THE EFFECT OF DIFFERENTIATED INSTRUCTION ON STANDARDIZED ASSESSMENT PERFORMANCE OF STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

by

Kimberly Gail Williams
Liberty University

A Dissertation Presented in Partial Fulfillment
Of the Requirements for the Degree
Doctor of Education

Liberty University
June 2012

THE EFFECT OF DIFFERENTIATED INSTRUCTION ON STANDARDIZED ASSESSMENT PERFORMANCE OF STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM

By Kimberly Gail Williams

A Dissertation Presented in Partial Fulfillment

Of the Requirements for the Degree

Doctor of Education

Liberty University, Lynchburg, VA

June 2012

APPROVED BY:

Dr. Linda Woolard, Chair	June 2012
Dr. Sherrie Diaz, Committee	June 2012
Dr. Amy McLemore, Committee	June 2012
Dr. Scott B. Watson, Associate Dean, Advanced Programs	June 2012

Kimberly Williams. THE EFFECT OF DIFFERENTIATED INSTRUCTION ON STANDARDIZED ASSESSMENT PERFORMANCE OF STUDENTS IN THE MIDDLE SCHOOL MATHEMATICS CLASSROOM. (Under the direction of Dr. Linda Woolard) School of Education, Liberty University, June, 2012.

ABSTRACT

Changing demographics, student diversity, and increased accountability have compelled educators to challenge the uniform constraints of traditional instruction and create an environment focused on individual achievement. Differentiated instruction empowers teachers to target multiple learning styles through varied themes, adapted content delivery, and assessment options. This quantitative quasi-experimental research study examined the effects of differentiated instruction on seventh grade student performance on standardized mathematics assessments using a repeated-measures design. Two independent research trials, controlling for initial group differences with 2011 Texas Assessment of Knowledge and Skills (TAKS) scores, provided inconclusive assessment results. Significant differences between students who received differentiated instruction compared to students who were instructed using traditional lecture-based strategies were inconsistent for each research trial. All learning groups, including special education, economically disadvantaged, English language learners, and gifted were included to determine if strategies were successful based on specific learning needs. Evidence obtained through classroom observations revealed deficiencies in effective instructional delivery of differentiated strategies, emphasizing the need for ongoing, quality professional development and support for educators.

Descriptors: differentiation, assessment, learning styles, high stakes testing, curriculum, instruction, teaching

Acknowledgements

To my soul mate and loving husband Jason: Thank you for always believing in me and supporting me throughout this four-year journey. You have always listened when I was discouraged, providing the confidence I needed to continue working. I cannot thank you enough for the sacrifices you have made to help me make this dream a reality. I love you with all of my heart.

To my wonderful children, Colby and Kameren: I love you both so much and thank you for never complaining when I had to study. I pray that you will find your purpose in life and that you realize you can make a difference in this world. You can always achieve your dreams with faith, hard work, family support, and a willingness to sacrifice.

To my mother, Beatrice Arnold: Thank you for raising me to believe I can accomplish anything. This achievement would not be possible without the values you have instilled in me and your unconditional love. You have always supported me and encouraged me even when I felt like giving up. I love you and I am thankful everyday that you are my mother.

To my sister, Kelly Sloan: Thank you for always encouraging me and listening to me when I achieved minor or major breakthroughs in my research. Thank you for being a surrogate mother to my children so I could complete my coursework in the summer months. You are always there for me when I need you and I love you.

To the teachers who participated in this study: This research would not have been possible without you. Thank you for trusting me and allowing me to be a part of your classrooms.

To Julia Truax and Norma Estrada-Keith: Thank you for taking time to work with me throughout the observation period of my dissertation. Your expertise, curriculum knowledge, and friendship have been invaluable to me throughout this process.

To my chair and committee members, Dr. Linda Woolard, Dr. Amy McLemore, and Dr. Sherrie Diaz: Thank you for your knowledge, wisdom, words of encouragement, and all of the positive feedback you have provided throughout this process.

First and foremost, I thank God for giving me strength, wisdom, motivation, and persistence to persevere throughout this process. I give all the glory to Him and know that "I can do all things through Christ, which strengthens me" (Philippians 4:13, KJV).

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Adequate Yearly Progress (AYP)

All Students, Including Special Populations (ALL)

Analysis of Covariance (ANCOVA)

At-Risk (AR)

Classroom Observation Scales Revised (COS-R)

Differentiated Instruction (DI)

Economically Disadvantaged (ED)

English Language Learner (ELL)

Elementary and Secondary Schools Act (ESEA)

Gifted and Talented (GT)

Identification (ID)

Individuals with Disabilities Education Act (IDEA)

Interactive White Board (IWB)

Multiple Intelligences (MI)

No Child Left Behind (NCLB)

Performance-Based Monitoring Analysis System (PBMAS)

Special Education (SPED)

State of Texas Assessment of Academic Readiness (STAAR)

Statistical Package for the Social Sciences (SPSS)

Student Observation Scale (SOS)

Teaching Style Inventory (TSI)

Texas Assessment of Academic Skills (TAAS)

Texas Assessment of Basic Skills (TABS)

Texas Assessment of Knowledge and Skills (TAKS)

Texas Education Agency (TEA)

Texas Education Assessment of Minimum Skills (TEAMS)

Texas Essential Knowledge and Skills (TEKS)

CHAPTER 1: INTRODUCTION

Legislature, political mandates, and high-stakes testing have created an educational setting in which teachers face intense accountability demands and standards-based curriculum. Providing students with a quality education is the goal of teachers, administrators, community members, and legislatures; however, reliance on a single academic indicator has compelled many educators to focus instruction on students capable of meeting a minimum pre-established proficiency standard. As a result, many students are not receiving the education they deserve. "A systematic approach to planning curriculum and instruction for academically diverse learners" (Tomlinson & Eidson, 2003, p. 3), referred to as differentiation, is necessary to provide a quality education while meeting rigorous political demands. This dissertation uses a repeated-measures design, with two independent research trials, to investigate how implementation of differentiated instruction in the middle school mathematics classroom affects student scores on standardized mathematics assessments. Five-week benchmark examinations, created from released Texas Assessment of Knowledge and Skills (TAKS) test questions, and previous TAKS scores provide the data for this study. Chapter 1 provides a background for the research, identifies the problem of the study, validates the significance of the study, and clarifies terminology.

Background of the Study

The No Child Left Behind (NCLB) Act of 2001 affected schools throughout the nation. This legislation revised high-stakes testing practices and adequate yearly progress (AYP) requirements, forcing educational institutions to analyze instructional practices to determine if they were meeting the needs of all students. The primary focus of NCLB (2001) was to ensure academic progress of special education students, minorities, economically disadvantaged, and English as second language learners. Accountability pressure has created an environment in which many teachers teach to the test, ensuring a minimum standard is met for all student populations (Chapman, 2007; Zimmerman & Dibenedetto, 2008).

The premise of NCLB (2001) was to challenge all students to reach their individual potential; excuses for student failure were no longer acceptable. Rush and Scherff (2012) summarized the intent of NCLB in the following:

> NCLB, or the 2001 reauthorization of the Elementary and Secondary Schools Act (ESEA), stood on four basic premises: stronger accountability for schools and teachers; increased flexibility and local control over federal funds; greater schooling options for parents; and a focus on proven, research-based teaching practices. (p. 91)

Today's teachers are faced with an inclusive classroom, where all students are expected to be challenged academically. Meeting this challenge is difficult but can be accomplished using differentiated teaching strategies that focus on individual student strengths and build on prior learning (Lewis & Batts, 2005; Nugent, 2006; Tomlinson, 2000a, 2000b, 2005).

Accountability for Texas did not begin with NCLB (2001); state-mandated assessments were initiated in 1980. The first state-mandated test, the Texas Assessment of Basic Skills (TABS), was administered to students in grades three, five, and nine in reading, mathematics, and writing. However, students were not required to pass the examination to receive a diploma. In 1981, the Essential Elements, currently referred to as Texas Essential Knowledge and Skills (TEKS), were developed based on House Bill 246, mandating creation of a statewide curriculum. The Texas Educational Assessment of Minimum Skills (TEAMS) replaced the TABS assessment program in 1986 and was implemented until 1990. Students unable to meet a minimum passing standard were denied graduation (TEA, 2004).

The Texas Assessment of Academic Skills (TAAS) expanded grades tested in 1990 and was implemented until replaced with the Texas Assessment of Knowledge and Skills (TAKS) in 2003. Promotion in grades three, five, and eight were contingent on students meeting a minimum proficiency level on the TAKS. Additionally, students were required to meet a minimum standard in exit level mathematics, science, English, and social students to receive a high school diploma. The same year, schools were evaluated to determine if they were making “Adequate Yearly Progress (AYP),” as required by the NCLB Act (2001).

