus ten equals twelve.” When he finished, Mitch stated that “you could use two for the width and four for the length,” indicating that he had a better understanding than he was originally admitting. At this point, I inquired about the area of these rectangles. Ralph stated that the area of his rectangle was

“five since one times five equals five.” Mitch chimed in by stating “two times four is equal to eight.”

Jenny proceeded to ask if a square was a rectangle. Manny stated that it was and said that if it had sides of three the perimeter would be equal to twelve, but an area of nine. At this point, Jessica stated “Hey, all of these rectangles have the same perimeter, but none of them have the same area!” This indicated that while students appeared not to understand the directions, they were able to use the intended objective of finding figures with the same perimeters having different areas.

Week four was a continuation of discovering area formulas using circles. Students circulated around the room measuring the circumference and diameter of each circle. Mitch remarked that circumference was just like the perimeter of the rectangles and squares. This led students into a discussion of what the meaning of pi (π) represented and why they had to use 3.14 in the formulas. Anton stated that, “it [pi] was created by a mathematician that was trying to make it hard for students to do math.” Nala replied “pi is for us to use to find the circumference and area if we don’t know the object in front of us. All I need is the diameter.” Using the information collected in the activity, students discovered that with each of the circles they explored, when they divided the circumference by the diameter the answer was very close to 3.14, which validated to them the use of 3.14 in formulas. When asked how to find the area of the circles, Conrad enthusiastically raised his hand and said “ πr^2 .” Following this I observed students finding the area of the circles with few difficulties. After this activity in his journal, Sammy explained that he finally understood how to find the area and circumference of a circle.

In weeks five and six, through analysis of field notes I discovered students were demonstrating more enthusiasm for working on their mathematics assignments in measurement. Students began to work with less teacher directed assistance. Tangram pieces were used to create and compare shapes of triangles and squares. I recorded that when the activity was introduced, Amy asked if this activity was similar to the activity that used the squares to find different perimeters. Alfonso responded to her that it was like it, but not exactly. He continued by stating that this activity was more like comparing figures that look alike or similar. In student journals comments were made to indicate that students were enjoying learning how to use the different “toys” to learn mathematics. Nina stated in her journal “I never knew I could learn by playing and putting together things to find areas. Are we going to apply this to learning volume, too?” This led well into the activities of the next week.

Volume was the focus of the activity for week seven. Students created a box that used 24 linking cubes. Due to the limited supply of linking cubes, students had to record this box and reconstruct the box using the same cubes with different dimensions. In my teacher notes, I noted that each group of students created a box with dimensions of one cube in height, three cubes in width, and eight cubes in length and recorded the surface area, volume, and dimensions of the box. As Sammy calculated the surface area, he noted that each side was on the box twice and asked his group if it made sense to find out the area of three sides and “multiply that by two?” Joshua in his group replied that it was a good idea but wanted to make certain it was right and proceeded to count the sides. In their journals for this activity, Sammy stated that he didn’t understand what surface area was until he started putting the cubes together. He wrote, “I liked using the cubes.” His

understanding of surface area was aligned with my notes on his interactions with the group and class discussion after the activity. Bobby wrote in his journal that he wanted to know where I got the cubes so that he “could buy some.” He also wrote that he felt more comfortable working with volume and surface area.

When the focus group met after the activity in week seven, Manny and Ralph stated they both felt like they would do much better with volume problems, but they were reluctant to continue to work with surface area without having cubes to work with. I asked if they had developed any formulas that they thought might help them to which they responded no. Ralph in the focus group asked them if they knew that each side was a rectangle. Jenny said, “Yeah, I noticed that each side was a rectangle.” Manny asked, “You know how to find the area of them, right?” Mitch stated that he could and then stated, “Oh, I get it! You just add them [the areas of the rectangles].” Kandi nodded that she understood; however, she did not have time to demonstrate this in the focus group.

During week eight, students began working without any direction from the teacher. I remarked in my field notes that when assigned the task to create the word MATH with tiles and record the perimeter and area “students went immediately to work.” In addition students explored ratios and proportions through scale drawings of cartoons. I observed during the activity Kevin and Joshua ask their group how to write a proportion. Nina and Anton led their groups by showing each group that proportions were “just ratios.” After this activity in their journals, I asked students to include how they felt about measurement after using hands-on activities to learn. Edward stated, “I feel like I understand better how to do problems that involve area, volume, and perimeter. I didn’t get them before. I really, really liked working with groups and having stuff to move

around to find out answers.” In Mitch’s journal, he stated, “You know, I didn’t get any of this at first, but now I know area and perimeter. I hope we can keep doing these kinda activities all year. I think I learned more.” Kevin wrote, “I liked doing the activities with my hands. I didn’t always like people in my group, but I still learned what the formulas mean like surface area and area.”

