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The effect of learning styles strategies on benchmark eighth grade middle school mathematics achievement

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ABSTRACT

The Effect of Learning Styles Strategies on Benchmark Eighth Grade Middle School Mathematics Achievement

by

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M.Ed. City University of New York, 1985
B.S., St. John's University, 1979

Doctoral Study Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Education
Administrator Leadership for Teaching and Learning

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Walden University

COLLEGE OF EDUCATION

This is to certify that the doctoral study by

Jean Ferrara

has been found to be complete and satisfactory in all respects,
and that any and all revisions required by
the review committee have been made.

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ABSTRACT

Low standardized mathematics scores resulted in a suburban middle school not reaching adequate yearly progress (AYP) for the 2 previous years. There were many possible factors contributing to this problem, among them the design of instruction. The purpose of this study was to identify learning styles of students and implement differentiated instructional strategies that address the learners' needs. The study was based on the Silver and Hanson's theory of learning style instruction and Gardner's multiple intelligences as a model for differentiating instruction. This sequential mixed methods quasi-experimental causal comparative design study investigated the effect of classroom intervention based on learning style differentiation on the improvement of mathematics achievement and the teachers' perception of learning style instructional strategies. An ANCOVA analysis of 8^{th} grade archival math achievement scores from a nonrandomized control and experimental-group pretest-posttest sample measured the effect of using a learning style strategy intervention on the experimental group. No statistical significance was noted for the student scores by instructional type. An anonymous teacher open-ended survey and classroom observations were used to determine teachers' perception of implementing differentiated instruction. NVivo was used to manage the qualitative data, and analysis revealed emerging themes of teachers reporting a better understanding of the importance of differentiation, and designing lessons to include learning styles' instruction. This study impacted social change by developing a working knowledge for teachers of learning style differentiation of instruction intervention so that student mathematical achievement may be positively impacted by a change in the design of their instruction.

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DEDICATION

I dedicate this doctoral study to my family…

To my husband Tom for his unconditional love and support, and unwavering encouragement; without whom I would ever have reached this long awaited goal; I share this achievement with you;

To my children Jessica, Thomas and Matthew for their inspiration that strengthened me and their patience that allowed me to stay focused on my goal;

To my late Mom, a loving and dedicated educator of young children, who encompassed the meaning of teacher and was my true role model;

To my late Dad for his incredible confidence and excitement in my successes in life; he allowed me to dream any goal is possible;

To my late mother-in-law Louise who always demonstrated the true meaning of remaining steadfast and faithful through many of life's challenges;

To my faithful pet and companion Emma, you stayed by my side for many an unending night as I persisted through my work.

To my colleagues and the profession we represent: may our desire to learn more about helping children reach success never dim.

Above all…my prayers have been answered throughout this entire doctoral journey by my Lord and Savior who never failed to provide me with the wisdom and strength to fulfill my dream. The Lord will fulfill his purpose for me; your love, O Lord, endures forever—do not abandon the works of your hands (Psalm 138:8 New International Version).

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SECTION 1: INTRODUCTION TO THE STUDY

Introduction

Organizational structure and climate of schools is associated with student-achievement levels (Zvoch & Steven, 2006). The relationship between teacher collaborative teams and their participation in the school decision-making process has also indicated a growth in student achievement in elementary and secondary schools (Conley, Fauske, & Pounder, 2004).

> Investigations of year-to-year changes in student academic performance have revealed that schools and teachers can have a much larger impact on student gains in achievement than on student-achievement levels. Student-achievement data has revealed that independent of student background, the size and social organization of schools and the practices of teachers share moderate-to-strong relationships with the progress of students. (Lee & Smith, 2001, p. 348)

Middle school math performance may be considered a predictor of a student's future academic success in the areas of mathematics and science at the high school setting, and set the groundwork of a student's future academic opportunities. Not only does school policy set restrictions on scheduling into more advanced courses, but the student may set his or her own restrictions based on developed self-perception (Ding & Navarro, 2004). The period of time that extends between the sixth grade and the eighth grade can transform a confident learner into a student who questions the purpose of putting forth effort before he or she will risk the challenge (Ding & Navarro, 2004). With the accountability pressures from the No Child Left Behind Act (NCLB, 2002), schools have been given the charge to increase the academic performance of all students and develop programs to enhance student success (Zvoch & Stevens, 2006, p. 347). It is necessary for middle school instructors to enhance their knowledge of data driven

instruction and incorporate lessons to meet the needs of differentiated learning styles in order to improve student achievement levels as measured by high stakes testing.

This study examined student achievement in relationship with instructional strategies aligned with learning styles. Learning styles of students were identified and aligned with instructional strategies to address differentiation of skills. The design for this study was a sequential mixed methods quasi-experimental causal comparative design. The study employed unequivalent control and experimental groups using archival data as the pre and post comparison of mathematics achievement. This investigative study was constructed and administered by six teacher leaders under the supervision of the researcher. The effect of the planned intervention model on mathematics achievement was examined with a pre and a post assessment of a local benchmark diagnostic by the district to the eighth grade level of student participants. A more detailed discussion on instructional design and instructional strategies may be referenced in section 2.

Evidence of the Problem at the Local Level

Data reported by the New Jersey Department of Education outlined the Adequate Yearly Progress (AYP) Status under NCLB Accountability Requirements: school years 2007 and 2008 for the middle school involved in this study. The School Improvement Status Summary indicated that this middle school was in Year 3 as a Hold Status. AYP was met for this school as a result of the 2008 administration of the New Jersey Assessment of Skills and Knowledge (NJ ASK); however, since the AYP was newly established for 1 year only, the improvement status did not progress out of a Hold Status. Past history over the last six administrations of the state's required assessments suggested

that this school had attained AYP before but failed to maintain this status for 2 consecutive school years in order to progress out of the Hold Status. This middle school is also identified as a Title I school as determined by the number of students who are eligible for free or reduced lunch.

Statement of the Problem

The problem at the middle school in a suburban school district was the mathematics achievement levels of students. At that current time, the school was in a Hold status as mandated by the state for any school that had not maintained 2 years of reaching AYP based on the results of the NJ ASK. Since the school in the study was eligible for Title I funding, based on the socioeconomic status of its population, regular after school mathematics reinforcement sessions had been offered free of charge to students identified as being at risk. However, the concern with students' mathematics achievement still remained a priority, particularly since the school needed to meet AYP for 2 consecutive school years to move out of Hold status. This problem impacted the grade 8 population because this cohort of students had a higher percentage of students below proficiency level on the NJ ASK than the other two grade levels in this school. There were many possible factors contributing to this problem, among which were the design of instruction in each of the mathematics classrooms and the need for teachers to address the learning style needs of each of their students through differentiation.

Built upon the commitments of No Child Left Behind, teachers throughout the nation need to be prepared to face the challenges of raising achievement and closing gaps. Student learning is based upon the quality of the teaching (Heacox, 2002). In a national study conducted by Hall and Kennedy (2006), effective teaching made a greater

impact on student performance. However, with the greater expectation of better teaching comes the realization that teachers need the support of professional development as well as the opportunity to articulate among grade level colleagues (Hall & Kennedy, 2006).

Nature of the Study

The study investigated the relationship between the differentiation of instruction, based on the identification of learning styles present in the classroom, and knowledge of researched intervention strategies with an improvement of mathematics achievement levels, as noted by a district administration of local pretest and posttest benchmark assessments. The design for this study was a sequential mixed methods quasi-experimental causal comparative design. To determine whether there was a relationship between a teacher's recognition of learning styles and implementation of differentiated instruction with his/her students' mathematical performance, this mixed methods study collected data from three general education grade 8 mathematics classes and three basic skills grade 8 mathematics classes in a suburban middle school. From this population, two of the three general education classes and two of the three basic skills classes were arbitrarily selected to be part of the experimental group. The remaining general education class and basic skills class comprised the control group.

Because of the nature of this study, a sequential explanatory mixed methods causal comparative design employed a nonrandomized control-group pretest-posttest design. In this design, the quantitative portion was the measure of student achievement before and after the implementation of learning style strategies as measured by an improvement of archival data on pretest and posttest benchmark assessments. The qualitative portion examined teachers' perception of learning styles and intervention

strategies through the completion of a reflection survey. Additional discussion regarding methods is addressed later in section 3.

Research Questions

The broader question of this mixed methods design study investigated the influence of instructional strategies aligned with learning styles on mathematics achievement at the middle school level. The following subquestions were addressed in this study:

1. What is the difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally?

H_o: There is no significant difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally.

H_a: There is a significant difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally.

2. What is the difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally?

H_o: There is no significant difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style

instructional strategies and the middle school basic skills students who were taught traditionally.

H_a: There is a significant difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally.

3. How do the teachers describe their perception of the effects of learning styles strategies on the students' benchmark mathematics achievements?

Purpose of the Study

The purpose of this sequential explanatory mixed methods causal comparative study was to examine the implementation of learning styles instructional strategies and the relationship to mathematics achievement of eighth grade students in a Title I middle school in a suburban school district. The implementation of NCLB on achieving proficient outcomes for all students is preventing educators from a focus on enhancing instructional strategies and a directive for all students to master basic skills (Lee, 2006). It may be necessary to establish instructional strategies aligned to learning styles of students to address the needs of all students in the same classroom (Silver & Hanson, 1996).

Theoretical Framework

Multiple Intelligences

According to Gardner (1983), each student is capable of processing information differently from another since they all possess a specific profile of intelligence. Plagued by a concern that only two exclusive intelligences, linguistic and logical-mathematical

symbolization, were used and tested in school, Gardner developed the multiple intelligence theory to include the many other forms of intelligences that exist both in and outside the classroom (Gardner, 1983). Gardner defined intelligences as the ability to do problem solving, not necessarily limited to the type of ability that can be measured by paper and pencil short answer tests. The original seven multiple intelligences included: linguistic, logical-mathematical, musical, spatial, bodily-kinesthetic, interpersonal, and intrapersonal plus the most recently added eighth intelligence: naturalist (Strong, Silver, & Perini, 2000).

Background Information of Learning Styles

Ryckman (2007) explored the work of Jung, particularly the way information is processed and evaluated to determine the four dimensions of personality: sensing, intuition, thinking, and feeling. Sensing and intuition explain how a person perceives information, and thinking and feeling explain how a person makes judgments about how to use the information. Silver considered Jung to be one of the great minds of the 20th century and used his work on learning styles as a foundation of his research on learning styles (Strong, Thomas, Perini, & Silver, 2004) Cooper and Miller (1991) investigated the application of Jung's theories by Myers-Briggs in the development of the Myers-Briggs Type Indicator (MBTI). This questionnaire is used to identify psychological type and allow a better understanding of one's personal differences. The MBTI is used to determine a person's strengths as a learner and worker and has been a guide to understand type differences in education, workplace, and relationships (Cooper & Miller, 1991).

The work of both Jung and Myers-Briggs was extended further in the field of education in an attempt to create a clearer vision of how the human personality impacts the process of learning. Researchers who applied the model of cognitive diversity to education included McCarthy, Butler, Gregorc, Mamchur, and Silver and Hanson. All of these learning-style theorists share the common focus on the process of learning (Strong et al., 2000).

Silver and Hanson (1996) developed a learning style model that resembled the quadrants of Jung's model. Taking the four basic functions first initiated by Jung, sensing and intuition used to perceive knowledge, as well as thinking and feeling used to apply knowledge, they created four combinations or learning styles (Strong et al., 2004):

1. Sensing-Thinking, also known as Mastery Style
2. Intuitive-Thinking, also know as Understanding Style
3. Intuitive-Feeling, also know as Self-Expressive Style
4. Sensing-Feeling, also know as Interpersonal Style

It is these four learning styles that became the foundation of this research study since it connects the knowledge and effects of learning styles with instruction in the classroom. More specifically, the work of Strong, Thomas, Perini, and Silver (2004) utilized an understanding of learning styles to develop instructional strategies as a means of intervention in the mathematics classroom.

Definition of Terms

Adequate Yearly Progress (AYP): An individual state's measure of yearly progress toward achieving state academic standards. Adequate yearly progress is the minimum level of improvement that states, school districts, and schools must achieve each year,

according to federal No Child Left Behind legislation. This progress is determined by a collection of performance measures that a state, its school districts, and subpopulations of students within its schools are supposed to meet if the state receives Title I federal funding (State of New Jersey Department of Education, 2009).

At-Risk Student: Students may be labeled at risk if they are not succeeding in school based on information gathered from test scores, attendance, or discipline problems (Pollock, 2007, p. 26).

Data Driven Instruction: Analyzing existing sources of information (class and school attendance, grades, test scores) and other data (portfolios, surveys, interviews) to make decisions about the school. The process involves organizing and interpreting the data and creating action plans (Wiggins & McTighe, 2005, p. 227).

Differentiated Instruction: This is also referred to as "individualized" or "customized" instruction. The curriculum offers several different learning experiences within one lesson to meet students' varied needs or learning styles; for example, different teaching methods for students with learning disabilities (Heacox, 2002, p. 5).

Peer Review Process:A team of educators, experts who are closely involved with the curriculum content, examine *evidence* compiled and submitted by school district that is intended to show that its assessment system meets NCLB requirements. Such evidence may include, but is not limited to, results from alignment studies; results from validation studies; written policies, if appropriate, on providing accommodations for students (NCLB, 2002).

Instructional Strategies: Methods used to differentiate a lesson in order to meet the needs of the learning styles of the students (Pollock, 2007, p. 70).

Learning Styles: The way students learn and how their preferences for certain types of thinking processes affect their learning behaviors (Strong et al., 2000, p. 24).