Beginning in spring 2012, the TAKS test was replaced with the State of Texas Assessment of Academic Readiness (STAAR) (TEA, 2010c). Grades and subjects tested at the elementary and middle school levels remained consistent; however, all standards and levels of difficulty were increased. The high school assessment system incorporated 12 end-of-course examinations at the high school level, increasing the rigor of student expectations. Students without a minimum cumulative score in each of the four core areas or individuals who fail to meet a minimum standard on English III or Algebra II do not graduate. A phase-out period from TAKS to STAAR began with 2012 spring testing. Ninth grade students during the 2011-2012 school year were the first STAAR testing cohort (TEA, 2010c). The new testing system assesses students at a rigorous level, requiring teachers to determine effective instructional practices to meet the needs of all learners.

In conjunction with state and federal student accountability, Texas applies a yearly Performance-Based Monitoring Analysis System (PBMAS) to evaluate program effectiveness of school districts (Texas Education Agency Department of Assessment, Accountability, and Data Quality, 2011). Performance is based on state assessment scores. Multiple areas are addressed, and each is labeled with a 0, 1, 2, or 3. Categories that receive a "0" have met the academically acceptable scores established by the state or have achieved the necessary yearly required improvement. Any area 10 points below the minimum score is assigned a 1. Categories that fall between 10.1 and 20 points below the standard are coded as a 2. Areas that score 20.1 or more points below the minimum standard receive a 3.

The PBMAS is guided by the following principles:

- Assist school districts with improvement efforts;
- Ensure compliance with legislative regulations;
- Provide data associated with student performance and identify areas of weakness;
- Ensure students are placed in the least restrictive environment;
- Address individual programs with low performance;
- Promote high standards for all students; and

- Audit school districts where areas of deficiency are noted (Texas Education Agency Department of Assessment, Accountability, and Data Quality, 2011).

The district of study was audited in 2011 and 2012 because of concerns in specific PBMAS areas. Multiple categories were coded in the range of 1 to 3, which triggered an audit. Specific areas of concern were those involving special education students and English language learners. Members of the PBMAS committee visited the district and provided a corrective plan of action for deficiencies. High stakes testing coupled with federal accountability require analysis of instructional practices to ensure all students are successful. Middle school is a critical period of the educational process. Students who are not effectively educated at the lower secondary level will not be prepared to meet increased expectations of high school curriculum (Crews, 2011; Ernst-Slavit & Slavit, 2007).

Statement of the Problem

The problem is 21% of seventh grade students and 24% of eighth grade students in the district of study failed to meet the minimum standard on the 2011 state mathematics assessment (TEA, 2011a), which was largely attributed to a lack of differentiation in the middle school mathematics classroom. Many teachers are failing to meet the diverse needs of students and are not providing a differentiated environment for learners (Tomlinson, 2000a, 2000b, 2005). Data from the Texas Assessment of Knowledge and Skills (TAKS) statewide assessment system represents a substantial difference in student performance in elementary grades compared to middle school grades (TEA, 2008a, 2009a, 2010a, 2011a). Special population results, with the exception of gifted learners, indicate a decline or lack of substantial improvement from grades five through eight (TEA, 2008a, 2009a, 2010a, 2011a). Table 1 depicts the progress of 2011 eighth grade students over a four-year period. Seventh grade students at the time of the study represented a 68% passing standard as sixth grade students, compared to an 84% passing rate as fifth grade students.

Table 1
District TAKS Progression

	ALL	SPED	ED	ELL	AR	GT
2010 – 2011 Grade 8	77%	62%	77%	55%	56%	98%
2009 – 2010 Grade 7	76%	33%	76%	54%	61%	100%
2008 – 2009 Grade 6	75%	58%	76%	57%	55%	100%
2007 – 2008 Grade 5	86%	77%	85%	75%	76%	100%

Note. All numbers are representative of student accountability for the year indicated. Students who entered or left the district subsequent to October 31 of the testing year are not included. Data was collected from the TEA Academic Excellence Indicator System (AEIS) published annually (TEA, 2008a, 2009a, 2010a, 2011a).

Purpose of the Study

The purpose of this quasi-experimental study was to determine if incorporating differentiated instructional practices in the middle school classroom has an effect on students' mathematics performance on standardized assessments. The research focused on answering the question, "What is the effect of differentiated instruction on standardized benchmark assessments scores, as measured by the Texas Essential Knowledge and Skills (TEKS), in the middle school mathematics classrooms for all student populations?"

Significance of the Study

Research supports improved academic performance of all student populations when differentiated instruction is implemented into existing curriculum (Fisher, Frey, & Williams, 2003; Lewis & Batts, 2005; McTigue & Brown, 2005; Nugent, 2006; Walker, 2002). Continuing studies support that successful integration of differentiated strategies is dependent on an educator's dedication, flexibility, and willingness to recognize unique talents and learning styles (Bailey & Williams-Black, 2008; Celedon-Pattichis, 2010; Cusumano & Mueller, 2007; Dee, 2011; King-Shaver, 2008; Logan, 2011). Although numerous qualitative studies validate differentiated instructional practices, research connecting the effects of differentiated instruction to student performance on standardized assessments is lacking (Dee, 2011; Ernest, Thompson, Heckaman, Hull, & Yates, 2011; McTigue & Brown, 2005; National Center on Accessing the General Curriculum (NCAC), 2002). This study will provide a basis for understanding the impact of differentiated instruction in the mathematics classroom. If results represent a positive relationship between differentiated instruction and standardized assessments, teachers will be encouraged to meet the needs of all students. In contrast, if no correlation exists, teachers will recognize that differentiated instruction does not negatively affect standardized assessments but represents quality instructional practices.

Research Questions

The following questions served as the guide for the research study:

1. What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS), when differentiated instruction is implemented for all student populations?
2. What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

Research Hypotheses

The focus of this study was to determine if student performance results represented significant differences when differentiated instructional practices were implemented in mathematics instruction compared to student results when differentiated instructional practices were not implemented. The null hypotheses for this study were as follows:

$H_0 1$: Implementing differentiated instructional strategies has no significant effect on the performance of students on standardized mathematics assessment as measured by benchmark examinations utilizing the Texas Essential Knowledge and Skills (TEKS).

$H_0 2$: Implementing differentiated instructional strategies has no significant effect on the performance of special education students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0 3$: Implementing differentiated instructional strategies has no significant effect on the performance of economically disadvantaged students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0 4$: Implementing differentiated instructional strategies has no significant effect on the performance of English language learners (ELL) on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0 5$: Implementing differentiated instructional strategies has no significant effect on the performance of at-risk students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

H_06: Implementing differentiated instructional strategies has no significant effect on the performance of students identified as gifted on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Identification of Variables

The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on standardized benchmark assessments. Student Texas Assessment of Knowledge and Skills (TAKS) scores for the 2010-2011 school year were used as a covariant to adjust for pre-existing differences. For the purposes of this study, differentiated instruction (DI) was defined as classroom practices that incorporate a variety of instructional tools and strategies to meet the diverse needs of all students, based on readiness levels, abilities, and interests (Tomlinson, 2000a, 2000b).

Overview of Methodology

Two independent five-week trials were conducted for this study. Based on student enrollment and the number of mathematics teachers employed during the research period, schools were divided into a control or treatment group. Campus A, employing one seventh grade mathematics teacher, and Campus B, employing three seventh grade mathematics teachers and one special education teacher, served as the control group for the first five weeks of the research period. One teacher from Campus A chose not to participate in the study, limiting the number of special education students involved in the research. Lecture-based instruction was delivered to 406 seventh grade mathematics students. Campus C, with three general education teachers and one special education teacher, served as the treatment group for the first five weeks of the research period.

Differentiated instruction was provided to 485 seventh grade mathematics students. For the second five-week period, Campuses A and B delivered differentiated instruction to 406 seventh grade students, and Campus C delivered lecture-based instruction to 485 seventh grade students (see Figure 1).