Overall student growth was monitored and analyzed on a weekly basis throughout the eight-week study using teacher field notes as a form of measurement. By the end of the eight-week period, I recorded that 20 of the 26 students demonstrated better understanding of measurement through the activities. Student performance was also apparent through discussions held in the focus group as students began to use more mathematical vocabulary appropriately in their discussions. Students openly assisted each other on concepts that posed difficulties. Some students still preferred working mainly with activities related specifically to area and perimeter and did not wish to work on the activities requiring similar figures or working with ratios and proportions.

At the end of the eight-week study students took a unit test on measurement concepts reflected in the hands-on activities. Students understood that the grade would not count against them, and they understood that I still expected them to do their best. The objectives tested included identifying appropriate measurement tools, calculating area and perimeter of figures, calculating volume, and using ratios and proportions. Of the 26 students that participated in the study, 21 of the students made scores of 70% and higher. The remaining five students made improvements as I observed in my field notes, though their gains were not notable on the unit test. There were no noticeable trends in

questions missed. Approximately 76% of the students typically score above 70% on unit tests.

These data, student journals, teacher field notes, and focus group responses indicated that most students increased performance in measurement through the use of hands-on activities. In addition to improving students' performance in measurement, improved student communication emerged. Students were eager to share their questions and comments through methods such as class discussions and journal writing. In addition students became better communicators while listening to their peers.

Student Communication

To analyze student questioning related to measurement, I examined journal entries and teacher field notes. Students wrote reflections in their journals on each activity. Brief class discussions were held following each activity to answer student questions.

At the beginning of the action research study, I noted that students demonstrated reluctance to participate in class discussions. In my observations during the first week, I asked students to share what they learned in the activities and the responses I recorded were blank stares and students looking at their desks. I changed the question to ask the students what they did during the activity. Kamica stated that she “figured out that a clock is a measuring tool,” which was something she had not thought measured anything originally. In their journals, very few students had more to say other than “I enjoyed playing with the different measuring tools.” Eighty-eight percent of the students (23 out of 26) responded similarly.

In student journals, students' comments for the first activity were "I learned a lot," "I had fun," and "I like learning in groups." I attributed this to unclear expectations for the journals. I recorded that the following day when I set my expectations that I needed students to be more specific in "what they learned or questions they still had," student responses for the next activity improved. Through field notes, I also noted that students were asking each other questions related to finding the area such as "what is the difference between perimeter and area?" and "why don't we find the area without having to count all the time? It seems like it would be easier."

Throughout the course of this study, students began to use questions that were more specific to the activity. During discussion following the activities during week three, Jenny asked, "Is there a formula to find out the area of [regular] hexagons?" Martina responded, "No, you have to split it [the regular hexagon] up." Conrad interjected, "yeah, you can split it into like two trapezoids." This student interaction continued during and after each activity.

At the conclusion of the study, all of the students responded positively to using hands-on activities to learn measurement and demonstrated better communication skills in mathematics during the activities with their groups as well as in discussions following each activity. Analysis of teacher field notes indicated that student questioning during the study changed from comments such as "I don't get it," to questions relating more specifically to the activities, such as "how can I know that I am using perimeter, area, or volume in a problem?" I noticed that as the study progressed students asked each other questions more often than asking the teacher. This demonstrated more independence in learning during the hands-on activities. Student comments to the activities in their

journals became more focused on what they learned. Students went from writing comments like “I don’t get it” to writing such as “I didn’t know how to find the area of a trapezoid before today,” and “I found out that surface area was just finding the area of a bunch of figures and putting them all together.”

Communication in mathematics improved throughout the study during class discussions and group interactions as documented through teacher field notes as well as through student journal writing. Additionally, attitudes towards participating in math assignments related to measurement improved.

Student Attitudes

Student attitudes towards measurement were determined using several strategies. The first was through the measurement survey (Appendix A) conducted at the beginning and end of the study. The survey measured students’ personal feelings about measuring and how comfortable they were with using various measurement tools. Another strategy used was reflective journaling. Students communicated their feelings on what they learned in each activity as well as communicated any further observations or questions they had regarding measurement and any other mathematics concept with which they were experiencing difficulties. I recorded students in the focus group provided additional insight related to student attitudes about measurement. Using the survey, journaling, and focus group’s comments I was able to provide triangulation regarding students’ attitudes related to measurement.