Mathematics Achievement: Indicator of a student's performance in mathematics based on the results of a formal or informal assessment (Blankstein, 2004, p. 156).

Myers-Briggs Type Indicator (MBTI): questionnaire used to identify an individual's personality type (Strong et al., 2000, p. 24).

National Assessment of Educational Progress (NAEP): NAEP (pronounced nape) is also known as The Nation's Report Card. It is a federally funded program (currently contracted to Educational Testing Service in Princeton, New Jersey.) that provides information about the achievement of students nationally and state-by-state. NAEP tests a representative sample of students in grades 4, 8, and 12 each year and reports the results to the public (State of New Jersey Department of Education, 2009).

NCTM Standards: A description of what students should be expected to learn in mathematics classes published originally in 1989 by the National Council of Teachers of Mathematics (NCTM). The mathematics standards became the model for other subject matter organizations that developed standards in the early 1990s. Those standards were not adopted by the federal government, so instead they are used primarily for reference rather than for official purposes. For example, many of standards adopted by most states in the mid and later 1990s were at least partly derived from the national standards (NCTM, 2000).

New Jersey Assessment of Skills and Knowledge (NJASK): With the enactment of the NCLB Act, New Jersey's statewide assessment of elementary students has undergone further change. Under the provisions of this federal legislation, every state is required to

administer annual standards-based assessment of all children in grade 3 through 8. Federal expectation is that each state will provide tests that are grounded in that state's content standards and that assess students' critical thinking skills in three content areas: language arts literacy, mathematics and science (State of New Jersey Department of Education, 2009).

No Child Left Behind Act: Signed into law by President George W. Bush in 2002, No Child Left Behind sets performance guidelines for all schools and also stipulates what must be included in accountability reports to parents. It mandates annual student testing, includes guidelines for underperforming schools, and requires states to train all teachers and assistants to be highly qualified (State of New Jersey Department of Education, 2009).

Professional Development: Programs that allow teachers or administrators to acquire the knowledge and skills they need to perform their jobs successfully (Loucks-Horsley et al., 1998, p. 16).

Professional Learning Community (PLC): An extended learning opportunity to foster collaborative learning among colleagues within a particular work environment or field (DuFour, 2004, p. 6).

Title I: A federal program that provides funds to improve the academic achievement for educationally disadvantaged students who score below the 50th percentile on standardized tests, including the children of migrant workers. (State of New Jersey Department of Education, 2009).

Traditional Instruction: This type of instruction is conducted without learning style delivery strategies. (Pollock, 2007, p. 62).

Scope and Delimitations

This research study took place within one middle school in a suburban school district. Grade 8 participants were selected for this study since this grade level permitted a sample of at least three general education mathematics classes as well as three basic skills mathematics classrooms during marking period 3.

1. The delimitations of this study are as follows: Participants: 100 general education and basic skills grade 8 students combined, three general education grade 8 teachers and three basic skills grade 8 teachers

2. Time: One day of professional development for the teachers and 5 days of intervention strategies in the classrooms

3. Resources: District approved grade 8 mathematics textbook *Pre-Algebra, 2003*; (McGraw-Hill Publishers); *Math Tools* (Silver, Brunsting & Walsh, 2008) and *Styles and Strategies for Teaching Middle School Mathematics* (Thomas, 2003); Pretest and Posttest results from district administered local benchmark assessments; results from the Learning Style Inventory for Students and Math Learning Style Inventory for Students, both administered by the district.

4. Location: Title I Middle School in suburban school district. Actual intervention to take place in regularly scheduled mathematics classes

Assumptions and Limitations of the Study

Assumptions

Considering the collaborative atmosphere present in this middle school setting, the assumption was made that all teacher participants invited to join this research study would be cooperative and committed to the goals of this study. It was also assumed that the information shared with the experimental teachers during the professional development sessions would be consistent with the learning style intervention strategies that were exercised during the instructional period with their sample population. The integrity of the confidentiality of intervention activities was assumed to be maintained by the experimental teachers. Lastly, it was assumed that the pretests and posttests were administered under the same testing variables, and that all participating teachers graded their assigned students' tests consistently with the rubric approved by the district.

Limitations

The weakness to this study has been attributed to: (a)the limited time for intervention and examination of data during the 1 week period of time allocated for this study, (b) inability to control for years of experience (tenure/nontenure status) of teachers in grade 8 as mathematics instructors, their certification in mathematics or highly qualified certification in mathematics, (c) time of day mathematics class is taught, (d) proportions of gender classifications in each classroom, (e) proportions of socio-economic status for purposes of Title I classification in each classroom, (f) probable attrition of student population that would impact sample size, (g) prior math performance of students in these classes, and (h) adopted curricula for scope and sequence.

Significance of the Study

This study investigated some of the pertinent factors that affect mathematics achievement at the middle school level. Included in this study is the analysis of the stratification of students at the middle school level, as well as curriculum expectations that are prevalent in the middle school classrooms. Standardized assessments as required by NCLB and designated by national and state standards were also examined in terms of the lasting impact on student achievement, particularly the method by which they learn mathematics. Learning styles of students were identified and aligned with instructional strategies to address differentiation of skills. Each teacher had an increased exposure to professional research as well as a better understanding of learning styles and differentiation of instruction to improve student achievement. The purpose of the intervention was to help students reflect on their learning so that they may develop a greater self-awareness of how they learn in order to retain knowledge and become improved learners (Strong et al., 2004). The significance of this study was to help students score higher on standardized assessments by providing an opportunity for teachers to gain a greater awareness of learning styles as well as the accommodating instructional strategies necessary to meet the needs of their students. Through planned professional development, teachers were shown how to implement learning style strategies in their lessons to differentiate their classroom instruction.

Summary

This study was intended to have teacher leaders, through the design of a Professional Learning Community (PLC), identify learning styles of students, articulate both horizontally and vertically, implement prescribed instructional strategies, and

ultimately raise mathematics achievement of students. The effects of their instructional intervention were measured by an examination of scores obtained from pretest and posttest local assessments administered by the district. Participating teachers received professional development regarding learning styles and effective instructional strategies that created productive differentiated classroom environments. Their perception of the effects of learning styles strategies on the students was also evaluated. The remaining sections of this study present the relevant scholarly professional literature on learning styles and intervention strategies (section 2), the description of the design and methodology (section 3), the analysis of the data results and findings of the study (section 4), and the conclusions and recommendations for further research (section 5).

SECTION 2: LITERATURE REVIEW

Introduction

The measure of an effective school practice is the ability of a school to enhance all levels of student performance and subsequently close the achievement gap among students. Creating teacher leaders, otherwise known as empowering teachers, establishes a sense of personal commitment that brings about positive change in student performance (Somech, 2005). Emphasis is placed on responsibility, the responsibility of all educators to bring about change in a realistic manner. This study investigated how teacher leaders address the charge of increasing the academic performance of all students. The literature review contains the following topics: Historical Data for Standardized Assessment, Testing and Its connection to Theories on Learning, Instructional Design to Improve Mathematics Achievement, Instructional Strategies to Improve Mathematics Achievement, and Theories on Learning. Extensive research was conducted in both professional peer-reviewed journals as well as published texts focused on the differentiated learning model. JSTOR, SAGE, ERIC and EBSCO databases were used to facilitate access to electronic copies of journal articles. Keywords and phrases used as the Boolean search words to initiate this electronic process were: *math achievement, middle school mathematics, standardized assessments, learning styles, and multiple intelligences.* The research of Dewey, Gardner, Marzano, Schön, Kolb, Jung and Silver were accessed and reviewed to support the theoretical data needed to validate the direction of this research study.

Historical Data for Standardized Assessment

The expectations of standardized testing have changed from the early 20th century to the end of the 20th century. Standardized testing during the first part of the 20th century was used to sort students into tracks, that is, college bound or vocational (Linn, 2001). According to Linn (2001), this was considered to be both an objective and an efficient classification. During the 1970s and 1980s, minimum competency tests were introduced to decrease the number of student retentions each year otherwise known as social promotion (Linn, 2001). This type of testing was an outgrowth of the progressive philosophy of the time which still encompassed the belief that not one type of educational program is good for all (Linn, 2001). As practiced during the earlier part of that century, some students were tracked to go to college, while others were tracked to join the labor forces (Baker, 2001). The concept of tracking continued to enhance efficiency of instruction by reducing the number of students retained by grade (Baker, 2001). Thus, by the end of the 20th century, the original goal of standardized testing serving as an empirical measure by which an educational system could predict the future actions of the test taker was now changing to an accountability method by which educational policies could determine the effectiveness of programs and the impact on students (Baker, 2001).

Concern for an educational system doomed to mediocrity, as well as an economy threatened by poor student achievement, spurred the National Commission on Excellence in Education in 1983 to produce a document entitled, *A Nation at Risk.* As a response to this study, legislators began focusing on the performance of students and the accountability of schools (National Commission on Excellence in Education, 1983).This document marked the commencement of the movement toward educational reform.

Upon entering the 21st century, the premise by which standardized testing is exercised has changed from the acceptance of differentiated standards of the elite versus the masses to the demand of higher standards for all (Kornhaber, 2004).With the adoption of NCLB, the focus of policymakers is now to make schools more accountable for the improvement of all student performance by testing all students from grades 3 through 8. NCLB redefined the role of the federal government in K-12 educational systems across the nation (NCLB, 2002). Its sole purpose is to eliminate the achievement gap between the disadvantaged, disabled, and minority students with all other students at that same grade level (Kornhaber, 2004).

The National Council of Teachers of Mathematics (NCTM) joined the reform efforts by developing a standards-based curriculum and this gave rise to a national effort, required by NCLB, to have a standards-based curriculum design for all subjects (Ding & Navarro, 2004). Once these state core curriculum content standards were developed, state assessments were aligned to the core curriculum standards for reading and mathematics and administered beginning with grades 4, 8, and 11 in the spring of 2003. With each consecutive year, every state is required to implement a state test aligned to the core curriculum content standards for grades 3, 5, 6, and 7 in the timeframe specified by the NCLB Act. Science has also been added to specified grade levels to the content tested by these mandated assessments (NCTM, 2000).

The expectations of the NCLB Act require school districts to meet (AYP) guidelines. AYP is the measure of each state's improvement in educational outcomes as reflected by a comparison of each state's educational progress objectives for all groups of students and actual attainment of proficiency goals for these students (Nation's Report

Card, 2006). This accountability system determines consequences for each state, either rewards or penalties, based on changes in student performance (Ding & Navarro, 2004). For grades 3 through 8, high-stakes state testing is the only criterion used to evaluate AYP. All school districts are expected to show that achievement levels are raising in order not to be penalized (Ding & Navarro, 2004).

The current annual state standardized tests used in the state of New Jersey are as follows for grades 3 through 8 and grade 11 respectively: NJ ASK3, NJ ASK4, NJ ASK5, NJ ASK6, NJ ASK7,NJ ASK8, and the High School Proficiency Assessment (HSPA). Each of these tests is equated horizontally or peer reviewed to ensure consistency across the system and is aligned with the New Jersey Core Curriculum Content Standards (NJCCCS) (New Jersey Department of Education, 2007).

Testing and Its Connection to Theories on Learning

As a reaction to the accountability statutes of the NCLB Act, the focus of the educational system's attention has been on developing standards to guide instruction and testing. According to the National Assessment of Educational Progress (NAEP), the NCLB Act is a policy that forces change without any grounding in specific educational approaches or targeted resources to ensure that effective programs are put in place (Lee, 2006, p. 8). At the same time that school districts are exerting efforts to move the scores upward that will determine their fate, a greater concentration of classroom instruction has been spent on test preparation and drill exercises and a narrowing of curriculum to only include topics that will be tested. Ultimately, teachers are teaching to the test, and this will lead to false measures of achievement, not a deeper knowledge of subject matter (Ding & Navarro, 2004). Recent data collected by NAEP for the Nation's Report Card

indicated no significant improvement in achievement levels in grades 4 and 8 for reading and minimal growth for mathematics for the same grade levels (Lee, 2006). The mathematics performance reported on the 2005 Nation's Report Card showed that fourth grade scores improved by 3 points from 2003 to 2005, and eighth grade scores improved by 1 point from 2003 to 2005 (New Jersey Department of Education, 2007). These results, researched by Lee, do not mirror the more positive results required by NCLB. According to Lee, reform takes time and test driven change is unrealistic (p. 9). It is necessary to reach out to educators to use data from these high-stake tests to recommend instructional strategies that will produce real gains for students. According to Dewey (2006),

> Examinations are of use only so far as they test the child's fitness for social life and reveal the place in which he can be of the most service and where he can receive the most help…I believe that to set up any end outside of education, as furnishing its goal and standard, is to deprive the educational process of much of its meaning and tends to make us rely upon false and external stimuli in dealing with the child…true education comes through the stimulation of the child's powers by the demands of the social situations in which he finds himself. (p.78)

Gardner's (1993) response to why all children do not excel on the same tests is because all children do not fit the same mold; they need to be able to explain material in their own manner. He claimed that there are seven different intelligences and that educators should implement his theory of multiple intelligences when planning lessons and interventions in order to reach all students in the classroom (Gardner, 1993). Since children learn differently, there should exist an individualized evaluation process. Preferred measures of assessment, according to Gardner, include student portfolios, or journals (Gardner, 1991). It is necessary to look at what students could do well, instead of what they could not do (Gardner, 1983).