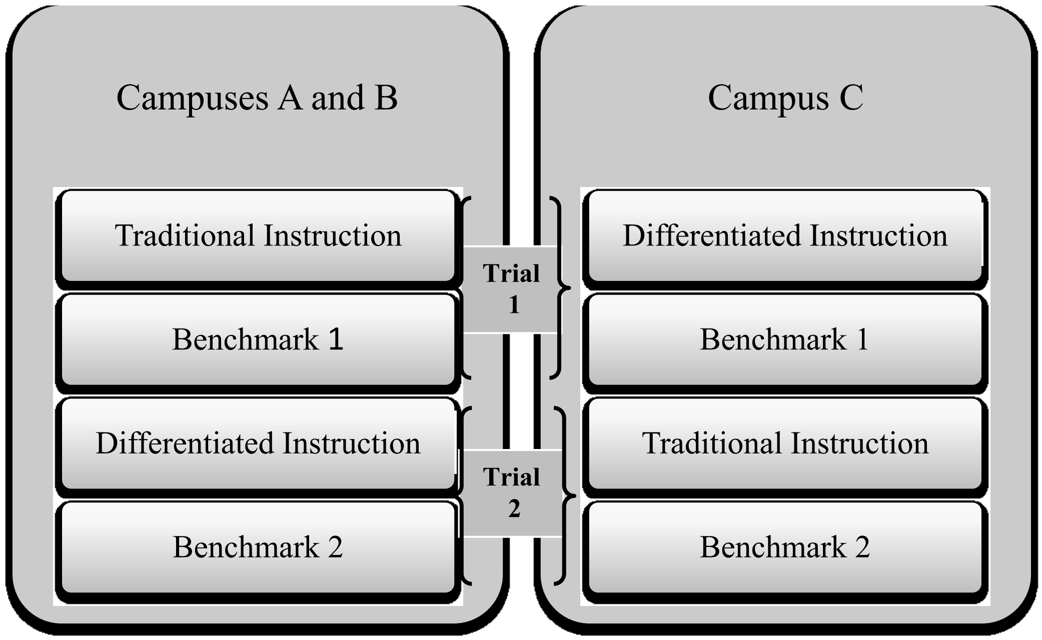


Figure 1. Summary of experimental design.

Research Plan

The rationale for this study was to support or reject the effectiveness of differentiation of instruction in relation to standardized mathematics testing. A quantitative approach was applicable because the objective was to determine if a significant relationship existed between teachers' use of differentiated instruction and standardized assessment results. A quasi-experimental study design was used because classes were established prior to the research study (Ary, Jacobs, Razavieh, & Sorensen, 2006). District wide, all seventh grade students and nine seventh grade teachers were involved with the study. Schools were divided into a control and treatment group, based on similar demographics. The control group and treatment groups were created using stratified random sampling; half of the students received lecture-based instruction and the other half received differentiated instruction.

All lessons were created by the researcher, following CSCOPE (Texas Education Service Center Curriculum Collaborative (TESCCC), n.d.), the district-established scope and sequence. CSCOPE (TESCCC, n.d.) is a comprehensive curriculum complete with vertical alignment documents, instructional focus documents, and lesson plans for teachers. Instructional sequences for each Texas Essential Knowledge and Skill (TEK) was clearly delineated in the curriculum alignment document for all teachers to follow. Furthermore, the level of depth and specificity of each TEK was established in the curriculum outline. Lesson plans were created for each TEK and were provided for teachers participating in the study. Each lesson included student objectives, vocabulary, example problems for each TEK, worksheets, and assessments. Teachers received accompanying flipcharts, presentations, activities, games, and hands-on activities when applicable to the lesson. Each instructional strategy was research-based and targeted multiple learning styles (Anderson, 2007; Carolan & Guinn, 2007; Kingore, 2007; Rock, Ellis, & Gable, 2008; Tomlinson, 2005). Teachers provided equivalent instruction for each student objective, unit vocabulary, and content; however, the delivery method was modified for the treatment group.

Differentiated lessons were modified by content, process, or product (Tomlinson, 2000a, 2000b, 2005). Content refers to adaptations to curriculum. Differentiated content included concrete representations, graphic organizers, illustration aids, representative models, visual presentations, and vocabulary terminology. Process describes the method of lesson presentation. Teachers differentiated the process of instruction by incorporating the following:

- collaborative projects,
- concept maps,
- educational games,

- flexible groups,
- hands-on learning,
- mathematical manipulatives,
- scaffolded instruction,
- paper folding,
- student journals,
- technology simulations, and
- vocabulary activities.

Product options represent student-produced work or assessments substantiating student learning. Lesson plans integrated the following: individual projects, instructional journals, open-ended tasks, tiered assignments, visual presentations, and written assessments (Bailey & Williams-Black, 2008; Fisher et al., 2003; King-Shaver, 2008; Kingore, 2007; Lavandez & Armas, 2008; Lewis & Batts, 2005; Lightfoot, 2012; Logan, 2011; Schweizer & Kossow, 2007; Tomlinson, 2000b; 2005; Walker, 2002). Lessons for each research period were created using the activities in Table 2 to ensure all learning styles were targeted. Each activity was research-based, and multiple intelligences strategies were incorporated to target a diverse student population (Bailey & Williams-Black, 2008; Campbell, 2008; Dee, 2011; Hyerle, Alper, & Curtis, 2004; King-Shaver, 2008; Kingore, 2007; Lavandez & Armas, 2008; Martin, 1996; Moss, Mayfield, Shellman, & Eury, 2011; Schweizer & Kossow, 2007; Tate, 2003; Tomlinson, 2000b; 2005; Walker, 2002).

Table 2

Resources for Creating Differentiated Instruction Lesson Plans

Activity	Lesson Component(s)	Multiple Intelligence(s)
Educational manipulatives (ETA Cuisenaire 2007; TESCCC, 2011)	Content Process	Bodily/Kinesthetic Logical/Mathematical Visual/Spatial
Hands-on activities (Activities Integrating Math and Science (AIMS) Foundation, 2009; ETA Cuisenaire 2007; TESCCC, 2011)	Content Process	Bodily/Kinesthetic Logical/Mathematical Visual/Spatial
Instructional games (Muschla & Muschla, 2004; Marzano & Pickering, 2005)	Content Process	Bodily/Kinesthetic Interpersonal Logical/Mathematical Verbal/Linguistic Visual/Spatial
Interactive White Board (IWB) flipcharts (Promethean, 2011)	Content Process	Bodily/Kinesthetic Interpersonal Intrapersonal Logical/Mathematical Verbal/Linguistic Visual/Spatial
Mathematical Mysteries (Tate, 2003; Yoder & Yoder, 2010)	Content Process	Intrapersonal Verbal/Linguistic
Mathematical Songs (Houghton Mifflin Harcourt, n.d.; Songs for Teaching, n.d.)	Content Process	Musical
Thinking maps (Hyerle, et al., 2004)	Content Process	Bodily/Kinesthetic Interpersonal Intrapersonal Logical/Mathematical Musical Natural Verbal/Linguistic Visual/Spatial
Video clips (Beyond Entertainment, 2010; Discovery Studios, 2005, 2006a, 2006b)	Content Process	Intrapersonal Musical Natural Verbal/Linguistic Visual/Spatial
Individual reflection (TESCCC, 2011; Tate, 2003)	Content Process Product	Intrapersonal Verbal/Linguistic

Table 2 Continued

Activity	Lesson Component(s)	Multiple Intelligence(s)
Real-world applications (TESCCC, 2011)	Content Process Product	Intrapersonal Logical/Mathematical Musical Natural Verbal/Linguistic
Vocabulary foldable activities (Zike, 1998)	Content Process Product	Bodily/Kinesthetic Interpersonal Intrapersonal Logical/Mathematical Musical Natural Verbal/Linguistic Visual/Spatial
Outside activities (ETA Cuisenaire, 2007)	Process	Bodily/Kinesthetic Natural
Collaborative activities (Kagan & Kagan, 2009; TESCCC, 2011)	Process	Bodily/Kinesthetic Interpersonal Logical/Mathematical Verbal/Linguistic
Scaffolded instruction (Teacher Created Materials (TCM), 2005; TESCCC, 2011; Tilton, 2009)	Process	Bodily/Kinesthetic Interpersonal Intrapersonal Logical/Mathematical Musical Natural Verbal/Linguistic Visual/Spatial
Assessment product options (Tilton, 2009)	Product	Bodily/Kinesthetic Interpersonal Intrapersonal Logical/Mathematical Musical Natural Verbal/Linguistic Visual/Spatial
Puzzle options (Muschla & Muschla, 2004; Tilton, 2009)	Product	Logical/Mathematical Verbal/Linguistic

Note: The resources listed were integrated into each research period. A combination of resources was used to create each lesson to ensure optimum compliance with the operational definition of differentiated instruction.

The researcher provided all lessons for the control and treatment groups using a uniform lesson plan (see Appendix A). Lesson plan formatting was constant for both groups with one exception. The treatment group received lesson plans that included each differentiated component as presented in Table 2. Differentiated lessons incorporated at least one daily strategy targeting students' preferred intelligence (Gardner, 2003). Each of the eight intelligences was targeted at least once on a biweekly basis. Lesson plans spanned multiple days of instruction because TEKS were not taught in isolation. Academic content was clustered allowing for connections among mathematical concepts.