The measurement survey was administered to 24 out of the 26 students in the class at the beginning and end of the research period. The same two students were absent

for the administration of the pre and post survey. The pre and post surveys (Appendix A) measured student attitudes in measuring and were separated into two sections; one for how students felt about measuring and one for how comfortable they were with using measurement tools. The survey contained six indicators for student feelings and comfort regarding measurement and six for identifying student knowledge of measuring tools. Statements 3, 6, and 11 were written to generate a strongly disagree response. Statements 1, 2, 4, 5, 7, and 8 indicated student attitudes on measurement. The responses were placed in a spreadsheet and percentages for each response were calculated, Table 2 below.

Table 2: Pre-survey results for Measurement (Attitudes)

Statement Number	Strongly Agree	Agree	Disagree	Strongly Disagree
1	4	42	38	17
2	17	38	32	13
4	4	46	42	8
5	13	33	42	13
7	17	38	29	17
8	16	54	17	13

Note: Numbers are expressed as percent of students' responding to questions.

From the table, close to 50% of the students consistently have negative attitudes and feelings on measurement, with the exception of statement 8 where most students agree they could accurately use formulas for finding the perimeter, area, and volume of figures. Over half of the students surveyed did not feel comfortable approximating without a ruler, converting within the metric system, or using a ruler that did not start at zero. Few students' demonstrated total confidence in their attitudes as can be noted by the percent of students selecting strongly agree.

Statements 3, 6 and 9-12 indicated students' basic knowledge of measurement. As previously stated statements 3, 6, and 11 were written to generate a strongly disagree

response. The following table (Table 3) represented the percentages calculated for each response.

Table 3: Pre-survey results for Measurement (Knowledge)

Statement Number	Strongly Agree	Agree	Disagree	Strongly Disagree
3	8	17	63	13
6	4	21	33	42
9	25	54	8	13
10	50	33	17	0
11	4	8	21	67
12	50	42	8	0

Note: Numbers are expressed as percent of students' responding to questions. Statement numbers 3, 6, and 11; a negative response is expected.

Most students understood that measurement involved using tools to find the measurement of angles, length, width, and height. Students' knowledge of measurement indicated that less than 25% of students were not comfortable with measuring. This indicated to me that students had a basic foundation in measurement at the beginning of the study.

The last question on the survey was a free-response question for students to identify what they believed measurement means. The following lists a sample of the responses to the pre-survey:

1. "the width of things"
2. "knowing how tall an object is"
3. "to measure objects with measuring tools"
4. "measurement means that you measure stuff"
5. "a distance of an object."

The remaining student responses were similar to the above indicating comprehension of measurement to be limited to the actual act of measuring items.

When the research period concluded, the measurement survey was administered again and evaluated using the same method. Again only 24 of the 26 students were present for the survey administration. The same 24 students were in attendance; therefore, all of their data were included. The results from the post survey were separated; Table 4 displays student attitudes.

Table 4: Post-survey and comparison results for Measurement (Attitudes)

Statement Number	Strongly Agree	Agree	Disagree	Strongly Disagree	Pre survey Disagree Responses	Pre - Post difference
1	25	63	13	0	54	42
2	25	50	21	4	45	21
4	21	46	29	4	50	17
5	25	50	21	4	55	29
7	8	21	38	33	46	-25
8	21	63	13	4	30	13

Note: Numbers are expressed as percent of students' responding to questions.

The information from the table showed that student attitudes towards measurement concepts indicated positive change over the course of the research period. Confidences in their abilities to measure were also indicated in survey questions one, two, five, and eight, where students indicated their comfort with doing work that involved measurement concepts. In comparison, five of the statements indicated a decrease in the number of disagree response with the exception of statement number 7, which refers to students asking for assistance on homework related to measurement. I attributed this to students to an increase in communication about measurement tasks.

The results for the post survey displayed in Table 5 below indicate that an increased number of students have a better understanding for basic measurement tasks. In comparing the pre and post survey, more students selected disagree or strongly disagree on statements 3, 6, and 11, which explains the negative difference.

Table 5: Post-survey and comparison results for Measurement (Knowledge)

Statement Number	Strongly Agree	Agree	Disagree	Strongly Disagree	Pre survey Disagree Responses	Pre - Post difference
3	4	4	63	29	75	-17
6	0	13	42	46	75	-13
9	25	67	4	4	21	13
10	50	50	0	0	17	17
11	0	4	25	71	88	-8
12	58	42	0	0	8	8

Note: Numbers are expressed as percent of students' responding to questions. Statement numbers 3, 6, and 11; a negative response is expected.