Marzano recognized that there are different learning styles and that educators need to adapt differentiated teaching strategies to facilitate learning for all students (Marzano, 1992). Marzano (2001) described the nine effective teaching strategies that will influence student achievement: identifying similarities and differences; summarizing and note taking; reinforcing effort and providing recognition; homework and practice; nonlinguistic representation; cooperative learning; setting objectives and providing feedback; generating and testing hypotheses; and questions, cues, and advance organizers. Gardner and Marzano each contributed toward improving student achievement. Together, Gardner's theory on multiple intelligences and Marzano's theory on teaching strategies provide an awareness of how best a student can learn and retain information.

Strong, Silver, and Perini (2000) distinguished the four dimensions of math learning to include computation, explanation, collaboration, and problem solving. With recognizable connections to Marzano's meta-analytical research on best practices to use in the classroom, Silver et al. developed instructional strategies to use in the mathematics classroom (Silver, Brunsting, & Walsh, 2008). In addition to Marzano's nine effective teaching strategies, Silver et al. added vocabulary and writing to make better connections between their recommended instructional strategies and the NCTM Standards (Silver, et al., 2008).

Instructional Design to Improve Mathematics Achievement

Connecting mathematical concepts to practical application is essential to the improvement of performance levels of students. Attention must be paid to the demands of the current trend of mathematical curriculum (Mero, 2007). Lee (2006) determined that

the nature of a classroom discourse on mathematics was directly related to the effects on students of differing abilities, both academic and social/cultural. The NCTM suggested that the selection of mathematical tasks for students is key to changing students' expectations about the subject. It is recommended that mathematics be viewed as useful knowledge taught in thematic units utilizing the students' knowledge base as a reference. At the middle school level, the methodology of instruction for mathematics is a transition from traditional concrete math at the elementary level to abstract math at the high school level. Senge (2000) suggested that students need a more active role in problem solving and in critical thinking activities to stimulate their interest in mathematics.

The environment in the classroom requires a shift in focus. In order for students to take risks and problem-solve or conjecture, they need to feel as if their information is important to the class (Strong, 2001). The one-size-fits-all method of solution strategy should no longer exist (Ogbuehi & Fraser, 2007). Students should be able to relate their problem-solving strategies to their general knowledge of mathematics or connect it to a real world situation if they are to succeed in mathematics achievement.

Embedding mathematical concepts and skills in a relevant context enhances students' interest and motivation to learn and seek solutions (Gilbert, Reid, & Marzolf, 2004). These practices may be encouraged and monitored by administrative personnel (Gilbert, Reid, & Marzolf, 2004). Challenging a student to pursue higher order critical thinking is not intended for a student to become totally frustrated and disconnected (Shields, 2005). Student performance has a direct relationship with the characteristic and attitude of a teacher. Shields (2005) stated,

> Standard Six in The Professional Standards for Teaching Mathematics (1991) states that a teacher should promote a positive disposition by communicating a love for

> mathematics and a spirit that illustrates that math is a great invention of the human mind. Secondly, a teacher should demonstrate the value of math as a way of thinking and illustrate its application in other disciplines as well as in society. (p. 327)

According to Dewey in his 1913 publication, interest is a vital educational factor (Freeman, McPhail, & Berndt, 2002). The Third International Math and Science Study, conducted in 1995, issued a report stressing the importance of curriculum and its significance in providing challenging mathematics in the classroom. There is a concern regarding the plethora of topics introduced in the middle school mathematics curriculum without the provision of in-depth investigations and opportunities for inquiry-based learning (as cited in Bandlow, 2001). Many middle school curriculums may be considered an extension of the elementary curriculum rather than a preparatory program for higher level courses. As stated by Bandlow (2001), "Schools should discontinue the use of commercially-designed curriculum and adopt curriculum guides that emphasize hands-on, research-based, inquiry-centered approaches to learning" (p. 73). Many exemplary math programs require teachers to have an in-depth understanding of mathematics. The experience and knowledge base to present topics as a mathematics facilitator may require many middle school administrators to provide professional development opportunities. Teachers need to know more about how to effectively teach the subject areas they are responsible for teaching (Bandlow, 2001).

> During middle school, the mathematics curriculum becomes more abstract. Memorization and knowledge of past strategies isn't enough to get by any more. Students need to be constantly trained to apply their knowledge to new ideas and to use math as a discovery tool. The curriculum needs to deepen understanding of topics and enhance skills. (Shields, 2005, p. 328)

Instructional Strategies to Improve Mathematics Achievement

According to Turner, Meyer, Midgley, and Patrick (2003), certain instructional practices are associated with positive motivation. These include focusing on instruction, fostering enjoyment of mathematics, applying mathematical concepts to real-world relationships and encouraging self-confidence as a mathematical learner. Student motivation is considered to be one of the most important factors affecting student achievement. With this premise in mind, it is necessary to address the question of what activities do middle school students view as facilitative toward learning (Freeman et al., 2002).

Currently, math reform movements base recommendations on the constructivist theory in which a student must construct his/her own knowledge through meaningful experiences. In response to this reform, curriculum and instructional design has become more scientifically based particularly for reading and mathematics (Liston, Whitcomb, & Borko, 2007). According to Lane (2007), a constructivist instructor is one who uses teaching methods that help students develop, reflect, and evaluate in order to modify their own conceptual framework. As Schön (1987) recommended, both teachers and students need time during the learning process to reflect on their actions to modify their approach to learning or problem solving.

Constructivist Approach in Mathematics

In constructivist learning, the student creates his/her own understandings and in effect, his/her own knowledge (Ishii, 2003). Ishii stated many important features of constructivism in the classroom that influence the effectiveness of a lesson:

1. Use prior knowledge to engage learner,

2. build lessons around big idea/concepts,
3. make learning meaningful by valuing students' comments,
4. address curriculum to students' hypotheses, and
5. assess learning throughout the lesson as students engage in meaningful tasks.

According to Brooks and Brooks (1999), it is also essential to make note of the necessary characteristics of the constructivist teacher: encourage student initiative, evaluate data, respond to student learning by adjusting instructional strategies, encourage student dialogue and engage students in discussions, construct connections to prior lessons, and nurture curiosity and encourage inquiry.

Learning math is a two-sided equation: what students bring to the process and the quality of the instruction (Schwartz, 2006). Less time should be spent on lecturing and drilling and more time on engaging in activities that require social interactions and discovery (Lane, 2007). The research of Senge (2000) showed that teachers should create environments and provide assignments in which students are in charge of their own learning and are granted opportunities to interact with other students to enhance their problem solving skills.

Karns (2006) recommended teaching strategies to improve mathematical achievement by focusing on improved communication and collaboration between the teacher and the student. Effective instruction should begin with a curriculum that allows students to make connections to their real-world experiences. Testing would have a greater impact on learning if feedback is given to students in a timely manner (Karns, 2006).

Silver and Hanson (1996) recognized the importance of matching instructional strategy or teaching style to learning styles prevalent in the classroom. They categorized effective teaching strategies into five areas: Mastery, Understanding, Self-Expressive, Interpersonal, and one that combines these four called Meta-Strategies. Mastery strategies focus on practice and drill of computational procedures, Understanding strategies focus on explaining or proving solutions, Self-Expressive strategies help students visualize problems rather than rote learning, Interpersonal strategies connect learning to real-world experience and lastly; Meta-Strategies incorporate all of the preceding strategies to address all four learning styles (Silver & Hanson, 1996).

Evidence of the Problem

Achievement gaps constitute important barometers in educational and social progress (Lee, 2006). The measure of an effective school practice is the ability of a school to enhance all levels of student performance which in turn will close the achievement gap among students.

> An effective school is a school with high achievement and small variation in achievement among its students. Therefore, to determine school effectiveness it is crucial to examine school characteristics and practices that can reduce student achievement variation. (Choi & Kim, 2006, p. 10)

Achievement levels are measured two ways: student achievement and school achievement. Typically school achievement is a comparison of various schools' standardized testing results within a particular District Factor Grouping (DFG). The results are reported in the Nation's Report Card as all states are required by Congress to participate in the National Assessment of Educational Progress (NAEP, Hall & Kennedy,

2006). This is an assessment of the variance in achievement between schools or districts, often compared to national expectations.

The second way to assess student achievement is an analysis of the variance of students' performance within a specific school. According to Choi and Kim (2006), a successful school should have a small variation in their students' achievement levels. This mantra should serve as a guide to assessing school policies, so that the focus of current research would be devoted to determining what school practices are associated with creating smaller student achievement variations. Using this strategy to analyze the research at hand is the best way to examine interventions designed for equalizing the effect of school practices on student performance.

Theories on Learning

The recognition that students attend to a learning situation differently dependent upon their methods of processing information has been the focus of many research studies on learning. Jung's research investigated how one perceived the world through sensing and intuition. Myers-Briggs extended Jung's psychoanalytical theory and measured the degree of sensing and intuition through the Myers-Briggs Type Inventory (MBTI) (Cooper & Miller, 1991). Sharing a connection with these theorists, Kolb's research focused on experiential learning and developed the experiential learning circle model. This characterizes learning as a four stage process between two bipolar dimensions: concrete (feeling) and abstract conceptualization (thinking), and reflective observation (watching) and active experimentation (doing) (Cornwell & Manfredo, 1994). According to Kolb's model, individuals will use different learning strategies that will relate to how effective they are as learners using their primary learning style. He

termed these learners as accommodators, convergers, divergers, and assimilators (Cornwell & Manfredo, 1994). Kolb emphasized a danger in being locked into any one style of learning since each possesses both strengths and weaknesses (Kolb, 1988). These theories will shed light on this study since there exists a need for individual style consideration leading to higher student achievement.

Felder (2005) introduced the Index of Learning Styles which assesses the preferences of learning on a five scale learning style model which is parallel to a corresponding teaching style model. A connection exists between the dimensions of Felder's learning and teaching styles with that of Jung (sensory/intuition) and Kolb (active/reflective). Felder hypothesized, "instructors who adapt their teaching style to include both poles of each of the given dimensions should come close to providing an optimal learning environment for most (if not all) students in a class" (1988, p. 675). Since Felder concluded that the natural learning style is inductive, whereas the natural teaching style is deductive, his research supported that a more inductive teaching approach would promote a more effective learning environment. Felder suggested that "matching teaching style to learning style will result in a deeper understanding and more positive subject attitude" (as cited in Giles, Ryan, Belliveau, DeFreitas, & Casey, 2006, p. 214).

Gardner (1991) probed the theory of multiple intelligences and emphasized a connection between the recognition of multiple intelligences by the instructor with the improved ability to reach more students. According to Gardner, "But when the appropriate observational lenses are donned, the peculiar nature of each intelligence emerges with sufficient (and often surprising) clarity," (1983, p. 9). Silver and Strong

introduced the four learning style model, which largely encompasses the research of Jung and Gardner. These learning styles include Mastery, Understanding, Self-Expressive and Interpersonal. According to Silver, Strong, and Perini (1997, p. 42), the preferences of each learning style are described as follows:

1. Mastery Learner – very structured directions; rote drill and practice
2. Understanding Learner – problem solving approach; discussions and projects
3. Self-Expressive Learner – creative, multi-tasks, alternative thinker
4. Interpersonal Learner – teamwork/collaborates, makes connections to real world

Silver, Strong and Perini (2007) recommended to teachers that students be permitted to work in their stronger learning style but to be encouraged to use this strategy as a means to develop confidence in the other three learning styles, ultimately to become balanced, diverse learners. For this purpose, the Learning Style Inventory for Students (LSIS) was created so that both students and their teachers could have a better awareness of prevalent learning styles in the classroom. In so doing, it is equally important for teachers to gain an insight regarding both their learning style and teaching style. In typical learning environments, according to Silver and Strong, the learning style of the teacher may dominate the classroom instruction, which may not meet the needs of the learning styles present and result in disengagement and lack of motivation on behalf of the student (2000). Silver recommended that teachers complete a Learning Style Inventory for Adults (LSIA) as well as a Teaching Style Inventory (TSI). These theories indicate that both

teacher and student learning styles impact instructional strategies recommended to raise student achievement.

Sternberg, a professor of Cognitive Psychology at Yale University, found through his extensive investigation of students' diverse cognitive abilities that students exposed to teaching styles that matched their learning style outperformed students who did not have this experience. He concluded that students taught in a manner that "fits" how they think will perform better in school (Sternberg & Spear-Swerling, 1996). In a follow-up study, Sternberg assigned groups of students to one of three instructional conditions: traditional instruction, instruction matched to learning style preference, and instruction that incorporated all four learning styles. His conclusion was that even though students who had instruction that matched learning style outperformed those students given traditional instruction, students exposed to all four learning styles performed the best (Sternberg, 1997).

Conclusion

This section is a summary of the current literature on the investigations of learning styles of students and the methods by which they process information. Attention was given to the importance of recognizing learning styles in order to obtain optimum results within the classroom environment. The research emphasized on keeping students engaged throughout the instruction to raise student achievement. This may result primarily from addressing learning styles through differentiation and researched intervention strategies. A description of the design and methodology follows (section 3), the analysis of the data results and findings of the study (section 4), and the conclusions and recommendations for further research (section 5).

SECTION 3: RESEARCH METHOD

Introduction

This sequential explanatory mixed methods causal comparative study examined the implementation of learning styles instructional strategies and the effect on mathematics achievement of eighth grade students in a Title I middle school in a suburban school district. The implementation of NCLB with the purpose of achieving proficient outcomes for all students is preventing educators from a focus on enhancing instructional strategies and a directive for all students to master basic skills.