Rubrics for differentiated instruction and lecture-based instruction were used to evaluate each lesson plan, ensuring strategies were applied consistently (see Appendices B and C). Each of the following components was identical on the differentiated instruction and lecture-based instruction rubrics:

- Texas Essential Knowledge and Skills (TEKS),
- Content Objective,
- Language Objective,
- Vocabulary,
- Materials,
- Advance Preparation,
- Engage, and
- Accommodations.

Explore/explain and evaluate categories were included on both scoring guides. Non-differentiated instruction targeted teacher-centered strategies and assessment options were not provided. The differentiated lesson plan rubric focused on student-centered strategies and varied performance indicators. The differentiated instruction rubric included each of the following components: extension activities, student learning styles, and content, process, and product differentiation. Students in the treatment group engaged in curriculum using varied instructional strategies. The control group received the same content as the treatment group with the exclusion of academic choices.

As shown in Table 2, many differentiated approaches overlapped between categories. Strategies were not exclusive to one category; the focus of differentiation is to provide multiple modalities of learning in each aspect of instruction (Bailey & Williams-Black, 2008; Fisher et al., 2003; King-Shaver, 2008; Kingore, 2007; Lavandez & Armas, 2008; Lewis & Batts, 2005; Schweizer & Kossow, 2007; Tomlinson, 2000b; 2005; & Walker, 2002). Multiple approaches to learning are common among the intelligences. Therefore, one differentiation strategy impacted several learning styles (Gardner, 2003).

All students were exposed to the control and treatment groups, in independent research trials; however, not all student results were used. Stratified random sampling was used to determine student scores for the statistical analysis of results. Interpretation of the data determined if significant differences were present between the control and treatment groups for each test. Data analysis focused on each of the following: all students (ALL), special education (SPED), economically disadvantaged (ED), English language learners (ELL), at-risk (AR), and gifted and talented (GT). Students may have been included in multiple categories based on their student demographic information. Students were listed by a numerical identifier, and every tenth student was randomly selected for the study. The process continued until the optimal number of participants, pre-determined by a power statistical analysis, was reached.

The study was conducted during the second two six-week periods of the 2011-2012 school year. However, each six-week period was shortened to five weeks because of semester scheduling. Thus, research was conducted during two five-week periods, followed by data analysis using a paired *t*-test and analysis of covariance (ANCOVA). Students were exposed to 22 days of instruction, followed by two days for review and one day for assessment. Two independent research trials were conducted to minimize extraneous variables and threats to internal validity. Students and teachers who were assigned to the control group for the first five-week period served as the treatment group for the second five-week period. Students and teachers who were assigned to the treatment group for the first five-week period became the control group for the second five-week period. Stratified random sampling was used to determine student scores used for statistical analysis. Only students with a benchmark assessment score for both five-week research periods were included in the population. Additionally, students who did not have a covariant Texas Assessment of Knowledge and Skills (TAKS) score were excluded from the sample population as well as those retained in the seventh grade.

Assumptions and Limitations

Assumptions. Each teacher received training on the process of differentiating the curriculum to avoid misconceptions. Participants were provided with complete lesson plans with activities and handouts to maintain integrity of the instruction. Observation teams received training to emphasize the importance of eliminating bias from the study while meeting expectations. Teachers were trained on the self-assessment instrument and were provided a clear understanding of the procedures to follow and the confidentiality of the instrument.

Limitations. The primary limitation of the research is that the results may not be applicable to all grade levels or to all regions of the country. Although all district seventh grade classrooms were involved in the study, student demographics, socioeconomic status, and language barriers are contributing factors to the outcome of the research. To minimize the aforesaid limitation, schools were assigned to either a control or treatment group, and students were randomly selected using stratified sampling. To minimize statistical errors, research was conducted in two independent five-week research trials.

Definition of Key Terms

Adequate yearly progress (AYP): A minimum accountability performance indicator established by NCLB that requires campuses, districts, and states to meet annual improvement criteria for reading/language arts, mathematics, and either attendance rate or graduation rate (TEA, 2012).

At-risk: A term used to describe students who have one or more economic, physical, emotional, or academic factors that place them in danger of dropping out of school (Texas Association for the Gifted and Talented (TAGT), n.d.).

Differentiated instruction: Instruction or curriculum that has been modified by content, process, or product to meet diverse student needs in the classroom (Tomlinson & Eidson, 2003).

English Language learner (ELL): A student who is in the process of learning English and has a first language other than English (The Education Alliance, n.d.).

Gifted learner: The federal Elementary and Secondary Education Act [Title IX, Part A, Definition 22] defines gifted and talented students as "students, children, or youth who give evidence of high achievement capability in areas such as intellectual, creative, artistic, or leadership capacity, or in specific academic fields, and who need services and activities not ordinarily provided by the school in order to fully develop those capabilities" (TAGT, n.d.).

High-stakes testing: "The practice of attaching important consequences to standardized test scores" (Nichols & Berliner, 2008, p. 672), such as failure to advance to a subsequent grade level or failure to meet high school graduation requirements.

Interactive white board: "A large interactive display that connects to a computer and projector . . . [projecting] the computer's desktop onto the board's surface, where users control the computer using a passive pen or finger" (E Learn, 2009, para. 1).

*Manipulatives: "*Materials that are physically handled by students in order to help them see actual examples of mathematical principles at work" (Jones, n.d., para. 1).

No Child Left Behind (NCLB) Act: A 2001 federal law that requires that 100% of all students meet state standards in reading and mathematics by 2014; it requires schools to meet a minimum yearly state passing standard to avoid sanctions (Lewis, n.d.).

Opportunity-to-learn: A national report targeting the needs of individual states to close the educational gaps for disadvantaged student groups (Schott Foundation for Public Education, 2009).

Special education student: A student who has been evaluated in accordance with §300.304 through §300.311 and has been determined to have one or more of the following: "mental retardation, a hearing impairment (including deafness), a speech or language impairment, a visual impairment (including blindness), a serious emotional disturbance (referred to in this part as "emotional disturbance"), an orthopedic impairment, autism, traumatic brain injury, any other health impairment, a specific learning disability, deaf-blindness, or multiple disabilities, and who, by reason thereof, needs special education and related services" (National Dissemination Center for Children with Disabilities (NICHCY), 2008).

Standardized testing: Assessments that have "set rules for administration such that everyone taking the test receives the same exact directions and has the same restrictions of time and resources" (Marchant, 2004, p. 2).

Thinking maps: Visual aids that "combine the flexibility of brainstorm webs and the structure of task-specific graphic organizers with a clearly defined, common thinking process language" (Hyerle et al., 2004, p. 1).

Tiered instruction: "Adjusting the degree of difficulty of a question, task, or product to match a student's current readiness level" (Tomlinson & Eidson, 2003, p. 239).

Summary

The No Child Left Behind Act (2001) created federal guidelines to ensure academic equity and success of all students in the classroom. Teachers must target individual learning styles to ensure all students reach their maximum potential (Tomlinson, 2005). Differentiated instruction allows educators to evaluate student interests, learning styles, and readiness levels; and modify instructional strategies to meet the needs of all students. Determining effective means of educating students while improving standardized assessment performance serves as the research rationale. This study analyzes student results from benchmark assessments to determine the effect of differentiated instructional practices on student performance. Chapter 2 presents a comprehensive review of the literature including research-based instructional strategies for special populations of students. The methodology of this study is discussed in Chapter 3 followed by a presentation of statistical results in Chapter 4. This dissertation concludes with Chapter 5, which provides suggestions and implications for future research.

CHAPTER 2: LITERATURE REVIEW

Chapter two presents a comprehensive review of current research beginning with the theoretical foundation of differentiated instruction, focusing on the theory of multiple intelligences (Gardner, 1983, 1993). Next, each component of differentiated instruction is reviewed to provide a detailed summary of strategies associated with this type of classroom instruction. Following the synopsis of differentiated instruction, research-based teaching strategies are reviewed in terms of the literature. The effects of high-stakes testing on students, teachers, and administrators are also reviewed. Finally, prior research studies are examined to provide background information for this study.

Introduction

Mathematical applications are crucial in today's highly competitive world. According to the National Council of Teachers of Mathematics (NCTM, 2000), "Excellence in mathematics education requires high expectations and strong support for all students" (p. 11). States determine content requirements for schools; however, instructional delivery of the subject matter is left up to the teachers' discretion. Educators must ensure curriculum building blocks have been laid before moving on to a more complex level of learning (Levy, 2008). Student interests and ability levels differ; therefore, activities must be varied and targeted to ensure individual understanding of the curriculum (Levy, 2008; Tieso, 2003).