The student responses to the free-response question demonstrated an increase in student comprehension regarding measurement and clearer understanding of measuring. Their responses also indicated an increase in communication of mathematical vocabulary. The following is a sample list of the responses to the post-survey:

1. "it is measuring the mass, length, and weight of objects"
2. "measuring involves finding out what the measure is around the outside and inside of figures are"
3. "Measurement involves being about to use measuring tools, working with area and perimeter. It also means I have to know how to change from feet to inches some times."
4. "To me, measuring means I need to know how to use measuring tools to find out the length outside. It also means I have to be able to find the space inside a figure and how much space is taken by volume."
5. "it is how long or wide something is and how you find that out using a ruler, protractor, or other measuring tool"

At the conclusion of the research period, student communication in measurement also increased in their journaling and questioning as evident in the above sample responses.

Student participation through hands-on activities increased their attitudes towards measurement as well as their confidence in asking questions as was revealed through student journaling. At the beginning of the research period, students were asked to write what they considered their strength mathematics. All students with the exception of one

student stated that their strength was in adding, with the one stating their strength as being in multiplication. Not one student considered topics beyond the four basic operations. Throughout the action research study, students were asked to reflect on the activities and what they learned in each activity. A sample of student responses at the beginning of the study is list below:

Amy-“I learned a lot.”

Desiree-“It was fun.”

Nina-“I liked learning with my friends.”

Joshua-“I learned new tools.”

After reflecting on these responses, I demonstrated with the students my expectations for their reflections in their journals. I gave them the example, “I learned to use different measuring tools (or items) and where I can use them.” This guidance appeared to have the desired effect, because in the subsequent journal entries students wrote statements such as “I measured using a paper clip because it was closer to an inch. I knew how to use a ruler, but I didn’t know how to use the marks in between each centimeter.” Further analysis of students’ journals throughout the action research study indicated student responses to be more concise and indicated a positive change in their beliefs on their performance with measurement. At the conclusion of the eight-week study, students’ journal responses were as follows:

Amy-“This activity stretched my brain. I learned more about ratios and proportions and how I can use them when I am measuring. I think I learned more when I was learning using my hands and working with a group.”

Desiree-“I didn’t like math that much when we started. I think working with people and using things to help me learn made me like it better. I know how to use area formulas and I think I can handle almost every problem that has measurement in it. I need to work more on changing to measurements though, like from cm to mm.”

Nina-“I learned that measuring isn’t just using a ruler. I learned that measuring involves formulas and proportions and can be seen everywhere.”

Joshua-“I feel more comfortable talking about what I don’t know how to do. I learned how to use proportions in measuring but I think I still need a lot more practice.”

These entries aligned with teacher field notes that indicated students remained on task during the activities and demonstrated excitement towards learning measurement.

Summary

The purpose of this study was to examine the effects of using hands-on activities to teach seventh grade students mathematics. Analysis of data revealed student performance, communication, and attitudes improved during the study period as recorded by teacher observations, student mathematics journals, and focus groups. Chapter Five will conclude my study on the effects of using hands-on activities to teach measurement, where I will review the findings and make recommendations for further research in the area of teaching measurement with hands-on activities.

CHAPTER FIVE: CONCLUSION

“Action research is an invitation to learn, a means to tackle tough questions that face us individually and collectively as teachers, and a method for questioning our daily taken-for granted assumptions as a way to find hope for the future” (Mills, 2003, p. v).

The purpose of this study was for me as a teacher to use action research to examine the effects of using hands-on activities to teach seventh grade students mathematics.

Throughout the research period, data were collected to assist in understanding students’ performance and attitudes in measurement. Student journals, teacher field notes, and focus group discussions served as evidence about student performances in a seventh grade mathematics classroom. Pre and post surveys along with student journals and teacher field notes were used to measure student attitudes and questioning related to measurement. These data were collected and analyzed to provide insights related to my practice of using hands-on activities as reflected in student performance and attitudes in measurement. My seventh grade students benefited by developing deeper understanding of measurement, investigating measurement by developing questioning skills, reflecting on learning by journaling their mathematical reasoning, and participating in hands-on activities.