According to Creswell (2003), quantitative research in a mixed methods approach would include experiments, choosing subjects for treatment conditions, as well as surveys for data collection to form generalizations. These strategies were incorporated in this research study.Qualitative research in a mixed methods approach can include the following strategies: ethnographies, grounded theory, phenomenological research, narrative research, and case studies. Ethnographies focus on cultural studies, observing subjects in their natural setting. Using grounded theory, the researcher develops a theory based on views of the participants of the study (Creswell, 2003). Phenomenological research requires prolonged involvement with the subjects of the study to create relationships and identify patterns (Creswell, 2003). Narrative research is created by the researcher through stories told by the participants. Lastly case study, the strategy selected for this research, finds the researcher collecting data using various procedures over a period of time (Creswell, 2003).

According to Yin (2009), qualitative studies are the preferred research strategy when how, what, and why questions are being asked; when the researcher has little control over the event; or when the research is being carried out in a real-life context. The choice of a mixed methods design was made for this study because expo facto data were available quantitatively by way of the pretest and posttest results, and were collected by the researcher qualitatively through surveys and observations of participating teachers. The researcher conducted the quantitative investigations initially, followed by the qualitative investigations, and she then compared findings of each within this single study. The priority between both methods was equally distributed. This type of design is best suited for a shorter data collection period (Creswell, 2003, p. 217).

Research Questions

The purpose of this sequential explanatory mixed methods causal comparative study was to implement and evaluate researched instructional strategies that will positively impact mathematics achievement. Student achievement was measured by an improvement of test scores obtained from pretest and posttest local benchmark assessments administered by the district. Six eighth grade classrooms of a suburban middle school were chosen to investigate the influence of instructional strategies, aligned with learning styles, on mathematics achievement. The following research questions were addressed in this study:

1. What is the difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally?

H_o: There is no significant difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally.

H_a: There is a significant difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally.

2. What is the difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally?

H_o: There is no significant difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally.

H_a: There is a significant difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally.

3. How do the teachers describe their perception of the effects of learning styles intervention strategies on the students' benchmark mathematics achievements?

Research Design and Approach

The design for this study was a sequential explanatory mixed methods causal comparative study. It employed a nonrandomized control-group pretest-posttest design using archival data as the quantitative before and after comparison of mathematics achievement of the eighth grade students. The specified instructional strategies (independent variable) were implemented in the mathematics lessons of all students in the experimental population. A pretest measure, the results of a local benchmark assessment administered by the district, was followed by a treatment for the experimental groups, that is, intervention of instructional strategies, which was concluded with a posttest administration of a local benchmark assessment to all students in the study. A control was placed on the experiment by separating the population into two subgroups: no intervention/traditional instruction, and intervention based on strategies to address all four learning styles, Mastery, Interpersonal, Understanding, and Self-Expressive with an emphasis on the Interpersonal.

There were two forms of qualitative data collected for this study: a classroom observation form (Appendix A) during the intervention, and an anonymous teacher open-ended reflection survey at the completion of the intervention (Appendix B). Teachers were given the anonymous open-ended survey to complete; classroom observations were conducted by the researcher as part of regular job responsibilities. Creswell (2003) stated that mixed methods design is chosen to capture ideas from real-life contact.

Setting and Sample

This research study was conducted in a 42-square mile suburban school district located in the northeastern United States. The total student enrollment for the district is

over 15,000 students from 12 elementary schools (K-5), two middle schools (6-8) and the one high school (9-12). The population of the area is approximately 79% White, 11% Asian, 5% Black, and 5% represented by Native American, Pacific Islander, Hispanic, Latino, and other.

The middle school chosen for this study was selected because of its record of low math performance as stated on the state School Report Card. The grade 8 population was selected due to the history of this grade level's performance on the NJ ASK8, as well as the necessity to prepare these students for transition to the rigors of the high school curriculum. The school is also classified as a Title I middle school since the requisite number of students as mandated by the state are eligible for free or reduced lunch. The Title I classification also permits the district to provide resources to this school to enhance student achievement (NCLB, 2002).

Using the Sample Size Calculator, specifying a 95% confidence level and 8.5 confidence interval, for this middle school's total grade 8 population of 515 students, the sample size needed would be 106 students. Approximately 110 students' data from this Title I middle school population, to include both regular education and basic skills classes, were analyzed. A convenience sample was employed because the participants were selected from preassigned class rosters. A representative number of students from each general education classroom and a proportional number of students from each basic skills classroom were selected to represent grade 8 in this middle school population. Class rosters from grade 8 were used to make up the sample 76 general education students per participating grade level and 19 basic skills student per participating grade level. Six teachers of these middle school students participated in the study; four who

received training in the experimental group and two teachers who did not receive any training on learning styles were in the control group. There were two groups in this study: the experimental group and the control group. The experimental group, made up of 62 students from two general education classes and two basic skills classes, received learning styles intervention instructional strategies. The control group, made up of 33 students from one general education class and one basic skills class, had traditional instruction with no intervention.

The grade 8 general education teachers in this study teach the district approved mathematics curriculum. The grade 8 basic skills teachers in this study teach a supplemental mathematics curriculum to support those students who need additional reinforcement of computational skills and test taking strategies. The basic skills classification for students is determined by a low performing score in mathematics on the standardized assessment from the prior year's test results.

Confidentiality

The identity of the participants as well as the data sets remained confidential. This confidentiality was maintained by keeping all data in a secured file. Anonymous teacher open-ended surveys were stored in this secured file. Archival data for pretest and posttest assessments of the study were protected by storage in a locked cabinet in the administrator's office.

Data Collection and Rationale

Archival data of all 110 middle school students' mathematics benchmark achievement were analyzed using two quarterly assessments. Quantitative procedures

focus on the measurement of facts and also determine a relationship among the variables of the study (Creswell, 2003). Benchmark assessments are quarterly assessments collected by the middle school as part of their Title I assessment. The data were made available to the researcher with a data usage agreement for the study.

There were two forms of qualitative data collected for this study: a classroom observation form (Appendix A) during the intervention, and an anonymous teacher open-ended reflection survey at the completion of the intervention (Appendix B). The observation was conducted by the researcher as part of the verification of implementation process congruent with the school district guidance for interventions of professional development. All 6 teachers were observed during the intervention process. Each of the six teachers had completed a consent form in which they agreed to be part of this study. The researcher constructed follow-up questions for the six teachers on the implementation of learning style instructional strategies. Strengths of this type of data collection are that it can be reviewed repeatedly, exact evidence by the participants is contained, and it allows for broad coverage of previous events (Yin, 2009).

Intervention

As part of a district Title I initiative, learning style inventories were given to middle school students after their teachers attended professional development on learning styles. There were two groups in this study: the experimental group and the control group. The experimental group, made up of 62 students from two general education classes and two basic skills classes, received learning styles intervention instructional strategies. The control group, made up of 33 students from one general education class and one basic skills class, had traditional instruction with no intervention.

Only 4 of the 6 six participating teachers were assigned to the experimental group and received professional development over the course of 1 full day (6 hours) directly from. Silver, an expert in integrating learning styles and multiple intelligences into instruction and assessment. The two remaining participating teachers, assigned to the control group, did not receive training. Silver's training was based on his research of learning styles and effective instructional strategies for the middle school mathematics classroom to improve student achievement. Over 50 district teachers attended the first 3-hour session of this district presentation by Silver which was held in the library of the local high school. The design of this part of Silver's professional development included a PowerPoint description of the Four Learning Styles, supported by a presentation of recommended intervention/teaching strategies and concluded with an open question and answer discussion. As part of the Title I initiative, four experimental group teachers out of the six participating teachers in this study attended Silver's professional development. These teachers were from the two general education classes and two basic skills classes that received intervention. The remaining two teachers of the control group of this study did not receive training. These teachers were from the one general education class and one basic skills class that did not receive intervention.

The second 3 hours of. Silver's professional development was attended by the four experimental group teachers who participated in this study. This part of the professional development was specifically designed so that these teachers would gain a greater understanding of the Four Learning Styles as well as review the recommended intervention strategies developed by Silver. Lessons designed by Silver and his associates were presented which focused on the importance of differentiation of instruction to

recognize the integration of various learning styles present within a classroom with an emphasis on the Interpersonal style of learning. This information can be referenced in the work of Silver in his 2008 publication (Silver et al., 2008). The experimental group of teachers was directed to select strategies to create lessons that were implemented in each of the four participating grade 8 classrooms that were intended to receive treatment over the course of 1 week. The results of this intervention were measured by the results of the district administration of a posttest local benchmark assessment.

Data from the Learning Style Inventory for Students (LSIS) and the Math Learning Style Inventory (MLSI) were used to design instructional strategies for students based on the identification of students preferred learning styles (Silver, Strong, & Perini, 2007). The middle school teacher leaders also completed inventories: the Teaching Style Inventory (TSI), and the Learning Style Inventory for Adults (LSIA) (Silver, Thomas & Perini, 2008). It is recommended that an awareness of one's learning style as an adult will give a greater sensitivity to the limitations caused by the use of only one teaching style in the classroom (Silver & Hanson, 1996). A working knowledge about the relationship between learning styles and instructional styles was established by way of professional development presented by Silver to the teacher leaders.

The four middle school teachers who received training and represent the teacher-participants of the experimental group met collaboratively over a period of 1 week after style inventory student and teacher results were provided to each teacher who designed appropriately aligned lessons based on the inventories. Lessons were designed collaboratively by the four teachers. The four teachers in the experimental group delivered the lessons designed with learning style instructional strategies to their middle

school students in a classroom setting. The two teachers representing that control group continued to deliver traditional instruction to their students. Traditional instruction is referred to as instruction without learning style delivery strategies.

Instruments

Benchmark assessments are administered at the end of each 10-week marking period on an assigned date by each of the middle school mathematics teachers to all general education and basic skills students. Each of these timed assessments is composed of 20 questions: multiple choice, short answer, and open response. The assessments are scored expertly by a district committee. Data are parametric and reported in raw scores for analysis. The benchmark assessments were created by an expert team of middle school grade level mathematics teachers and district curriculum committee members. The curriculum meetings were designed to align curriculum and construct the diagnostic benchmark assessments. The draft versions of the benchmarks were then reviewed by all the remaining middle school mathematics teachers and district curriculum committee for comments and recommendations. The benchmark committee reconvened to address and make revisions for any concerns that were raised by their grade level colleagues to create the final version of the assessment.

Each of the quarterly benchmark assessments is aligned with the New Jersey Curriculum Content Standards (NJCCS) as well as the National Council of Teacher of Mathematics (NCTM) standards. This expert team created diagnostic tool is used to determine mastery level of key concepts in preparation for the NJASK state standardized testing. These benchmarks also serve as a diagnostic tool to modify instructional methodology as well as identify best practices and lesson objectives for the following

marking periods. For the purposes of this study, two benchmark assessments were compared to assess level of achievement.

Anonymous teacher open-ended surveys and classroom observation forms were also used as part of this study. The teacher open-ended survey was created as a compilation of questions raised by the teachers during the professional development with Silver. The classroom observation is a district approved document.

Reliability and Validity

Merriam (1998) posited that all research is concerned with producing valid and reliable results that are trustworthy. The benchmark assessments are expertly created and designed to measure a specific set of skills aligned with state and national standards. Face validity is a judgment by experts that the measure appears to be valid. Test retest reliability was used to establish consistency of the measure. The researcher recognized possible threats to validity of the outcome: students who dropped out during the intervention due to external reasons, as well as the communication between students of the control and experimental groups which had an influence on the outcome. The teacher open-ended survey and classroom observation document have gone through a peer-review process and have been calibrated to ensure validity and reliability.

Data Analysis Procedure

Quantitative Data Analyses

An ANCOVA provided an analysis of whether learning styles instructional strategies had an effect on the outcome of student mathematics achievement. The benchmark assessment scores from marking period three, collected as the posttest results,

were analyzed as the dependent variable of student achievement; the pretest scores from the marking period three benchmark assessment served as the covariate. SPSS Statistical Software (SPSS Inc, 2005) is the most appropriate for implementing a statistical analysis. This was used to measure archival data. The analysis of the quantitative data provided a measure of change on student mathematics achievement benchmark scores. There were four groups of students, 62 total, in the experimental group taken from two general education classes and two basic skills classes. There were two groups of students, 33 total, in the control group taken from one general education class and one basic skills class.

Qualitative Data Analyses

Yin (2009) stated that the researcher may develop a general explanation that is aligned with individual cases even with multiple and varying details. A coding process was used to complete the data analysis for the protocol. Qualitative coding NVivo software was used to analyze patterns in qualitative data collected from teacher open – ended surveys and classroom observations. In addition, the software was used to transcribe all survey data and assign a nominal scale for identification, develop coding categories aligned with the protocol dimensions, and analyze frequency of appearances. From this process emerging themes were drawn from the data analysis to reveal perceptions of teachers concerning implementation of learning style strategies on student achievement. Since classroom observations are part of the job responsibilities of the researcher, there are procedural administrative checks approved by the district. Since the respondents to the teacher open-ended survey remained anonymous, the interpretation of the survey response themes by the researcher was not affected.

Role of Researcher

The researcher is a K-12 district mathematics supervisor. The duties are to oversee the implementation of the mathematics curriculum in the district, formulate the mathematics budget to include new textbook adoptions, present workshops to in-service teachers and the community, conference with parents, and observe and evaluate elementary, middle, and high school staff members. The researcher observed teachers during the intervention period to confirm the incorporation of the learning style strategies during mathematics instruction as a follow-up to the Title I plan to improve mathematics achievement. None of the teachers were evaluated regarding job performance by this researcher in relationship to this study. Bias was controlled by allowing the teachers to select the class roster of students' scores that were evaluated. Class rosters from grade 8 were used to make up the sample, 76 general education students per participating grade level and 19 basic skills student per participating grade level. Six teachers of these middle school students participated in the study: four who received training in the experimental group, and two teachers who did not receive any training on learning styles were in the control group. There were two groups in this study: the experimental group and the control group. The experimental group, made up of 62 students from two general education classes and two basic skills classes, received learning styles intervention instructional strategies. The control group, made up of 33 students from one general education class and one basic skills class, had traditional instruction with no intervention.