All students have the right to be challenged to reach their full potential. However, with political mandates and federal accountability required by NCLB (2001), ensuring minimum passing standards have become the norm in many classrooms. Learning disabled students, English language learners, and gifted students often receive an education geared toward the average student. Diversity is present in all classrooms, requiring adaptations and modifications to curriculum. Therefore, educators must incorporate strategies for language acquisition, modify instruction for lower-performing students, and find ways to challenge gifted and high-achieving students, even in this era of state-mandated assessments (Lee & Jung, 2004; Powers, 2008; Scot, Callahan, & Urquhart, 2009; Walker, 2002).

Theoretical Framework

Numerous psychological studies provide evidence of varied, unique learning styles, substantiating the need for differentiated instruction. Effective teachers recognize that because students exhibit diverse learning styles, one must provide multiple opportunities for academic achievement. Successful educators realize learning styles vary and that all students must make personal, meaningful connections to the content to maximize learning opportunities.

- Visual learners need images, diagrams, and illustrations for comprehension of subject matter.
- Auditory learners require discussion, verbal instruction, and listening to achieve success.
- Tactile/kinesthetic learners prefer hands-on activities for curriculum acquisition (Hill, 2005; Rayneri, Gerber, & Wiley, 2003; Snyder, 1999).

Thus, meaningful content targeting multiple learning styles is necessary for academic engagement and achievement.

One of the most notable theories of variations in individual learning styles is Howard Gardner's 1983 development of the theory of multiple intelligences (MI), establishing that "an intelligence is a computational capacity" (Gardner, 1983, p. 23). The original theory of MI established that individuals exhibit intellectual ability in seven different ways: visually, verbally or linguistically, logically or mathematically, bodily or kinesthetically, musically, interpersonally, or through self-reflection (Gardner, 2003). Continuing research has established a naturalist and possibly an existentialist approach to learning. Gardner's theory defied the typical meaning of "intelligence," challenging that the term should be viewed through a biological and psychological lens (Gardner, 1983).

The theory of MI (Gardner, 1983) proposed the idea that individuals are intellectually stimulated by varied activities and social events, specific for each intelligence. Verbal or linguistic learners exhibit sensitivity to words and language, often challenged through reflecting, writing, and speaking. Individuals with preferred musical intelligence benefit from tonal stimulation, rhythm, and patterns. Logical-mathematical refers to persons who experience a sense of excitement when they solve logical or mathematical problems. The ability to manipulate objects through visual stimulation and learn through imagery is typical of the spatial intelligence. Individuals who represent the bodily-kinesthetic intelligence typically have fine motor skills and excel in physical activities or when working with precision. Engaging in social situations and thriving in an interactive environment is typical of the interpersonal intelligence. In contrast, intrapersonal intelligence refers to self-reflection as a primary component of the learning process (Gardner, 1983).

Although the original intent of the research was not educational-based, the implications for educators were inevitable. Gardner (1993) stated that MI theory leads to the following conclusions:

- All of us have the full range of intelligences; that is what makes us human beings, cognitively speaking.
- No two individuals – not even identical twins – have exactly the same intellectual profile because, even when the genetic material is identical, individuals have different experiences.
- Having a strong intelligence does not mean that one necessarily acts intelligently. (p. 23)

Three themes of education emerged from the theory of MI. First, education requires instruction to be individually centered, focusing on unique student differences. Second, no theory is the basis of a quality educational program. Educators must establish educational goals and decide how to achieve desired outcomes. Practice, not theory, drives a successful school program. Third, students require multiple representations of key concepts because of varied learning styles (Gardner, 1993). Recognizing varied learning styles is essential to challenge all groups of students to meet their full academic potential.

Multiple intelligences theory has significantly challenged "fundamental educational principles and practices" (Helding, 2009, p. 193). Although criticisms have been voiced toward the conceptual foundation of the theory, one must acknowledge its impact even with those criticisms. Educators recognize that student learning styles and diverse needs vary in every classroom. Effective teachers ensure the assessment of individual learning styles prior to classroom restructuring and "differentiate instruction through the use of Gardner's MI. Each intelligence is broadly defined and allows flexibility when making adjustments to existing curriculum" (McCoog, 2007, p. 25).

A primary benefit of implementing strategies targeting multiple intelligences is that student behavior will likely improve, interest levels in mathematics will increase, and learners will be engaged in learning (Hill, 2005; McTighe & Brown, 2005; Temur, 2007). The use of multiple intelligences strategies in the classroom accommodates multiple learning styles and alleviates students' short attention spans (Furner, Yahya, & Duffy, 2005). Accommodations allow all students to reach their full potential while working at their own pace and level.

The focus of this research study is to determine if student performance improves, as measured by standardized assessments, when teachers incorporate differentiated instruction into everyday classroom practices and focus on individual student strengths. Analysis of the literature provides a clear explanation of differentiated instruction while presenting strategies for successful classroom interventions. Research substantiates the need for modified classroom instruction and supports that student success is dependent on the teacher's willingness to implement differentiated instruction and appropriate adaptation of course materials in the regular classroom setting (Tomlinson, 2000a, 2000b, 2005). The need for modified classroom practices is emphasized throughout the literature, stressing the value of meeting diverse student needs. Research supports that creating a balance between effectively educating students and implementing curriculum-based standards is essential for individual achievement (Anderson, 2007; Carolan & Guinn, 2007; Ernest et al., 2011; Lavadenz & Armas, 2008).

Differentiated instruction empowers teachers to draw on individual learning styles to prepare engaging, multi-faceted lessons. According to the National Center on Accessing the General Curriculum (NCAC, 2002), "Classroom teaching is a blend of whole-class, group, and individual instruction. Differentiated instruction is a teaching theory based on the premise that instructional approaches should vary and be adapted in relation to individual and diverse students in classrooms" (p. 2). Differentiation "is not an instructional strategy. It is not what a teacher does when he or she has time. It is a way of thinking about teaching and learning" (Tomlinson, 2000a, p. 6).

Differentiated Instruction

Numerous scholarly resources validate the importance of differentiated instruction to challenge all learners to reach their individual potential (Anderson, 2007; Broderick, Mehta-Parekh, & Reid, 2005; Carolan & Guinn, 2007; Douglas, Burton, & Reese-Durham, 2008; King-Shaver, 2008; Lewis & Batts, 2005; Sherman, 2009; Tomlinson, 2000a, 2000b, 2005; Witzel & Riccomini, 2007; Wormeli, 2011). However, before an analysis of existing research and its implications for educational practices can be discussed, one must have a clear understanding of what differentiation is and some of the myths associated with the term. Differentiation is defined as "designing lesson plans to meet the needs of a range of learners; includes learning objectives, grouping practices, teaching methods, varied assignments, and varied materials chosen based on student skill levels, interest levels, and learning preferences" (Southeast Regional Educational Laboratory, 2008, p. 2). Many of the tools teachers use daily to engage students in the classroom, such as cooperative learning and interactive activities can be altered to reach all learning styles (King-Shaver, 2008).

Effective differentiation focuses on three distinct areas, which can be used individually or simultaneously to vary instruction. Educators have the following options: (1) differentiating the content, (2) modifying the process or activities, and (3) offering product options (Tomlinson, 2000b). Tasks should be aligned with objectives and learning goals; however, content can be modified to meet the needs of all students. Concept-focused and principle-driven instruction allows students to make personal connections to the curriculum and think critically (NCAC, 2002; Tomlinson, 2005). Flexible grouping, cooperative learning in pairs or groups, and tiered instruction are fundamental elements of differentiated instruction (Bailey & Williams-Black, 2008; Douglas et al., 2008). Traditional ability grouping is based on individual capability. However, flexible grouping allows students to change clusters, as needed, based on concepts being presented.

Content differentiation. Common classroom practices such as cooperative learning and interactive activities can be altered to reach all learning styles. Assessments and data are used to determine student placements based on instructional readiness, skills, backgrounds, choices, or interests (Kingore, 2007; Logan, 2011). Teachers may allow students to choose a group or assign peer tutoring pairs or random teams. "Tiered instruction blends assessment and instruction . . . [and] aligns complexity to the readiness levels of students" (Kingore, 2007, p. 6). Teachers may begin content delivery with whole class instruction, continue by having pairs share with the class, and proceed to group work. Individual conferencing, literature circles, writing options, and book choices are methods of modifying curriculum to meet individual learner needs (King-Shaver, 2008). Content should be presented using multiple approaches such as vocabulary activities, manipulatives, visual aids, diagrams, varied reading levels of materials, concept maps, graphic organizers, hands-on activities, brainstorming, games, online projects, and experiments (Kingore, 2007; Lawrence-Brown, 2004; Logan, 2011; Muschla & Muschla, 2004; Tomlinson, 2000b, 2005). Additional variations are "acceleration, compacting, variety, reorganization, flexible pacing, advanced or complex concepts, abstractions, materials, and interdisciplinary or thematic approaches" (Bailey & Williams-Black, 2008, p. 136).