“Action research is about incorporating into the daily teaching routine a reflective stance-the willingness to critically examine one’s teaching in order to improve or enhance it” (Mills, 2003, p. 10). With this in mind, I conducted action research in my seventh grade classroom by including hands-on activities enhanced with reflective journal writing to teach measurement concepts. Reading students’ reflective journals gave me the

opportunity to determine students' strengths and weaknesses in measurement. In addition, reviewing and analyzing student journals after each activity helped me reflect on my teaching methods and determine the effectiveness of my communications with my students. I reflected on activities and student surveys regarding measurement each week to determine which course of action would be most effective to help my students develop more comfort in solving problems involving measurement. I believe that changing my strategies to include hands-on activities and reflection enhanced my teaching and gave me opportunities to differentiate my instruction to reach students at a variety of levels.

This study demonstrated the positive effects of using hands-on activities to improve student performance in measurement. Students expressed their thoughts and opinions about measurement through journaling and discussions throughout the action research study. Focus group discussions were used for further insight into growth in student performance in measurement. Students showed interest in learning about measurement through hands-on activities. At the conclusion of the study, only five out of twenty-six students received scores lower than an average of 70%. However, gains were still made by these students. It is my belief that incorporating hands-on activities to teach measurement concepts improved student performance.

Subsequently, student attitudes towards measurement improved while using hands-on activities as a learning strategy. At the beginning of the year, student attitudes toward measurement were that of apprehension and a lack of confidence in their abilities related to measurement. At the conclusion of the study, student attitudes expressed enthusiasm and excitement towards mathematics and problems dealing with measurement.

When reflecting on the research for how students' learn measurement, I believe that many of my students were not fully developed in their learning of measurement. Most students seemed to grasp Piaget's three areas of learning measurement; conservation, transitivity, and unit iteration. The depth of these concepts appeared lost to them when asked to measure for precision and accuracy. Additionally, my students needed time to explore the meaning of measurement terms such as area, perimeter, and volume. Using hands-on activities seemed to support that exploration and improved their abilities to perform tasks related to measurement.

Recommendations

One limitation of this study was time frame when the study was conducted. Students entered the classroom following their scheduled lunch time midway through their day. I encountered a variety of behaviors throughout the action research study that were possibly related to the students' lunch habits or lack of eating lunch. I noticed when Edward did not eat lunch that his behavior was unpredictable and often more disruptive than when he ate lunch. In addition, if he ate mainly sugar for lunch, such as brownies and slushy drinks, he would enter class full of energy and suddenly become sluggish and inattentive to the lesson. I believe that further studies on how student eating habits affect their academic performance and behavior are needed.

The sample size was also small. It included only twenty-six seventh grade students in a school with a population exceeding five hundred seventh graders alone. This sample does not represent a diverse enough group or a sample strong enough to support that hands-on activities to teach measurement are affective to other students. Research

would need to be conducted on a larger sample size to be able to generalize these findings.

While conducting my research on the effects of hands-on activities, I often felt rushed during the hands-on activities to complete each activity within the allotted time frame. I believe this was unique to the learning environment of the school due to changing student schedules for the year. This change affected student learning as well as shortened the time students had to learn the required curriculum, which added to the pressure of learning the material. Given a more consistent time frame to conduct the research, I believe would have produced higher results on performance.

Within the scope of this study, I did not feel that I gave ample time to covering the more difficult concepts of using proportions for measuring; however, I gave a great deal more time to measurement concepts such as building concrete connections with area of geometric figures allowing more time to completely grasp these area concepts. This was evident in student resistance to work on problems involving similarity. This concept is generally not covered in great depth in the curriculum for seventh grade; however, students are expected to know how to set up proportions and ratios involving two dimensional figures. Since students in the middle grades need additional work with these concepts, supplemental work following this action research will be included. In the future, I will place more emphasis in problem solving with measurement, providing students with connections to how this relates to real-world problems.

An additional area of study presented itself when researching ethnicity of the students of my school and my classes. The population at the school was continuing to grow throughout the course of the year as was the number of English Language Learners

in each class. Further study into how hands-on activities affect student learning for these students is needed.

Discussion

“The goal of teaching mathematics is to help all students understand concepts and use them powerfully” (Daniels, Hyde, & Zemelman, 2005, p. 113). This often requires teachers to step out of their “comfort zone” and demonstrate a willingness to explore mathematics with the students. It requires changing methods of teaching from traditional methods commonly used to methods that include collaborative learning and hands-on activities. More emphasis must be placed on concepts involving measurement, including helping students make connections with every day problem solving applications.