The researcher presented no immediate contact with students to sway results of district testing or intervention procedures. The researcher did not do any of the training in relationship to this study. All responses are confidential, without risk of consequence, and

are not connected to job or student performances. The researcher obtained a data usage agreement with the school district to analyze the archival data for this study. This school district archival data are maintained on file according to district policy. Each of the six teachers had completed a consent form in which they agreed to be part of this study.

Summary

This section provided the rationale for choosing a sequential explanatory mixed methods causal comparative study that examined the implementation of learning styles instructional strategies and the relationship to mathematics achievement of eighth grade students in a Title I middle school in a suburban school district. Quantitative data collection was ex post facto from district administered pretest and posttest local benchmark assessments, as well as from the district's records of the Learning Style Inventory for Students and Math Learning Style Inventory for Students. Qualitative data collection was done through anonymous teacher open-ended surveys and classroom observations of participating teachers. Data analysis of both the quantitative and qualitative investigations addressed the three research questions. Teachers benefited from examining the findings of this study in relationship to the implementation of learning styles instructional strategies. The remaining sections of this study are the analysis of the data results and findings of the study (section 4), and the conclusions and recommendations for further research (section 5).

SECTION 4: RESULTS, ANALYSIS AND FINDINGS

Introduction

The purpose of this sequential explanatory mixed methods causal comparative study was to examine the implementation of learning styles instructional strategies and the relationship to mathematics achievement of eighth grade students in a Title I middle school in a suburban school district. This study investigated the relationship of the differentiation of instruction based on the identification of learning styles present in the classroom and knowledge of researched intervention strategies with an improvement of mathematics achievement levels as noted by a district administration of a pretest and posttest local benchmark assessments. Six eighth grade classrooms of a suburban middle school were chosen to investigate the influence of instructional strategies, aligned with learning styles, on mathematics achievement. The findings discussed in this section are determined from the data analysis conducted based on the following research sub questions addressed in this study:

1. What is the difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally?

2. What is the difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally?

3. How do the teachers describe their perception of the effects of learning styles strategies on the students' benchmark mathematics achievements?

Data Collection Procedures

This study examined the implementation of learning styles instructional strategies and the effect on mathematics achievement levels in district benchmark assessments of eighth grade students by incorporating both quantitative and qualitative data collection procedures. To answer each research question, the researcher obtained approval from the IRB to conduct a sequential mixed methods quasi-experimental causal comparative design study. Archival data were used as the before and after comparison of mathematics achievement for these eighth grade middle school students. A Data Use Agreement was signed by the superintendent of schools to use the district's archival data. The six participating teachers, four general education and two basic skills, were asked to sign a Consent Form which explained the purpose of the study as well as the role of each teacher in the study.

A pretest measure, the results of a local benchmark assessment administered by the district, was followed by a treatment for the experimental groups that is intervention of instructional strategies, which was concluded with a posttest administration of a local benchmark assessment to all students in the study. The population was put into one of two groups: the control group with no intervention traditional strategies; and the experimental group with intervention based on strategies to address the learning styles.

Ninety-five students' data from both regular education and basic skills classes were analyzed; class rosters from grade 8 were used to make up this sample of 76 general education students and 19 basic skills students. There were two groups in this study: the four classes in the experimental group which was composed of two general education and two basic skills classes, and the two classes in the control group: one general education class and one basic skills class. Six teachers of these middle school students participated in the study; four who received training were in the experimental group and two teachers who did not receive any training on learning styles were in the control group.

Quantitative Data Collection Procedures

This study employed a nonrandomized control-group pretest-posttest design using archival data as the quantitative before and after comparison of mathematics achievement of the eighth grade students. A pretest measure was a local benchmark assessment administered by the district at the beginning of the marking period to all students in the study. This pretest measure was followed by an intervention period of 1 week in which specified instructional strategies addressing the differentiation of learning styles were employed by only the four experimental teachers. The intervention treatment was concluded with a posttest measure of a local benchmark assessment to all students in the study from both experimental and control groups.

Both the pretest local benchmark assessment and the posttest local benchmark assessment were created by an expert team of middle school grade level mathematics teachers and district curriculum committee members. Each quarterly assessment is aligned with the New Jersey Curriculum Content Standards as well as the National

Council of Teacher of Mathematics standards. This diagnostic tool composed of 20 questions: multiple choice, short answer, and open response is used to measure mastery of key concepts included on the NJASK state standardized testing.

Each of the six participating classes were administered the assessment within a class period of 42 minutes under regular testing conditions. The participating teachers proctored the assessment and collected the completed assessments for grading purposes. Any absent students were given the assessment upon their return to school. The assessments were scored by a district committee of grade level teachers and the scores were reported as a raw score for purposes of data analysis for each of the participating teachers' classes.

Qualitative Data Collection Procedures

The six participating teachers were invited to participate in this study since the target research group was the eighth grade population and these teachers were assigned to this grade level as part of their instructional day. Prior to collecting any qualitative data, teachers were informed of the research study to be conducted and were asked to review and submit a signed copy of the Consent Form which outlined the purpose of the study, their role, the procedure, risks and benefits as well as being assured of confidentiality. Qualitative data were collected by the use of anonymous teacher open-ended surveys and classroom observation forms. The teacher open-ended survey consisted of 10 questions that were generated by the experimental teachers during their professional development experience with Silver. All six participating teachers completed the open-ended survey. None of the teachers kept their responses anonymous. The contents of the open-ended

survey questions and teacher responses was guarded by emailing each teacher a copy of the document and accepting the completed form in a sealed envelope sent interoffice mail within a set period of time. The inclusion of names on each document was optional. All six teachers identified themselves on the survey.

The classroom observation form was a district approved document that included a narrative statement completed by the researcher as part of the regular job responsibility of a district mathematics supervisor. The researcher visited all six classrooms during the math instruction by the six participating teachers throughout the 1 week period of intervention, and recorded a narrative of what was observed during the lesson. The completed teacher observation form was part of the district's archival data which is routinely completed for each tenured staff member and those who have not attained tenure status. This document is maintained in the personnel records of the district's central administration offices. The teacher observations were reviewed by the researcher together with the responses from the teacher survey, and the change in student performance noted between the pretest and posttest benchmark assessments to triangulate the data.

Data Analyses

The researcher chose a mixed methods design for this study because it was the best method in consideration of the availability of archival data and the sample size of teachers participating in the study. Quantifiable, archival data were available with the pretests and posttests and was collected qualitatively with the surveys and observations.

Quantitative data analysis was conducted initially, followed by the qualitative data analysis. The priority of both methods was equally distributed.

Triangulation of the data collected was conducted to corroborate findings from the ANCOVA analysis, the researcher's observations of the lessons (Appendix C) and the responses to the teacher open-ended reflection survey (Appendix D). According to Creswell (2003), "triangulation of data will validate and substantiate findings" (p. 217).

Quantitative Data Analyses

The SPSS Statistical Software (SPSS Inc, 2005) was deemed the most appropriate for implementing the statistical analysis and was used to measure the archival data. The quantitative data provided a measure of change of student mathematics achievement scores from the pretest to the posttest benchmark assessments. An ANCOVA provided the analysis of whether learning styles instructional strategies had an effect on the outcome of the student achievement levels. The benchmark assessment scores from marking period three, collected as the pretest scores were the covariate, the posttest results at the end of the same marking period were the dependent variable, the intervention or treatment period was the independent variable. There were four groups of students, 62 in total, in the experimental group composed of two general education and two basic skills classes. There were two groups of students in the control group,33 in total, in the control group taken from one general education class and one basic skills class.

Qualitative Data Analyses

Qualitative coding NVivo software was used to analyze patterns in qualitative data collected from teacher open-ended surveys and classroom observations. A coding process was used to complete the data analysis. The software was used to transcribe all survey data and assign a nominal scale for identification, develop coding categories aligned with the protocol dimensions, and analyze frequency of appearances. Emerging themes were drawn from the data analysis to reveal perceptions of teachers concerning implementation of learning style strategies on student achievement. Classroom observations were reviewed by the researcher for district approved procedural checks. The researcher further reviewed these observations to identify emerging themes and/or patterns of instruction.

The NVivo software for the qualitative research process will automatically take the data that the researcher inputs and create nodes which are main categories emerging from the data. All data are selected to be coded according to these nodes. For purposes of this research, the responses to the teacher open-ended survey were analyzed using this coding process by NVivo. The results of this survey can be referenced under Table 3 in this section on page 57.

Research Questions

The following table (Table 1) provides a summary of the results from the district administered pretest and posttest benchmark assessments. The data presented in this table along with the quantitative analysis provided by the use of the SPSS software were referenced to address the first two research questions of this study.

Table 1

Average Pretest and Posttest Results for the Experimental and Control Groups

Experimental Group	Number of Students By Class	Teacher/Class	Pretest Average Score	Posttest Average Score	Change in Average Score
General Education	23	A	87.83	81.09	-6.74
General Education	17	B	73.71	81.41	+7.70
Basic Skills	12	C	68.58	74.42	+5.58
Basic Skills	10	D	70.8	75.9	+5.51
Sub-Total	62	Average Performance	75.23	78.21	+2.98

Control Group	Number of Students By Class	Teacher/Class	Pretest Average Score	Posttest Average Score	Change in Average Score
General Education	24	E	79.42	80.79	+1.37
Basic Skills	9	F	72.2	73.7	+1.50
Sub-Total	33	Average Performance	75.81	77.25	+1.44

In Figure 1, which follows, the data from Table 1 are presented so that the improvements in test scores from the pretest to the posttest could be easily identifiable. In the experimental group, scores of 3 out of 4 classes improved slightly in Classes B, C and D respectively. The scores in Class A decreased minimally. For the control group, scores

improved slightly both classes despite the lack of provision of professional development to the instructors regarding learning style intervention strategies.

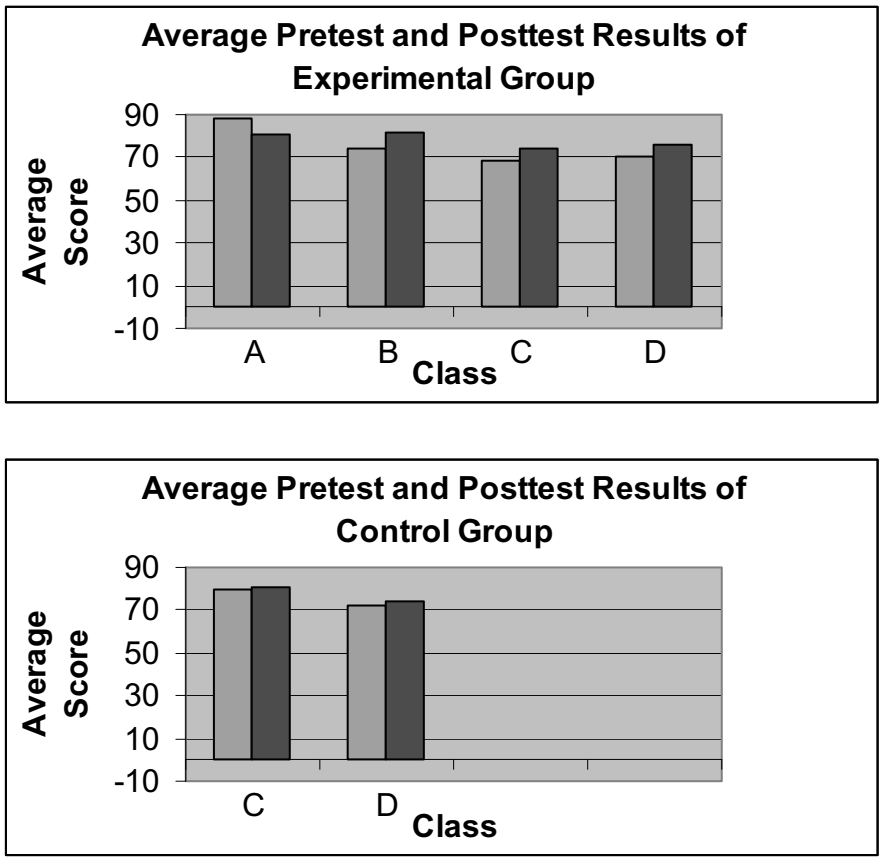

Figure 1. Average Pretest and Posttest Results.

The following table (Table 2) provides a summary of the results from the quantitative analysis conducted using the SPSS software. The results of the district administered pretest and posttest benchmark assessments were the basis of this quantitative analysis. An ANCOVA provided the analysis of whether learning styles instructional strategies had an effect on the outcome of the student achievement levels. The results from the ANCOVA presented in this table were referenced to address the first

two research questions of this study. ANCOVA was used to determine if any significant difference is noted between the pretest and posttest scores after adjusting for baseline performance. A significance value of .05 or less will denote statistical significance. Based on the results recorded in Table 2, no statistical significance was noted for the student scores [$F(1, 3) = 3.486$, $p = .159$].

Table 2

ANCOVA Results of Intervention

Tests of Between-Subjects Effects

Dependent Variable: Posttest Score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	35.287a	2	17.644	1.806	.306	.546
Intercept	108.703	1	108.703	11.126	.045	.788
Instruction	1.833	1	1.833	.188	.694	.059
Pretest score	34.058	1	34.058	3.486	.159	.537
Error	29.310	3	9.770			

*R Squared = .546 (Adjusted R Squared = .244)

Research Question 1

What is the difference in mathematics achievement between middle school general education students who were taught with learning style instructional strategies and the middle school general education students who were taught traditionally?