Academic vocabulary represents an area of difficulty for the majority of students. Multiple strategies for teaching vocabulary are present throughout the literature. Realia, demonstrations, graphic organizers, and hands-on learning provide the foundational background needed to connect vocabulary to mathematical content (Furner et al., 2005; Hansen-Thomas, 2008). Visual drawings and symbols make concepts more comprehensible for struggling learners. Crossword puzzles and vocabulary games engage learners in vocabulary development (Slavit & Ernst-Slavit, 2007). Students need the opportunity to relate their learning to everyday situations and real world applications through discovery and process learning (Hansen-Thomas, 2008).

The majority of mathematical instruction occurs at the abstract level in secondary classrooms. Recognizing the value of progression from concrete to abstract understanding is critical for student learning. A beneficial strategy for assisting students in this development is through the use of mathematical manipulatives, defined as "concrete objects that can be viewed and physically handled by students in order to demonstrate or model abstract mathematical concepts" (ETA Cuisenaire, n.d., para. 1). Technology advancements allow for the use of virtual manipulatives in the classroom, thus providing a visual representation of abstract mathematical concepts (Goldsby, 2009). Research supports the use of virtual and concrete manipulatives in the mathematics classroom to increase student understanding of difficult concepts, especially with diverse learners (Belenky & Nokes, 2009; Curtain-Phillips, n.d.; ETA Cuisenaire, n.d.; Goldsby, 2009). Furthermore, the use of hands-on manipulatives allows students to become actively engaged in their learning.

Examples of manipulatives include geoboards, pattern blocks, algebra tiles, centimeter cubes, colored chips, and so on (ETA Cuisenaire, n.d.). Many teachers view manipulatives as purchased items, which may be unobtainable because of recent budget cuts. However, inexpensive objects may be integrated into classroom instruction to engage students. Rulers, playing cards, toothpicks, beads, paper, and other classroom supplies can be used to allow exploration options (Curtain-Phillips, n.d.). Corporations, technological entities, and local companies will often provide donated resources or classroom grants to offset limited financial resources. Many free templates are available via the Internet, which can be used with minimal expense. Regardless of the types of manipulatives used in the classroom, students will develop mathematical relationships between concrete objects and abstract concepts (Maccini & Gagnon, 2000; Raymond & Leinenbach, 2000).

Multiple studies have been conducted to determine the effect of manipulatives on student performance. Literature supports the use of manipulatives in the classroom as a learning tool to engage students (Belenky & Nokes, 2009; Cass, Cates, Smith, & Jackson, 2003; Crawford & Brown, 2003; Lach, 2005; Maccini & Hughes, 2000; Moyer, 2001; Moyer & Jones, 2004; Stein & Bovalino, 2001). An important factor to consider is that the use of manipulatives without teacher facilitation or monitoring will prove ineffective for student learning. Quality classroom instruction requires teachers to bridge concrete modeling to abstract concepts through facilitation and mentoring. Frustration is commonplace in the mathematics classroom when students are not involved in the learning process and do not comprehend complex applications. Recognizing that the use of hands-on activities is beneficial for students at the secondary level will have a long-term positive effect (Cass et al., 2003; Goldsby, 2009). Extensive research has been conducted in elementary grades, but studies are not as prevalent at the secondary level (Goldsby, 2009). However, experts agree that engaging students, increasing interest and enjoyment in the classroom setting, and allowing students to shift from concrete to abstract representations is conducive to the learning process at any grade level (Curtain-Phillips, n.d.; ETA Cuisenaire, n.d.; Furner et al., 2005; Hansen-Thomas, 2008).

Integrating the use of manipulatives is often overwhelming for teachers who have never used hands-on activities as part of their curriculum. They may fear student opposition, believe they lack effective planning time, or have doubts about their ability for effective integration. Each is a legitimate concern; older students may be resistant in the beginning but are likely to realize the value of hands-on instruction when they begin to grasp difficult concepts (Lack, 2005; Maccini & Gagnon, 2000). Motivation is crucial for student success; mathematics is often viewed by students as a boring subject with traditional lecture from a teacher. When teachers dominate classroom instruction without involving students in the learning, they may reduce students' problem-solving abilities (Jensen, 2000). Research suggests the power of incorporating hands-on learning and activities to motivate students (Furner et al., 2005; Hansen-Thomas, 2008).

Gaming is one means of creating an atmosphere of fun and active student learning in the classroom. Focus of instruction is student achievement; therefore, students who are allowed to have fun and become engaged in the learning become successful (Moyer & Jones, 2004; Muschla & Muschla, 2004; Schweder & Wissick, 2008). Educators must use caution when choosing digital games to ensure mathematical concepts are presented in the appropriate context and students are provided with explanations for incorrect answers. Scanlon, Buckingham, and Burn (2005) referred to many educational games available on the web as "quite problematic" (p. 130). Research supports the use of games in the classroom; however, teachers must examine carefully each medium or create their own games to ensure appropriate learning is taking place.

Adaramola and Alamina (2008) conducted a quantitative study focusing on the effect of mathematical card games on mathematical performance of Nigerian students in secondary schools. Results indicated increased performance of students exposed to games compared to students who were not. The authors concluded that gaming was a valid teaching and learning strategy. A 2009 qualitative study evaluated the effects of gaming and the attitudes associated with the instruction approach (Clark & Ernest, 2009). Results indicated that students became active learners and the classroom environment was engaging. Potential enhancements through gaming were provided for visual-spatial learners, and students identified as at-risk of dropping out of school were motivated. The study included 258 participants from 20 states and four countries, indicating the probable differences in demographics and socioeconomic status. Results demonstrated that 93% of students, parents, teachers, and administrators supported the use of gaming in education as a "pedagogical tool" (Clark & Ernest, 2009, p. 25).

Digital learning provides opportunities for student engagement in the classroom through a variety of media sources (Hirsh, 2011; Quiones, 2010). Three-dimensional figures and modeling inspire critical thinking through visual concept illustrations. Students will connect to mathematical concepts through the use of video clips and musical representations. As with other types of instructional strategies, videos and digital media are not meant to replace the classroom teacher. Class discussions and continual summarization are required for successful integration (Quiones, 2010).

Students who find mathematics enjoyable are likely to develop a continuing interest in mathematics, which leads to increased mathematical aptitude (Gasser, 2011; Stein & Bovalino, 2001). Having fun while learning content in a mathematics classroom motivates learners and challenges students. Activities that are enjoyable engage the right side of the brain, helping students create content understanding (Jensen, 2000). Teachers can incorporate classroom games with the aid of manipulatives or technological resources. Moreover, students may create their own games to play with other classmates, leading to a highly developed conceptual understanding of mathematics (Crews, 2011; Furner et al., 2005; Gasser, 2011; Slavit & Ernst-Slavit, 2007).

Instructional delivery. Traditional lessons normally include teaching all students the same topics in an identical format with equivalent independent practice and assessment. Rock et al. (2008) developed *REACH*, an acronym that helps teachers implement differentiation, and it represents the following:

> A general plan of action composed on proven, effective, research-based methods to improve outcomes for all students by promoting cognitive access, participation, and progress in the general curriculum.

R – reflect on will and skill

E – evaluate the curriculum

A – analyze the learners

C – craft research-based lessons

H – hone in on the data (p. 33)

Understanding individual needs of all students is imperative for a challenging educational environment. Gifted characteristics, special education needs, and language barriers must be defined and assessed to determine areas where students need assistance (Ernst-Slavit, 2007; Giambo, 2010; Lay & Stokes-Brown, 2009; Moon, 2009).

Differentiated instruction is recognized as a method for reaching all student learning styles in the classroom, but effective teaching is not a new concept. Many veteran teachers were focused on helping all students succeed before the term differentiation was coined. Today's educators must continue to provide a quality education for all students while focusing on the skills necessary for the 21st century (Luterbach & Brown, 2011). The literature suggests several ideas to assist students as they move into future roles as leaders. Problem-based instruction has emerged as a theme to ensure students are prepared for the future. Incorporating problems that peak student interest allow for meaningful and personal connections. Students must learn to analyze situations, incorporating multiple steps to reach an appropriate solution (Gasser, 2011; Perritt, 2010).