“Learning mathematics requires that children create and re-create mathematical relationships in their own minds” (Burns, 2000, p. 24). Through the use of hands-on activities in measurement students create these relationships to take experiences from concrete interactions to abstract concepts of building formulas to find the area and volume of geometric figures. During my observations of my students’ in my action research study, students developed connections between previous learning experiences and how to problem solve in measurement. However, I believe continued research on *how* middle school students learn measurement is necessary.

“Without a concerted effort to give students experiences that build their conceptual understanding of [the use of standard measuring devices and formulas], performance with measurement will likely continue to lag in the coming years” (Struchens, Martin, & Kenney, 2003, p. 206). Stress on educators to have students

demonstrate improved academic achievement creates the feeling that teaching means “cover the material.” While time was a limiting factor during this teaching year, the time I spent with these students was crucial to their mathematical development in reasoning and problem solving involving measurement. With the various activities students were able to explore other concepts and share their knowledge with each other, creating a more diverse curriculum that included additional mathematical concepts.

Having the students’ journal following hands-on activities provided me with valuable information and offered a “safe” place for students to express their feelings and understandings of the measurement concepts being explored. “Teachers must build a safe environment in the classroom where students believe they can freely express their ideas without negative consequences for mistakes” (Daniels et al., 2005, p. 117). I noticed as I gave students feedback in their journals about their mathematical reasoning, they became more comfortable with sharing their thoughts in the classroom both by vocalizing their thoughts and expressing themselves in their journals with increased clarity. While reading student journals required an increased amount of time on my part as a teacher because I chose to respond to *each* student entry, I intend to continue and extend the use of journals to all mathematics classes that I teach in the future.

As a result of my study, I will continue to integrate hands-on activities to teach measurement as an instructional strategy. I found hands-on learning to be a valuable teaching strategy when combined with reflective journaling. Students’ knowledge, apprehensions, and misconceptions about measurement were evident in their communications, both verbally and written. Through the use of hands-on teaching

strategies and journaling, I was able to provide immediate feedback to my students, while I also helped to move students to a better understanding of measurement in the process.

APPENDIX A: MEASURMENT SURVEY

Measurement in Mathematics

The following survey is designed to discover your feelings in measurement and your comfort level with using measurement tools in mathematics. Take a few minutes to read each question and circle the response to the statements regarding measurement that most accurately describes your feelings. Four (4) represents strongly agree, three (3) agree, two (2) disagree and one (1) strongly disagree. This survey is anonymous and not graded, so please be honest in your answers.

	SA	A	D	SD
1. I know how to approximate the measurement of objects without using a ruler.	4	3	2	1
2. I consider myself skilled with using a ruler.	4	3	2	1
3. When given a math assignment with measurement, I panic.	4	3	2	1
4. I know how to convert within the metric system.	4	3	2	1
5. If the ruler doesn't start at zero, I can measure most small objects.	4	3	2	1
6. I use measurement only at school.	4	3	2	1
7. If my homework involves measurement, I get help on answers.	4	3	2	1
8. Given formulas for finding the area of various figures, I can use the right formula to solve problems.	4	3	2	1
9. Measurement is knowing how to use a ruler, compass, or protractor to measure objects.	4	3	2	1
10. A protractor is a measuring tool to measure angles.	4	3	2	1
11. A 12-inch ruler would be the best tool to find the distance around the classroom.	4	3	2	1
12. Perimeter, area, and volume are all measurement terms.	4	3	2	1

In your own words, what does measurement mean? _____

APPENDIX B: PERMISSION TO USE CMAT

8700 Shoal Creek Blvd.

Austin, TX 78757-6897

(512)451-3246

(512)451-8542(fax)

Request for Dissertation or Thesis

Thank you for your request to use the **CMAT** for your research project. Please print this page and fax or mail it to us and we will be happy to supply you with one free copy of the instrument. It is our understanding that you will use this test for your research project and that you will supply us with a copy of your paper when completed. We will contact you within a month of your completion date to make mailing arrangements.