Research Question 1 served as a tool to investigate the significance of the learning styles instructional intervention on mathematical achievement levels as measured by a comparison of the district administered posttest benchmark assessment scores adjusted by the pretest scores. The presentation of the data is in Tables 1 and 2.

The findings suggested that there was a slight improvement of the scores of most students. Even though the results from the SPSS software are not significant, there is an improvement of grades. There were 76 general education students in this part of the study. As recorded in Table 1, the average performance of general education students in Classes A, B and C receiving learning style intervention during instruction notes an improvement of scores in two of the three classes with an average improvement of at least 5.58 points. In the general education class taught without intervention, Class E, the average improvement of scores recorded was 1.37 points. Based on the results recorded in Table 2, no statistical significance was noted for the student scores [$F(1, 3) = 3.486$, $p = .159$]. The findings support the null hypotheses

Research Question 2

What is the difference in mathematics achievement between middle school students in the basic skills course who were taught with learning style instructional strategies and the middle school basic skills students who were taught traditionally?

Research Question 2 served as a tool to investigate the significance of the learning styles instructional intervention on mathematical achievement levels within the basic skills classrooms in this study as measured by a comparison of the district administered pretest and posttest benchmark assessments. The presentation of the data is in Tables 1 and 2.

This research question narrowed the measure of the effects of learning style instructional strategies on mathematics achievement by examining the results of the

intervention on the basic skills population. There were 19 basic skills students in this part of the study. The posttest results in Table 1 suggest that there was a slight improvement of scores from the pretest to the posttest for these students. As recorded in Table 1, the average performance of basic skills students in Class D receiving learning style intervention during instruction notes an average improvement of scores of at least 5.1 points. In the basic skills class taught traditionally, Class F, the average improvement of scores recorded was 1.5 points. Based on the results recorded in Table 2, no statistical significance was noted for the student scores [$F(1, 3) = 3.486$, $p = .159$]. The findings support the null hypotheses

Research Question 3

How do the teachers describe their perception of the effects of learning styles strategies on the students' benchmark mathematics achievements?

Research Question 3 served as a tool to investigate the feedback from the participating teachers regarding the use of learning styles intervention strategies as an instructional mechanism to improve student learning in mathematics. An anonymous teacher open-ended reflection survey (Appendix B) was disseminated to the participating teachers to gather data to identify common themes and/or patterns regarding their perception of the effects of learning styles strategies on the students' benchmark mathematics achievements. Actual responses from the teacher open-ended reflection surveys can be referenced in Appendix D. Table 3, which follows, summarizes the themes that emerged as the researcher reviewed the data presented by the NVivo coding.

Table 3

NVivo Results: Themes Categoried from Teacher Open-ended Reflection Survey

Survey Questions/ Themes	Emerging Pattern of Responses (*Representative of Quotes by Teachers as listed in Appendix D)*
Questions 1, 2 & 3: Theme 1 Use of Learning Styles	• Better understanding of the importance of differentiation • Improved knowledge of designing a differentiated classroom • Strongest Learning Style in final project was intrapersonal
Questions 4 & 5: Theme2 Expectations of Lesson Revealed to Students	• Student knowledge of expectations did assist with instruction • Students had more specific questions • Taught to mastery and to the test due to rigid timeframe
Questions 6 & 7: Theme 3 **Recommendations**	• Need to apply real world experiences in math lessons more regularly • Teach concepts; make more connections • Utilize differentiation more often
Questions 8, 9 and 10: Theme 4 Reflections	• Not enough time to implement strategies • Differentiation improved participation and encouraged more self-discovery • Need to incorporate more "hands on experiences" in lessons

Theme 1: The Use of Learning Styles Strategies to Differentiate Instruction. When learning styles are identified, learning is more successful which supports the importance of utilizing a variety of learning style strategies. Differentiation is not about teaching different lessons. It is about teaching meaningful lessons that address the methods by which students take in, comprehend and retain information. Knowledge of learning styles helps teachers teach outside of their comfort level; they are better informed to answer students' questions appropriately and completely and attend to students' needs more

successfully. Assessments to measure student understanding were also modified to match the learning styles of students; results of these assessments provided more accurate data for further instruction.

A representative response to Question 1 on the teacher open-ended survey regarding increased knowledge of learning styles and instructional strategies from Teacher A: “In my Masters Degree program, I learned how personal preferences of learning styles impacted my daily classroom instruction. We were not shown many strategies that could be used to help differentiate our instruction, and fight our natural tendencies to teach the way we learn best. I now have a much better understanding on what is meant by truly differentiating instruction”. (See Appendix D)

Theme 2: Expectations of Performance and Actual Performance Levels. Knowing the expectation of the lesson raised performance levels and students asked meaningful questions. More time was invested by students in attaining successful outcomes. Students were more motivated to seize opportunities for self-discovery and learn from each other.

In a sample response to Question 4 on the teacher open-ended survey regarding students’ advance knowledge of expectations on performance, Teacher F responded, “This method of giving information helped them digest information. The rapport in the room is one of confidence in the teacher and the lessons progressed smoothly.” (See Appendix D)

Theme 3: Recommendations by Teachers. After implementing the intervention strategies over the short period of time allotted to this task, all control teachers agreed that teaching whole concepts as opposed to isolated topics is more beneficial to mastery

of content. The final assessment project revealed a similar recommendation by both the experimental and control teachers: the inclusion of real world application of skills to solidify understanding of topics. Overall, a general recommendation by both groups of teachers was to chunk information into fewer topics, but to teach in greater depth within each topic. Sample recommendations as quoted by some of the teachers are as follows: Teacher F responded "Present material in smaller bites—not so much information so quickly; it's overwhelming for the students." Teacher C added "Learning can be made more meaningful by creating and applying real life experiences." (See Appendix D)

Theme 4: Reflections by Teachers. Time limits forces teachers to teach to the test and not for mastery. When the circumstances surrounding instruction are rigid, particularly the allotment of time, teachers lose sight of student learning for application of skill and focus solely on getting through the content of the lesson and the concluding assessment.

Representative of the teachers' reflections on time constraints during instruction, Teacher B had the following response to Question 8 on the teacher open- ended survey regarding the impact of time on instruction: "Time was a factor because I did not feel like I had enough time to cover the concept…I was not able to have time to reflect on each tool or discuss the topics the way I wanted to. I also would have liked to spend more time on the final task and time to reflect on it with the students." (See Appendix D)

Research Question 3 investigated the teachers' perception of learning styles strategies and its effect on their students' performance. The teacher observations conducted by the researcher, combined with the responses of the survey, corroborate the

prevailing theme regarding the perception that learning style intervention strategies may have a positive effect on student performance. Teachers A, B, C, D, E and F commonly reported in their surveys that they recognized positive benefits related to incorporating lessons that differentiate instruction to address learning styles. The researcher recorded in the observation notes class activity that represents high motivation, enthusiasm, student engagement and investigation.

Summary of Findings

Results of the district administered pretest and posttest benchmark assessments from both the experimental and control groups of this study reveal slight improvement in mathematical achievement levels as indicated in Table 1 which lists the average results from both benchmark assessments for both groups, and in Figure 1 which illustrate the slight increase in scores in 4 out of the 5 classes. When the researcher reviewed actual improvement of average scores by group recorded in Table 1 and in Figure 1, the measure of change between the pretest and posttest of the experimental group's average performance indicated that the scores were raised at least 5 points. This can be compared to the improvement of scores between the same two tests for the control group which indicated a slight change of 1.37 points. Although this observation might suggest that the learning style intervention had a positive impact on mathematical achievement, there is no significant evidence that Research Questions 1 and 2 were supported. The statistical results did not reach the minimum requirement to note significance; therefore, the results of the ANCOVA supported the null hypotheses.

The recognizable themes established from the NVivo analysis were recorded in Table 3 in this section of the study. The researcher identified a pattern of the teachers' responses to the teacher open-ended survey within these results which revealed that the teachers saw the value of the learning style intervention strategies when given the opportunity to incorporate them during instruction. Many of the responses suggested that the students' behavior and motivation were positively affected by the recognition of learning styles and the incorporation of strategies to address differentiation.

When the researcher reviewed the observational notes prepared when visiting each class during the week's intervention period, emerging patterns of instruction were clearly visible. These observations are included in Appendix C. The differentiation of instruction led to improved student participation as noted through conversations with the teachers. Students within the classrooms that incorporated the intervention of learning styles strategies during instruction expressed greater interest in the lesson and more active engagement in discussion than those students involved in the traditional instruction. Student discussion during the lessons revealed the use of multiple strategies for problem solving. In the remaining section of this study (section 5), the conclusions and recommendations for further research drawn from the analysis of the data will be discussed.

SECTION 5: DISCUSSION, CONCLUSIONS, AND RECOMMENDATIONS

Overview of the Study

The purpose of this sequential explanatory mixed methods causal comparative study was to examine the implementation of learning styles instructional strategies and the relationship to mathematics achievement of eighth grade students in a Title I middle school in a suburban school district. Creswell (2003) stated that mixed methods design is chosen to capture ideas from real-life contact. This study employed a nonrandomized control-group pretest-posttest design using archival data as the quantitative before and after comparison of mathematics achievement of the eighth grade students. Two forms of qualitative data were also collected for this study: a classroom observation form (Appendix A) during the intervention, and an anonymous teacher open-ended reflection survey at the completion of the intervention (Appendix B).

The pertinent factors that affect mathematics achievement at the middle school level due to the mandates created by NCLB and the connection between state funds with test results were investigated. Two groups, an experimental and a control group both comprised of an equal proportion of general education and basic skills students, were created to compare the effect of learning style intervention strategies on mathematics achievement. Learning styles of students were identified and aligned with instructional strategies to address differentiation of skills. A district approved pretest and posttest were used to measure change in mathematical performance of the students. Each teacher in the experimental group had an increased exposure to professional research to create a better

understanding of learning styles and differentiation of instruction to improve student achievement. Gardner (1993) claimed that there are seven different intelligences and that educators should implement his theory of multiple intelligences when planning lessons and interventions in order to reach all students in the classroom. Marzano (2001) described the nine effective teaching strategies that will influence student achievement. Silver, Strong, and Perini developed instructional strategies to use in the mathematics classroom which had recognizable connections to Gardner and Marzano (Silver, Brunsting, & Walsh, 2008). Consistent with the literature researched, the teachers received professional development to assist their lesson planning so that all four learning styles prevalent in a classroom would be addressed. The students also were also given the opportunity to become more familiar with the best methods by which they could process information from a math lesson; whether it was visual, oral or tactile instruction through the actual instruction provided by the teacher or the individual assignments. Teachers engaged students in collaborative groupings so that they could articulate their understanding of the lesson as well as the strategies they used to gain this understanding. According to Strong et al.(2004), students reflected on their learning and demonstrated a greater self-awareness of how they learn in order to retain knowledge and become improved learners (p.75).

The teachers' perception of the effects of learning styles strategies on the students was also evaluated with a review of their responses to an open-ended teacher survey on learning styles. At the conclusion of the intervention week, all participating teachers were given the teacher survey to complete. The experimental teachers were able to reflect on

the process by which they were introduced to learning style intervention, the lessons utilized to implement strategies, and the results they observed from the students' assignments as posttest results. The control teachers were given the same survey but only were able to reflect on the strategies they traditionally employ and the results the student achieved in their assignments and posttest benchmark assessment. The surveys were reviewed comparatively from both groups of teachers. Common threads of responses were identified as follows; shown collectively from all the teachers in Table 3.

- Both groups of participating teachers recorded a concern for not having enough time to teach the skills presented over the course of one week of instruction.
- Both groups of participating teachers noted an overall improvement in conceptual understanding as indicated from posttest benchmark results. However, the overall improvement of mathematical understanding was not as high as the teachers would have expected the students to achieve.
- Both groups of teachers attributed the lack of accomplishing significant results on the posttest benchmark assessment on the lack of time granted to the instruction. More specifically to the group of experimental teachers, the lack of time granted to the intervention strategies yielded limited results.

Interpretation of Findings

The research questions presented in this study established the framework in which the findings could be discussed and conclusions could be drawn. Within the literature reviewed, Lee (2006) discussed the necessity to reach out to educators to use data from

high-stake testing to recommend instructional strategies that will produce real gains for students. Keeping the focus of this research on this educational philosophy, the broad questions of this mixed methods design study investigated the influence of instructional strategies and their alignment with learning styles on mathematics achievement at the middle school level. Gardner (1993) recognized that all children do not fit the same mold and need to explain material in their own manner; hence this study also recognized the need to investigate the effects of differentiation of instruction. Marzano (1992) recognized different learning styles and the need to adapt differentiated teaching strategies to facilitate learning for all students. With recognizable connections to Marzano's research on best practices to use in the classroom, Silver, Strong, and Perini (2000) developed instructional strategies to use in the mathematics classroom.

These theories were essential to the design of this study and the direction of the investigation. To maintain consistency throughout the intervention period of the study, the researcher arranged for Silver to present 1 full day (6 hours) of professional development to only the experimental teachers. Silver's training was based on his research of learning styles and effective instructional strategies for the middle school mathematics classroom to improve student achievement.