Teachers who want to encourage critical thinking skills may incorporate problem-based learning. However, one must recognize that this strategy may be difficult for some individuals. Challenging students to alter their thinking process requires flexibility and acknowledgement that students are conditioning themselves to become problem solvers. According to Gasser (2011), "Allowing students to think through problems and invent their own possible solutions requires more patience than many math teachers have" (p. 111). Problem-based learning provides a subjective interpretation to evaluate student learning, which connects learning through meaningful exploration (Perritt, 2010). Teachers must embrace the concept of risk-taking, allowing students to learn from their mistakes. An environment of mutual respect, where students are encouraged to focus on correct processes versus what is incorrect, can be established when teachers set a positive tone for the classroom. A positive environment offers opportunity for collaboration and teamwork, preparing students for successful integration to a work environment (Furner et al., 2005; Sherman 2009; Wormeli, 2011).

Technological advancements afford educators access to an abundance of resources, providing differentiated opportunities for English language learners, "at-risk" students, gifted learners, and those with special needs. Schweizer and Kossow (2007) warn: "a classroom without technology can be a painful exercise of recitation—go to the encyclopedia, write down the relevant facts, and organize the facts into a paper—or memorization—listen, take notes, and retrieve the information for an end of the unit test" (p. 29). Technological integration can transform a traditional classroom into an engaging learning environment.

The majority of classrooms today are equipped with an interactive white board (IWB) to facilitate student learning. Recent studies have identified mixed results when investigating the effect of the IWB on student achievement. Some studies refer to the IWB as a replacement for the overhead projector, allowing for continued teacher-centered instruction (Kuehn, 2010). Other critics do not view the tool as a medium for development of long-term critical thinking skills (British Educational Communications and Technology Agency (BECTA), 2008). Several studies support the use of the IWB for student achievement of all student groups (Hofer & Swan, 2008; Many-Ikan et al., 2011; Moore, 2008; Oleksiw, 2007; Starkman, 2006; Swan, 2007). Consistency throughout the literature emphasizes a need for teacher training and support for effective integration of the IWB into classroom instruction (BECTA, 2008; Moss et al., 2011; Schweder & Wissick, 2008; Zittle, 2004). Educators must have a positive attitude toward using a new medium for instruction or the IWB simply becomes another task that must be completed.

Technology-driven instruction can become more meaningful for students because of the unlimited resources available. Mathematics studies have confirmed that students gain a clearer understanding of difficult concepts when teachers use the IWB for visual illustrations, multimedia integration, and representations that are impossible without the aid of technology (Manny-Ikan et al., 2011; Schweder & Wissick, 2008; Swan, 2007; Zittle, 2004). When used correctly, the IWB encourages cooperative learning and allows teachers to collect real-time data to assess student learning (Manny-Ikan et al., 2011). However, without a focus on pedagogy in addition to technology, the IWB will become another tool for teacher lecture (BECTA, 2008; Kuehn, 2010; Lightfoot, 2012). One teacher summarized the value of the IWB as follows: “It isn’t about the boards; it’s about the learning that is happening. The boards are a conduit to the curriculum” (as cited in Starkman, 2006, p. 36).

Technology accommodations can enhance learning through videos, multimedia, and interactive solutions. However, educators must recognize that student-teacher interaction is still a critical instructional component. Additionally, if new technology advancements are used as a direct teaching tool, they are not being used to involve students in active learning (Hofer & Swan, 2008; Swan, 2007). Researchers continue to investigate the effect of the IWB on student achievement in multiple subject areas. One must remember that student engagement is a critical component of student success. Effective integration of this type of technology engages students through visual stimulation and provides resources that have never been available before (Schweder & Wissick, 2008).

Product options. Product differentiation provides alternative approaches to demonstrate conceptual understanding and varied expectations encourage academic exploration (NCAC, 2002). Variety can help fight student boredom and promote a learning environment in which risk-taking and abstract thinking are encouraged. Students can choose to create a product that is "oral (speeches, debates, or discussions), written (journal collages), kinesthetic (skits, models, demonstrations) or technological (Websites, slide shows, videos)" (Walker, 2002, p. 105). Other examples include task cards, tic-tac-toe boards, and learning stations (King-Shaver, 2008).

Product options motivate students to achieve at higher levels by (a) incorporating a range of modalities to match students' strengths, (b) providing choice, (c) appealing to students' varied interests, (d) increasing the variety and novelty of learning responses, and (e) allowing a range of complexity levels to encourage students to stretch their comfort zone and experience continuous learning (Douglas, et al., 2008; Kingore, 2007).

Teachers must determine the strategies they are already using, build on those, and incorporate additional activities as they feel more comfortable (King-Shaver, 2008).

Product options that allow students to reflect on curriculum reinforce reading and writing skills. Allowing students to generate their own word problems requires critical thinking, provides formative assessment for the teacher, and assists students in taking mathematical concepts to an abstract level (Furner et al., 2005). From an oral standpoint, thinking aloud and working through the learning process requires students to verbalize their thinking process, allowing educators to identify areas of weakness in student understanding. Students will often correct their errors when sharing explanations.

Special Populations

Accommodating all learners is the expectation in today's mathematical classroom. According to the NCTM (2000), "Equity requires accommodating difference to help everyone learn mathematics" (p. 13). Multiple strategies are applicable to all student populations and can be included in daily instruction to meet the needs of all learners. However, teachers must have high expectations and believe all students can be successful (Dee, 2011; McTighe & Brown, 2005). Individuals who commit to incorporating research-based practices, participate in ongoing staff development, and choose to meet the learning styles of all students will establish a positive, motivating, learning environment (Moss et al., 2011; Sherman, 2009; Wormeli, 2010).

The term differentiated instruction is directly correlated with strategies to assist students with learning disabilities. Individuals identified for special education services receive curriculum that has been modified, and specific strategies are implemented to ensure they are receiving an equitable education. Engaging students in the learning process through vocabulary development, scaffolded instruction, use of manipulatives, technology assistance, and the other differentiated strategies that are applicable to all students will increase the achievement levels of students with special needs (Kingore, 2007; Levy, 2008; Logan, 2011; Marzano & Pickering, 2005; McCoog, 2007; Quiones, 2010). Several studies emphasized the connection between differentiated instruction and the success of learning-disabled students (Broderick et al., 2005; Cusumano & Mueller, 2007; Dee, 2011).

A 2007 comparative study was conducted to determine the effect of implementing *Chemistry that Applies* (CTA), a hands-on, discovery, inquiry-based science curriculum (Lynch, et al., 2007). Of the 2,282 students who participated in the study, 202 were diagnosed with special needs. Results determined that "eighth grade CTA students outscored their peers overall … and those who used CTA significantly outscored their comparison peers on the posttest" (Lynch et al., 2007, pp. 202, 217). Data supported the importance of hands-on learning for students with special needs.

Acrey, Johnstone, and Milligan (2005) addressed the following questions by implementing the elements of universal design: "How can we reach students with diverse needs? How do we help students who have disabilities or are English Language Learners?" (p. 22). The research began as a research project with the National Center for Educational Outcomes (NCEO) to determine "differences in student achievement that occurred when large-scale assessment items included elements of universal design" (p. 22). Upon completion of the study, school members recognized the need for increasing student achievement for exceptional learners.

A collaborative effort to improve performance levels of all students targeted three phases of implementation. First, teachers were trained to gain a clear understanding of the elements of universal design. Study guides were developed based on the principles identified. Each component of the program was evaluated and refined to "determine whether they met school-determined of assessment of essential information" (Acrey et al., 2005, p. 26). Results were positive and scores increased for the first year of statewide testing. The Principles of Universal Design can be implemented in a classroom or through schoolwide implementation to target increased student performance. Each component focuses on student diversity and the need for varied strategies. Teachers reported "that designing study guides and classroom assessments by using the elements of universal design was simple and intuitive, and we discovered that we did not need to make major changes to our existing routine to make our instruction more accessible" (Acrey et al., 2005, p. 23).

English language learners denote one of the fast growing populations of students in today's diverse classrooms. As the number of second language learners increases, new challenges are presented in an inclusive classroom setting (Cirillo, Bruna, & Herbel-Eisenmann, 2010; Tan, 2011). One common misconception regarding English language learners is that the needs of second language learners are no different from any other diverse student group (Harper & deJong, 2004). On the contrary, learners of English as their second language do have the same learning needs as students from other backgrounds, but emphasis must be placed on academic vocabulary and developing linguistic skills. Quality teaching is applicable for all student groups but is insufficient for language acquisition without appropriate supports (Lee & Jung, 2004; Thompson &

Rubenstein, 2000). Teachers must recognize that students learn at different rates and understanding the English language is no exception. Language skills vary based upon the individual's exposure to English, family social situation, and other factors. Therefore, approaches to language acquisition must vary for this subgroup of learners. Teachers of ELL students must be committed to helping students succeed and making content understandable (Celedon-Pattichis, 2010; Short, Echevarria, & Richards-Tutor, 2011).