Test Requested: CMAT

Name: Darlene Hoke

Estimated Completion Date:
May 2006

Signature: Darlene Hoke

Advisor's Name: Dr. Juli Dixon EDF 123F

Signature: J. Dixon

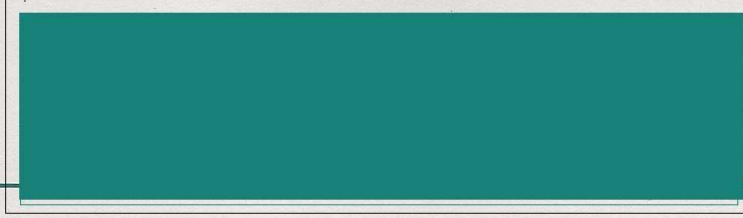
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APPENDIX C: TABLE OF ACTIVITIES

Table of Activities

Week	Objectives	Manipulatives Used
Week 1	<ol style="list-style-type: none"> 1. Students identified measuring tools and the use of each tool. 2. Students determined the precision of each tool and created a table listing the tool, its use and precision. 	Tools included measuring cups and spoons, thermometer, trundle wheel, meter sticks, yard sticks, scales, measuring tapes, and clocks
	<ol style="list-style-type: none"> 1. Students chose an item from their bag to approximate the measure of the remaining items and then measured the remaining items using the item chosen as a measuring tool. 2. Students approximated and measured the same items in terms of centimeters. 	Paper bag containing paper clips, candles, straws, pencils, crayons, garbage tie, candy, and pens Rulers
Week 2	Student measured the area and perimeter of a triangle, rectangle, trapezoid, and hexagon with a ruler not starting at zero.	Rulers with an inch cut from each end
	Students use tiles to represent figures with the same perimeter but have different area.	Square tiles
Week 3	<ol style="list-style-type: none"> 1. Students used 10 Cuisenaire Rods to create different rectangles using all rods and recorded the perimeters and areas of each. 2. Students investigated patterns between them. 	Cuisenaire Rods- 2 green, 2 purple, 2 yellow, 2 dark green, and 2 black 1 white to use as one unit
Week 4	Students measured the circumference and diameter of various circles to discover the measure of π . Students used this information to find the area of each circle.	Measuring tapes Circular items included plastic cylinders, coffee can lids, garbage cans, plates, pie tins, and rolls of tape
Week 5	<ol style="list-style-type: none"> 1. Students built squares and triangles with Tangram pieces and calculated the area of the squares and triangles. 2. Students used pattern blocks to create a large hexagon and found the area of the hexagon using the rhombus-shaped block. 3. Students explored relationships between the area of the hexagon using the rhombus and using other shapes. 	Pattern Blocks and Tangrams
Week 6	<ol style="list-style-type: none"> 1. Students created similar squares and rectangles of different dimensions and compared with perimeter. 2. Students created similar squares and rectangles of different sizes and compared with area. 	Geoboards
Week 7	<ol style="list-style-type: none"> 1. Students created different size boxes with the same number of cubes and recorded the picture, volume, and surface area. 2. Students created nets of their designs and cut them out to wrap around the designs. 	Link Cubes
Week 8	<ol style="list-style-type: none"> 1. Students created the word MATH with tiles and recorded the perimeter and area. 2. Students explored ratios, scale drawings, and proportions. 	Square tiles

APPENDIX D: PRINCIPAL LETTER



August 10, 2005

Dear IRB Coordinator,

Mrs. Darlene Hoke has notified me of the nature of her action research to take place from August 2005 to May 2006. It is my understanding that her action research will investigate the effects on student performance of using hands-on activities to teach measurement concepts in mathematics.

Mrs. Hoke has made it clear that student participation or nonparticipation in this study will not affect student progress, and there are no anticipated risks to students during the proposed action research. Upon receiving the required parental consent form and student assent, I authorize Darlene Hoke to conduct the proposed study.

Sincerely,

Mr. David Tucker
Principal



Vision + Knowledge + Family = Success

APPENDIX E: IRB APPROVAL



Office of Research & Commercialization

July 25, 2005

Darlene Hoke
13623 First Ave
Winter Garden, FL 34787

Dear Mrs. Hoke:

With reference to your protocol #05-2732 entitled, "Effects on Student Performance of Using Hands-on Activities to Teach Seventh Grade Students Measurement Concepts" I am enclosing for your records the approved, expedited document of the UCFIRB Form you had submitted to our office. **This study was approved by the Chairman on 7/21/05. The expiration date for this study will be 7/20/06.** Should there be a need to extend this study, a Continuing Review form must be submitted to the IRB Office for review by the Chairman or full IRB at least one month prior to the expiration date. This is the responsibility of the investigator. **Please notify the IRB when you have completed this study.**

Please be advised that this approval is given for one year. Should there be any addendums or administrative changes to the already approved protocol, they must also be submitted to the Board through use of the Addendum/Modification Request form. Changes should not be initiated until written IRB approval is received. Adverse events should be reported to the IRB as they occur.