The quantitative research questions of this study investigated the difference in mathematics achievement of middle school students who were taught with traditional instruction and those who were given learning style intervention strategies during their instruction. Research question 1 examined the effects of this difference in methodology with regular education middle school students; research question 2 examined the same

premise with basic skills middle school students. The findings from the SPSS data analysis for both research questions supported the null hypothesis. Although no significant difference was noted in mathematical achievement gains between the pretests and posttests via the data analysis, it is noted that a minimal increase in overall mean score in mathematical achievement for both the general education and basic skills education students between these two benchmark assessments was visible.

Silver, Strong, and Perini(2007) emphasized that all students rely on all four learning styles to learn mathematics. A teacher must tap into the students' learning styles and build upon students' strengths by accommodating preferred styles to develop less preferred styles (Thomas, 2003, p.14). This rotation of utilizing learning style intervention strategies to tap into students' approach to problem solving takes time. As evidenced by the literature, further investigation regarding the extension of learning style intervention strategies with the identical student sample in this study would allow the researcher to develop additional conclusions about the effect of the length of the intervention period with the measure of mathematical achievement. Several of the participating teachers in this research study inferred via the teacher open-ended survey that the mathematical achievement levels could have possible improved with an extension of the intervention period with the students. There was a slight difference in the experimental groups regarding noted common themes regardless of the opportunity shared during the professional development on learning style strategies.

Implication of Social Change

The intention of this study was to have teacher leaders, through the design of a PLC, identify learning styles of students; articulate both horizontally and vertically, implement prescribed instructional strategies, and ultimately raise mathematics achievement of students. Included in this study was the analysis of the stratification of students at the middle school level, as well as curriculum expectations that are prevalent in the middle school classrooms. Standardized assessments as required by the NCLB and designated by national and state standards were also examined in terms of the lasting impact on student achievement, particularly the method by which they learn mathematics.

This study revealed an awareness of the four possible learning styles that may be prevalent in any classroom. It is suggested that teachers be made aware of how to differentiate their instruction to appropriately address these learning styles. In conjunction with this reasoning, assessments should be redesigned to allow students to problem solve using their learning style preference while strengthening the weaker of their learning styles.

This study impacted social change by the improved horizontal collaboration among teachers, particularly with their discussion regarding student performance and their recommendations for modifying the current mathematics program. More specifically, this study assisted in teacher awareness of alternative methods by which they could reach the underachieving student and assist that student in making connections to the material instructed. Non-traditional assessment measures such as projects were incorporated into lessons so that students who typically perform poorly with traditional

testing could discover an avenue by which they could demonstrate their mastery of the lesson's objective.

Teachers are continually challenged with the demands made on presenting evidence of student achievement particularly through the results of standardized assessments. It is incumbent on today's educator to learn how best to present information during instruction to assist students in gaining as well as demonstrating mastery of content.

Recommendations for Action

Although the results of the data analysis of the pretest and posttest assessments did not indicate significant improvement, the scores did improve slightly. The time constraints resulting from the length of the marking period within which the cohorts for the basic skills students remained the same might have factored into the minimal improvement recognized between the pretest and posttest scores. Following the professional development provided by Silver, experimental teachers were allowed less than two weeks of using intervention strategies during instruction. A recommendation by the teachers on the teacher open-ended reflection survey was the provision of more time to implement learning style strategies so that greater improvements in mathematics achievement on these district benchmark assessments could be expected.

The results of this study should be shared with middle school classroom teachers as well as administration. Teachers should be made aware of the potential in using learning style intervention strategies during the course of their instruction to increase the practice of incorporating differentiation on a more regular basis. Administrators should

be aware of learning style intervention strategies when observing lessons, particularly when identifying the activities implemented by staff to differentiate instruction to meet students' academic challenges. Additional professional development opportunities for middle school staff to learn about learning styles intervention strategies should be considered so that more teachers would have an improved awareness of how to implement its use in daily instruction.

Recommendations for Future Research

The focus of this study into the investigation of learning styles intervention strategies and the results which supported the null hypotheses has led the researcher to raise additional questions for further consideration. Questions which may be considered when reflecting on recommendations for further research include:

- Would the continuation of the use of learning style intervention strategies over an extended period of time lead to significant improvements in students' mathematical achievement levels as noted on the district's benchmark assessments?
- Does a need exist during classroom instruction to incorporate the use of learning style intervention strategies for all levels of learners?
- Do teachers need to be informed of the concept of learning styles and be made aware of both their own individual learning style as well as the existence of the learning styles in their assigned classes? Would this knowledge affect their teaching style?
- Should professional development opportunities for all teachers be

considered part of the vision of the school district to improve student achievement through the recognition of learning styles and the need to differentiate instruction to obtain maximum learning?

- Should assessments and reporting of its grades be designed to measure and record individual gains in mastery levels in coordination with the recognition of learning style differences?
- Should resources be provided in the form of instructional materials to enable

and strengthen all four learning styles for students?

- Should further investigation be conducted to determine if gender has an impact on the difference in student mathematical performance?

Summary

This study acknowledged the concern of how middle school teachers can address the low standardized mathematics scores in a suburban school district. In concert with the objectives of NCLB, this study focused on the improvement of the mathematics achievement levels of students at the eighth grade level. The purpose of this study was accomplished by identifying learning styles of students and implementing instructional strategies that addressed the learners' needs within the mathematics classroom. The sequential mixed methods quasi-experimental causal comparative design of this study did investigate the effect of classroom intervention based on learning style differentiation on the improvement of mathematics achievement levels in district benchmark assessments.

The results of this study, namely the differences in scores from the pretest and posttest district benchmark assessments after the implementation of learning style strategies during instruction, did not indicate significant improvement in scores. Although there was a minimal change in scores between the two district benchmark assessments; this change was not deemed significant by ANCOVA and research supported the null hypotheses. Recommendations to this study suggest that additional professional development as well as additional time for implementing learning style intervention strategies could possibly lead to significant improvement in middle school mathematics achievement levels.

This study does provide opportunities for further research. The incorporation of learning styles intervention strategies by teachers throughout their instruction is an area that would require further investigation with the intent of potential mathematical achievement gains. Increased awareness by teachers of the need to differentiate instruction to address students' learning challenges has also been suggested as a consideration for further research. The minimal results recorded from this short-term research study cannot be interpreted as evidence that intervention of learning style strategies during instruction would lead to the improvement in mathematical achievement of middle school students. However, this study impacted social change by the improved horizontal collaboration among teachers, particularly with their discussion regarding student performance and their recommendations for modifying the current mathematics program.

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APPENDIX A

Classroom Observation Form

Name of Teacher:

Classroom:

Date:
Time of Day:

Number of Students Present:

Materials Used:

Objective of the Lesson:

Anecdotal Record of Activities Observed:

APPENDIX B

Teacher Open- Ended Reflection Survey

Name (optional):_____

Rationale: The purpose of this survey is to collect information about your perception of learning style strategies.

Directions: Please answer all 10 questions as honestly as possible and provide your responses in a word document. All information will be kept confidential and will not affect your personnel records. You may choose to keep your survey anonymous. Please submit this survey back to the researcher within one week of receipt in the envelope provided. Thank you.

1. What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

2. How were you able to determine which learning styles performed better from your observations of student performance?

3. How were you able to determine which learning styles performed better from the final project results?

4. Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

5. As the teacher, knowing the final task, did you "teach to the test" or for mastery of content? Could this present a problem?

6. How can we make learning more meaningful to students during and after this intervention study?

7. How would you redesign your curriculum after experiencing instruction using intervention strategies?

8. How did time impact your instruction?

9. Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

10. Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

APPENDIX C

Classroom Observation Form for Each Teacher

Classroom Observation Form for Teacher A

Name of Teacher: Teacher A

Classroom: Pre-Algebra

Date: Wednesday, April 15, 2009
Time of Day: period 1

Number of Students Present: 23 students

Materials Used: Recipe cards; geometric manipulative shapes (namely, prisms and cylinders); calculators; worksheets

Objective of the Lesson: To identify prisms and cylinders and determine if they are more alike or different

Anecdotal Record of Activities Observed:

- The teacher directed the students to take out their recipe cards for volume. The definition of volume was discussed.

- Visual shapes for a cylinder, rectangular prism and triangular prism were presented. Students were directed to complete recipe cards for each of these shapes. The teacher initiated a discussion among students comparing the similarities and differences among shapes.

- Using the recipe cards as a reference, students calculated volume of a cylinder with the diameter and height given.

- Rectangular prism was presented. Students completed recipe card for this shape.

- The same process continued for a cone. A relationship was created between a rectangular prism and cone. The formula for the volume of the cone was derived using the formula for the rectangular prism.

- Students on task and engaged in lesson; enthusiastic learners; dynamic class

- Teacher facilitated instruction after a preliminary exercise in explaining objective of the lesson; teacher created excitement in the room. Questions were posed and addressed throughout lesson.

Classroom Observation Form for Teacher B

Name of Teacher: Teacher B

Classroom: Pre-Algebra

Date: Wednesday, April 1, 2009
Time of Day: period 6

Number of Students Present: 17

Materials Used: Vocabulary Knowledge Worksheet

Objective of the Lesson: Introduction of three-dimensional objects

Anecdotal Record of Activities Observed:

- Students completed a Vocabulary Knowledge Rating worksheet as a Do Now assignment.
- The class discussed what they would be doing with three-dimensional shapes over the next couple of weeks. A discussion continued about where they saw geometric shapes in real life.
- Power-point presentation of some real-life examples. Class discussed video
- Students were given the final task worksheet with the backwards learning organizer on the second page. A brief discussion was conducted by the teacher about the final task and what the student would be expected to do over the following days to prepare for the culminating assignment
- Students on task and engaged in lesson; enthusiastic learners; dynamic class
- Teacher facilitated instruction after a preliminary exercise in explaining objective of the lesson. Student questions were addressed throughout lesson.
- Students were “in charge” of their learning. There was much peer group discussion.

Classroom Observation Form for Teacher C

Name of Teacher: Teacher C

Classroom: Pre-Algebra/ Basic Skills

Date: Wednesday, April 15, 2009
Time of Day: period 4

Number of Students Present: 12 students

Materials Used: Recipe cards; geometric manipulative shapes (namely, prisms and cylinders); calculators; worksheets

Objective of the Lesson: To correctly identify prisms and cylinders using notes and manipulatives

Anecdotal Record of Activities Observed:

- The teacher presented the vocabulary and geometric shapes and asked students to recall definitions and draw comparisons.

- The objective of the lesson was introduced on the chalkboard. Students would learn to identify a cylinder and a cone, and to identify a rectangular prism and a pyramid. Formulas for each shape were provided.

- Worksheets were distributed with recipe cards. Students worked in groups; each of the four groups was given a shape. Two groups worked with cylinders/cones; two groups worked with prisms/pyramids. Students calculated volume of shape and recorded shapes to solve for volume on the recipe cards.

- At the conclusion of lesson, each group acted as experts on their shape and presented their findings of volume calculations to the remainder of the class.

- Students on task and engaged in lesson; participation noted

- Teacher facilitated instruction after a preliminary exercise in explaining objective of the lesson. Student questions were addressed throughout lesson.

- Information was disseminated in smaller “doses” and visually assessed intermittently throughout lesson

Classroom Observation Form for Teacher D

Name of Teacher: Teacher D

Classroom: Pre-Algebra/ Basic Skills

Date: Wednesday, April 15, 2009
Time of Day: period 3

Number of Students Present: 10 students

Materials Used: Recipe cards; geometric manipulative shapes (namely, prisms and cylinders); calculators

Objective of the Lesson: To compare and contrast surface area and volume; to formulate a way to calculate the volume and surface area of a given polyhedron

Anecdotal Record of Activities Observed:

- Do Now: Complete a Venn diagram to compare and contrast surface area and volume. Review findings and discuss.

- The teachers distributed the recipe cards and directed the students to complete definitions for volume. Teacher reviewed vocabulary for polyhedrons, prisms and cylinders

- Teacher elicited description of shapes and asked for specific characteristics. Shapes were available as a visual display.

- Connections were made between rectangular prism and cylinder. For example, area of base times the height of prism will give volume. Student discussed common traits between two shapes.

- Teacher introduced triangular prism. Students were asked to reference recipe cards to demonstrate connection between triangular prism and rectangular prism.

- Highlights of lesson summarized by teacher with the input of students. For the closure activity, students were asked to write and recite the formula for one of the 3-D shapes.

- Students on task and engaged in lesson; enthusiastic about project

- Teacher facilitated instruction after a preliminary exercise in explaining objective of the lesson.

Classroom Observation Form for Teacher E

Name of Teacher: Teacher E

Classroom: Pre-Algebra

Date: Wednesday, April 1, 2009
Time of Day: period 7

Number of Students Present: 24 students

Materials Used: Do Now worksheet; text, calculator

Objective of the Lesson: To find the volume of prism and cylinders

Anecdotal Record of Activities Observed:

- The teacher presented a Do Now exercise for the standardized testing
- The Do Now was reviewed orally
- The homework was reviewed. Students were asked to discuss findings about the volume of prisms and cylinders. Students demonstrated their understanding of volume of these shapes by illustrating homework on chalkboard.
- The teacher emphasized the importance of showing each step of the solution for volume.
- The lesson was closed by reinforcing the steps for solving for volume for these shapes. The basic formula was reviewed and the students were reminded what the letter B was in the formula equation.
- Students on task and engaged in lesson
- Teacher facilitated instruction after a preliminary exercise in explaining objective of the lesson.
- Questions addressed; students excited about completing project
- Application to real world problems interested students. More discussion developed “where math can be used”.