Should you have any questions, please do not hesitate to call me at 407-823-2901.

Please accept our best wishes for the success of your endeavors.

Cordially,

Barbara Ward

Barbara Ward, CIM
IRB Coordinator

Copy: IRB file

BW:cc

12443 Research Parkway • Suite 302 • Orlando, FL 32826-3252 • 407-823-3778 • Fax 407-823-3299

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APPENDIX F: PARENT CONSENT

August 4, 2005

Dear Parent:

I am currently a graduate student in the Lockheed Martin/University of Central Florida Science and Mathematics K-8 Master's Program under the supervision of faculty member, Dr. Juli K. Dixon. I am conducting research on student performance in the middle school mathematics classroom. As a graduation requirement, I will conduct an action research project and document the findings in a thesis.

The focus of this **action** research is to examine the effects of using hands-on activities to learn measurement concepts, such as area and perimeter, in the mathematics classroom. This portion of mathematics is consistently low across the state on the Florida Comprehensive Assessment Test (FCAT). I have spoken with Principal Tucker and gained his support in this action research study.

The action research that I will be conducting consists of a Pre/Post Survey, Pre/Post Test, Student Journals, Student Interviews and Field Notes. Students will be introduced to the seventh grade mathematics standards with the integration of hands-on activities. Students will keep journals that will contain their thoughts and feelings regarding the use of hands-on activities in their experiences with the measurement curriculum. I will be collecting data using the Pre/Post Survey, Pre/Post Test, student journal responses, and interviews.

With your permission, your child will be audio or videotaped during various instructional periods. The audio and videotapes will be accessible only to the researcher for data collection and verification purposes. All audio and videotapes will be destroyed when the research is complete. Although children will be asked to write their names on their work, their identity will be kept confidential to the extent provided by law. Pseudonyms or coding will be used in all research reports. Participation or nonparticipation in this study will not affect your child's grades. Students not participating in the research will receive assignments to engage them during the time allotted for the action research study.

You and your child have the right to withdraw consent for your child's participation at any time without consequence. There are no known risks to the participants. No compensation is offered for participation. **The benefits for participating include a more accurate self-awareness of mathematical abilities and increased performance on high-stakes tests such as FCAT.**

If you have any questions about this action research study, you can, at any time, direct those questions/concerns to Darlene Hoke at [REDACTED], Principal Tucker at [REDACTED], the UCF faculty supervisor, Dr. Dixon at [REDACTED], or the UCFIRB Office at 12442 Research Parkway Suite 302 Orlando, Fl 32826. The phone number is (407) 823-2901.

Sincerely,

Mrs. Darlene Hoke

I have read the procedure described above. I voluntarily agree to participate in the procedure, and I have received a copy of this description.

_____ I have read and understand the letter for participation in **“Effects on student performance of using hands-on activities to teach measurement concepts”** action research study.

_____ Yes, I give permission to my child to participate.

_____ No, I do not want my child to participate.

Parent’s signature

Date

_____ I have read and understand the letter for participation in **“Effects on student performance of using hands-on activities to teach measurement concepts”** action research study. I understand the teacher-researcher may videotape some mathematics activities and the tapes will be destroyed at the completion of the study.

_____ Yes, I give permission for my child to be videotaped during the project.

_____ No, I do not want my child videotaped during the project.

Parent’s signature

Date

_____ I have read and understand the letter for participation in **“Effects on student performance of using hands-on activities to teach measurement concepts”** action research study. I understand the teacher-researcher may audiotape some mathematics activities and the tapes will be destroyed at the completion of the study.

_____ Yes, I give permission for my child to be audio taped during the study.

_____ No, I do not want my child to be audio taped during the study.

Parent’s signature

Date

APPENDIX G: STUDENT ACCENT SCRIPT

Student Assent Script

Hello. My name is Mrs. Hoke. I am a graduate student the University of Central Florida. I am doing an action research study on measurement in math. I would like to use video and audio tape while you work with different rulers to measure objects. You will not receive a grade or compensation for participating, nor will you be penalized for not participating. Do you wish to participate in this project?

APPENDIX H: COMPARING LINES

<p>1</p> <p>а —————</p> <p>б —————</p>	<p>4</p> <p>а ————</p> <p>б ————</p>
<p>2</p> <p>а ————</p> <p>б ————</p>	<p>5</p> <p>а —————</p> <p>б —————</p> <p>в —————</p>
<p>3</p> <p>а —————</p> <p>б —————</p>	<p>6</p> <p>а —————</p> <p>б —————</p>

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