Classroom Observation Form for Teacher F

Name of Teacher: Teacher F

Classroom: Pre-Algebra/ Basic Skills

Date: Wednesday, April 1, 2009
Time of Day: period 6

Number of Students Present: 9 students

Materials Used: Geometric manipulative shapes (namely, prisms and cylinders); worksheets

Objective of the Lesson: To name a 3-D figure and count the number of faces,, vertices, edges and surfaces on it.

Anecdotal Record of Activities Observed:

- Teacher showed the students a rectangular prism and explained the meaning of faces, vertices, and edges

- The teacher gave out triangular prism dice and had the student identify the faces, vertices and edges on the dice. The students were directed to count how many of each there were and showed the bases.

- The teacher gave out a worksheet about rectangular and triangular prisms. The students had to name the figure and identify how many faces, vertices, bases and edges were on each shape.

- The teacher gave out a different worksheet of a rectangular pyramid. The students were directed to name the shape, and then count the faces, vertices, bases and edges on it.

APPENDIX D

Teacher Responses to the Teacher Open- Ended Reflection Survey

Teacher A:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher A: In my Masters Degree program at Saint Peter's College in Jersey City NJ, I had taken learning style inventories, and had ascertained what learning styles worked best for me. I also had learned how these personal preferences impacted my daily classroom instruction. We were not shown many strategies that could be used to help differentiate our instruction, and fight our natural tendencies to teach the way we ourselves learn best.

I now have a much better understanding on what is meant by truly differentiating instruction. I also feel more comfortable knowing what a differentiated classroom environment should look like, as well as having a working knowledge of how to create a properly differentiated classroom.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher A: I am not quite sure I understand this question.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Styles
Teacher A: Students learning style preferences became most apparent when they completed their final project. Students' whom had a preference in reading and writing spent more of their time articulating their ideas, then they did on any other part of the project. Auditory learners were constantly talking their way through the completion of the final assessment, verbalizing their ideas. Many students might not have done a perfect job on every component of the project, but they were able to show competency giving strong performances in a few areas.

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher A: Yes. Because the students had a detailed explanation of what their final project was going to be. They were able to better understand how the lessons were engaged in would help them complete this final task. Once students knew where their final destination was going to be, I believe they better appreciated the steps they were taking along the way to get there.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery of content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher A: A combination of teaching to the test and mastery of content was utilized. I normally teach for mastery of content. Because of the strict time limitations, I was not able to teach completely to mastery, having to move at a greater pace then I would have liked. I did make sure all the concepts that would be needed for the final project were covered, but I would have appreciated a few more instructional days to maximize mastery of the concepts.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher A: Many teachers only teach a few learning styles, typically the ones they are themselves most comfortable with. This study gave us training to help us teach outside our normal comfort zone, and allowing us to more adequately instruct a larger segment of our student population.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A. Curriculum Recommendations
Teacher A: In a perfect world, I would give a learning inventory to my students the first day of school to establish which styles of learning best suits their learning needs. This would help me to differentiate my instruction accordingly. I don't know if this is feasible due to time limitations.

I am now aware of different techniques that can be utilized to differentiate classroom instruction. Having a final project and creating a student portfolio is a method that could be implemented in a mathematics curriculum to help gauge and track student progress and individual student growth.

Q8. Time
How did time impact your instruction?

Q8A. Time Impact
Teacher A: As mentioned previously, time did impact instruction, and more time before the issuing of the final project would have been helpful in ensuring student mastery.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher A: Being given a "toolbox" of activities helped to ensure we were teaching to accommodate multiple learning styles. Without this toolbox, it would be easy for myself to instruct using only the few "tools" that I was most comfortable with.

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher A: The most significant difference I noticed was that students learned through more self discovery utilizing the differentiated instruction, as apposed to be given the information.

Teacher B:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher B: I now understand that a balanced method of learning styles greatly increases the learning of each type of learner and that I do not have to necessarily teach a different lesson for each type of learner.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher B: I had a tough time being able to say that one certain type of learner did better in this study.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Styles
Teacher B: I can not say for certain

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher B: Telling the students the expectations did help in getting them ready for the final task and it also gave me a chance to take a step back every once in a while and check in with the students to see how well we were doing in getting the information and the understanding that we needed to complete the final task. They seemed more likely to take the time to make sure they were getting something right or understood what a word meant because they knew how and when it was going to be used.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery o f content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher B: I did feel like I was pressed for time and that I was teaching them more about what numbers and formulas to use and did not have enough time to spend on gaining conceptual understanding of volume or surface area. This could pose a problem because I don't think students are as likely to retain information if they are taught this way.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher B: Continue to make the learning personal and relate it to things in real life and discuss and explore the math that we are doing. It is also helpful to talk and write about the math we are doing.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A Curriculum Recommendations
Teacher B: I would spend more time on each concept, even if that meant teaching fewer topics. I would also teach concepts instead of chapters, and give each teacher a certain amount of time in the pacing chart to teach that concept. I would also allow each teacher to come up with his or her won lessons or activities even though I think it would be a good idea to have teachers get together to help create tools.

Q8 Time
How did time impact your instruction?

Q8A. Time Impact
Teacher B: Time was a factor because I did not feel like I had enough time to cover the concept of volume or surface area and I as not able to have time to reflect on each tool or discuss the topics the way I wanted to. I also would have liked to spend more time on the final task, and time to reflect on it with the students.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher B: I don't think my knowledge of my learning style affected how I taught.

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher B: I did try to do a little more connecting with the students and discussing the concepts and how things relate to real life because when I filled out my teaching style survey I became very aware that I do not do that very much and I am not much of an interpersonal.

Teacher C:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher C: Students need a multi-sensory approach because it improves their critical thinking skills by "doing". They are more interested and motivated when actively involved in their own learning.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher C: This was determined by the amount of student input, self-generated, and results of the final project.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Style
Teacher C: Students who used a kinesthetic and tactile approach were able to complete their projects with less support and difficulty, and in less time.

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher C: By utilizing a scaffolding approach, and giving the students specific directions, they were able to complete the task at hand with fewer questions and complete mastery of the final project.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery of content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher C: I taught for mastery of content. The problem it could present it is that the students would not know the format of standardized testing.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher C: Learning can be made more meaningful by creating and applying real life experiences. Students need to be active and participating learners.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A. Curriculum Recommendations
Teacher C: I use and will continue to use a hands approach, and incorporate cooperative learning enabling students to become active learners.

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Q8. Time
How did time impact your instruction?

Q8A. Time Impact
Teacher C: Time was an issue for this project. Students required more time than what was allotted to complete the project.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher C: This project influenced my own personal belief that students do have different learning styles, and they learn best by "doing."

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher C: It impacted my instruction favorably. My methodology of teaching is that students need this type of approach. I will continue to motivate students by having them actively involved, both kinesthetically and tactile.

Teacher D:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher D: I have learned that it is important and easy to differentiate instruction for most learners I my classroom. Although I am patient already, I am even more so since finding out that some learners really so not understand or absorb their learning through my personal instruction.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher D: I noticed, since I have basic skills students, that most of my students learn best by intrapersonal and hands on experiences. They always want a reasoning of how things work or why we need to know them. It was easy for me to see this because of students' responses at those teaching moments.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Styles
Teacher D: My experience with the final project was not a success. My students needed me there every second guiding them towards the correct responses and steps. They felt it was too overwhelming with all that was expected of them. It made me realize my students need basic/simplified instruction. They needed ONE directions and ample time to complete it before being told step two.

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher D: Yes, I feel that they were able to focus on certain concepts and ASKING QUESTIONS was a big one. They asked more questions then usual because they wanted to make sure they knew whatever they had to.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery o f content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher D: I started off by teaching to the test, but as questions and observation came to hand, I did teach to mastery instead. Moreover, I do not think that it would present a problem with my instruction, but could somehow affect others.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher D: I think this intervention really set a new perspective on my instruction. The students' attention was good enough for me to recognize how meaningful it is

to differentiate my instruction and that higher order thinking skills and motivational skills are definitely possible with basic skills students.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A .Curriculum Recommendations
Teacher D: It is meaningful it is to differentiate my instruction.

Q8 Time
How did time impact your instruction?

Q8A. Time Impact
Teacher D: I felt that this time of instruction presented is extremely time consuming. I am grateful that I do not have to follow a set curriculum like the "block" teachers do.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher D: The personal learning styles test brought to my attention that I teach in my learning style only, since this is what makes sense for me. This discovery helped me because I was able to add more to my instruction based on other learning styles (not just mine).

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher D: As in my learning style, I was able to add more to my instruction based on other learning styles in the classroom. I combined visual aspects with hands-on as well as reasoning, listening, and personal connections.

Teacher E:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher E: I learned that different instructional strategies allow you to connect with different students. It is important to use a variety of instructional strategies so you will reach all of your students.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher E: I was able to tell the styles that worked best by the expressions on the students' faces. Their expressions are worth so much more than words. Also, the way they approach the independent work told me their confidence level at approaching it. If they went right into it, I knew they learned the lesson.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Styles
Teacher E: I was able to determine the learning style that worked the best by the questions they had during the final project.

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher E: Yes it did. They would ask me specific questions while being taught the information.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery o f content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher E: Because we were given a very rigid time frame, I did "teach to the test." I needed to make sure they knew the specific information that they needed.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher E: We can focus our teaching and examples on more "real life" problems and not as much basic algebra. More "real-life" word problems would benefit students.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A .Curriculum Recommendations
Teacher E: I was part of the control group so I was not made aware of the intervention strategies.

Q8 Time
How did time impact your instruction?

Q8A. Time Impact
Teacher E: The way I have taught 3-dimensional figures in the past was different than this way. I usually take about a week just for them to understand what volume is. I then go into the formulas as to how to find volume. They retained the information better when I approached it this way. Because we only had a few days to teach more than volume, I had to give more notes and give formulas. I just had them plug numbers in.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher E: No it did not.

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher E: No it did not. I was the control group and had to do everything the most basic.

Teacher F:

Q1. Questions on Learning Styles
What questions regarding learning styles or instructional strategies are you now able to answer from being part of this intervention study?

Q1A. Learning Style Response
Teacher F: I wasn't part of the intervention study; however, I did research on multiple intelligences as part of my masters' thesis. I was also involved in a workshop using learning styles and am now able to make connections between learning styles and multiple intelligences.

Q2. Which Learning Style
How were you able to determine which learning styles performed better from your observations of student performance?

Q2A. Preferred Learning Style
Teacher F: I had a working knowledge of the learning styles of the students with whom I worked. Therefore I knew that my students were visual learners and made the lesson more user friendly and correspond with the existing learning styles.

Q3. Final Project Learning Style
How were you able to determine which learning styles performed better from the final project results?

Q3A. Resulting Learning Styles
Teacher F: I was able to see from the final project results that the students did perform better by addressing their visual learning style. I also made charts so that students were able to monitor progress of their learning. They could put together all the information and make connections.

Q4. Knowing Expectations
Did telling the students the expectations of the unit and of the final project assist with instruction and student mastery?

Q4A. Student Results from Expectations
Teacher F: Students knew that there was a final project; however, they were given information in a compartmentalized fashion. This method of giving information helped them digest information. The rapport in the room is one of confidence in the teacher and the lessons progressed smoothly.

Q5. Teaching to the Test
As the teacher, knowing the final task, did you "teach to the test" or for mastery o f content? Could this present a problem?

Q5A. Teacher Results from Expectations
Teacher F: I didn't teach to the final task. I taught more specifically to the objective of mastery of the topics.

Q6. Recommendations
How can we make learning more meaningful to students during and after this intervention study?

Q6A. Change in Methodology
Teacher F: You wanted more time to present material in smaller bites—not so much information so quickly; it's overwhelming for the students. Normally, I would have presented an experiential lesson for students to discover the meaning of surface area before they progress to volume. I use materials with varying objects/shapes.

Q7. Curriculum Changes
How would you redesign your curriculum after experiencing instruction using intervention strategies?

Q7A .Curriculum Recommendations
Teacher F: Again, I was not part of the intervention study. However, I do pull information from multiple intelligences to present information in a manner to address the varying learning styles.

Q8 Time
How did time impact your instruction?

Q8A. Time Impact
Teacher F: As mentioned previously, time did impact instruction, and more time before the issuing of the final project would have been helpful in ensuring student mastery.

Q9. Learning Style Knowledge
Did the knowledge of your learning style impact your instruction? If so, in what manner did it change from your typical methodology?

Q9A. Learning Style Knowledge Effects
Teacher F: I had prior knowledge of learning styles and have been incorporating this practice prior to this study.

Q10. Teaching Style Knowledge
Did the knowledge of your teaching style impact your instruction? If so, what changes did you notice?

Q10A. Teaching Style Knowledge Effects
Teacher F: I am a visual, problem solving teacher. I incorporate a lot of organizational and visual learning strategies and it works with my students' learning styles.

CURRICULUM VITAE

Jean M. Ferrara

Experience

2000-present	K-12 District Math Supervisor Old Bridge Township Board of Education Old Bridge, NJ
1995-2000	Middle School Mathematics Teacher Jonas Salk Middle School Old Bridge, NJ
1987-1995	Home Instructor and Per Diem Teacher Old Bridge Township Board of Education Old Bridge, NJ
1981-1986	Compensation Analyst and Benefits Administrator Guy Carpenter & Co. New York, NY
1979-1981	Actuarial Analyst Johnson & Higgins New York, NY

Education

2006-present	Walden University Ed.D. Candidate, Administrative Leadership
2000	Rutgers University Supervisory Certificate
1983	City University of New York M.Ed. Human Resources
1979	St. John's University B.S. Mathematics, Elementary Education and Speech

Certifications

K-12 Supervision
Mathematics
Elementary Education
Teacher of the Handicapped