English language learners represent a population of students who consistently lag behind their peers academically. Four strategies to assist students who struggle because of language barriers are as follows:

- "rigorous and relevant curriculum;"
- "connections with students' backgrounds, interests and experiences;"
- "comprehensible inputs;" and
- "interactions between teachers and students and between students and their peers" (Lavadenz & Armas, 2008, p. 17).

Additional support strategies include "multiple forms of assessments, portfolios, rubrics, and performance-based assessment" (Lavadenz & Armas, 2008, p. 18). Students need extended wait-time and verbal modifications. Speaking slowly in shorter sentences, repetition, and written explanations of speech will make content more understandable. Each of the strategies applies not only to students with language deficiencies but will benefit struggling students.

Several strategies are specific to teach second-language learners but will benefit other groups of students as well. Harper and DeJong (2004) refer to setting instructional objectives, identifying language development skills, and providing feedback as non-negotiable teacher practices. Academic language development hinges on developing a bridge between common language and academic terminology (Cirillo et al., 2010; New Teacher Center, 2005). The use of visual aids and manipulatives allow students to see and touch objects while making a connection to vocabulary. Visual representations allow students to make symbolic and pictorial representations of key terms, while not depending solely on language (Cirillo et al., 2010; Slavit & Ernst-Slavit, 2007).

English language learners benefits from additional instructional techniques as follows:

- Linguistic scaffolding
- Interdisciplinary connections
- Word walls (pictorial and written)
- Heterogeneous grouping
- Collaborative and cooperative learning
- Pairing a Native speaker with a non-Native speaker
- Front-loading academic vocabulary
- Hands-on experiences
- Use of graphic organizers
- Concept mapping (Cirillo et al., 2010; Harper & deJong, 2004; Perritt, 2010; Slavit & Ernst-Slavit, 2007).

Effective ELL instruction depends on teachers' commitment to helping all students succeed (Burnett & Lampert, 2011; Short et al., 2011). Successful implementation of any instructional program is dependent on the teacher, who is responsibility for student learning. According to Hirsh (2011), "Great teachers are the most important school-based ingredient for student success" (p. 18). Teacher support for differentiated instruction or curriculum adaptation is critical. One must be willing to improve in their classroom practices and recognize that ongoing change and professional development are the means to successful learning (Ernst-Slavit & Slavit, 2007; Hirsh, 2011; McTighe & Brown, 2005).

Today's diverse classroom setting requires teachers to identify advanced academic students. Gifted learners represent approximately 6% of school populations (National Association for Gifted Children, n.d.). Federal mandates and increased accountability have compelled many educators to teach a singular curriculum to each classroom of learners. Unfortunately, gifted students continuously pay the price for teachers who only focus on an overall percentage passing score and not on individual student needs. Gifted students learn differently from all other special populations, thriving through inquiry-based, discovery learning (McAllister & Plourde, 2008; Scot et al., 2009). This group of students requires interactive approaches to mathematics and collaborating with other high achievers (Manning, Stanford, & Reeves, 2010; Matthews & Farmer, 2008). Individuals identified as gifted are likely to lose motivation and may renounce school altogether if they are not challenged academically (McAllister & Plourde, 2008). Lectures are negatively associated with the achievement levels of gifted learners who do not engage in comprehensive classroom discussions (Matthews & Farmer, 2008). Teachers often have the misconception that gifted students will master any material presented and do not require academic support. Others mistakenly believe differentiation suggests additional assignments.

Self-guided project options allow students to think critically, implement their own strategies to achieve a specific desired outcome, and make the content relative and meaningful. Powers' (2008) investigation, documenting the effect of an independent study on gifted students' perception of learning, substantiates the importance of challenging all students. Every member of the sample population reported that the assignment allowed autonomous thinking, recognized the importance of individual choice, and validated the significance and meaning of individual projects. Teachers surveyed at the conclusion of the investigation indicated that students benefited by using higher order processing and problem-solving skills. Independent study provided an opportunity for gifted students to challenge themselves through self-guided motivation. Gifted learners deserve an opportunity to excel and reach their full individual potential (Powers, 2008).

Research supports that gifted students benefit from independent study and are intrinsically driven (Manning et al., 2010; Scot et al., 2009). French, Walker, and Shore (2011) conducted a study to determine if gifted students prefer to work alone and how their learning environment influenced those preferences. Results found that gifted students did not necessarily prefer to work alone; however, their choices were dependent on the classroom environment. Students indicated their affinity for working alone or with others was based on the level of support they received in the classroom. "Supportive" was defined as being valued in a community of learners. Students believed they were not well-supported when teachers implied that they needed less assistance than others because they were gifted (French et al., 2011).

High-Stakes Testing

The No Child Left Behind Act (NCLB) of 2001 was signed into legislation on January 2002, which focused on closing achievement gaps between minority and nonminority, and more advantaged and disadvantaged students (NCLB, 2001). In an effort to raise the achievement level of all students, standardized testing has become the norm throughout the nation (Ellis, 2008; Grant, 2004; Moon, 2009; Nichols & Berliner, 2008). A dramatic shift has occurred in the last decade as a result of increased accountability for students and teachers. Educational organizations are facing increased pressure from legislature at the state and federal levels. Several states have adopted "high stakes" testing policies because of increased political pressure (Jones, 2007; Lay & Stokes-Brown, 2009; Madaus & Russel, 2010; Sloane & Kelly, 2003). The changes taking place appear to have the greatest impact on classroom teachers.

Increased accountability for educators has amplified feelings of apprehension for many educators (Au, 2007; Harrell, 2009; Pedulla, 2003). The most significant concern lies in classroom instruction, specifically in states where high-stakes policies have been mandated. Increased accountability has compelled teachers to devote an increased amount of class time to prepare students for state-mandated testing. However, most educators do not believe these tests accurately measure student performance. Furthermore, teachers are using instructional strategies that contradict their educational beliefs to prepare students for a test often viewed as unreliable for measuring student success (Au, 2007; Dwyer, 2004; Grant, 2004; Lai & Waltman, 2008; Wills & Sandholtz, 2009).

State mandated testing was created to measure student achievement and compare assessment results on a state level. Standardized testing in relation to classroom instruction is described as follows:

> Widespread use of standardized testing began after World War II as a scientific and objective means of evaluating students' academic progress. These tests were usually voluntary, and . . . were provided as diagnostic tools for teachers to use in determining the instructional needs of individual students in their classrooms. These tests were not based on particular curricula or absolute standards and were not designed to motivate changes in classroom behavior by increasing accountability. (Muller & Schiller, 2000, p. 73)

Assessments were originally created to provide diagnostic and formative results, providing opportunities for reteaching and revising instructional practices. However, testing programs are currently used to evaluate student and teacher performance in the classroom (Ellis, 2008; Hess, 2004; Lay & Stokes-Brown, 2009; Marchant, 2004; Zimmerman & Dibenedetto, 2008). Federal accountability requires schools and districts to attain a minimum passing standard to meet Adequate Yearly Progress (AYP). Performance standards have increased consistently since 2005, as represented in Table 3. Mathematics, reading, and English language arts targets increase to 100% for all student populations in 2014.

Table 3

Required AYP Student Performance Standards

Year	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Math	42%	42%	50%	50%	58%	67%	75%	83%	92%	100%
Reading/ELA	53%	53%	60%	60%	67%	73%	80%	87%	93%	100%

Note. Results published annually in *Technical Digest* (TEA, 2005, 2006, 2007, 2008b, 2009b, 2009c, 2009d, 2010d, 2011b).

Creating a quality education for all students was the original focus of NCLB (2001). Legislators required an alignment of state standards and an assessment to determine if target objectives were being achieved (Lay & Stokes-Brown, 2009). The intent was to modify educational practices to provide equity for all students (Butzin, 2007). Educators, parents, students, and politicians have varying viewpoints concerning NCLB (2001) and current testing practices. Positive and negative benefits of high-stakes testing and increased accountability are a current debate, evidenced throughout the literature (Grant, 2004; Jones, 2007; Lay & Stokes-Brown, 2009; Marchant, 2004; Moon, 2009; Nichols & Berliner, 2008; Sloane & Kelly, 2003). Nichols (2007) stated, "[There is] no consistent evidence to suggest high-stakes testing leads to increases in student learning" (p. 47).

Many teachers suggest that an accountability system is necessary to ensure alignment with state standards and improve classroom instruction. Numerous schools work collaboratively on alignment between grade levels (Au, 2007; Jones, 2007; Sloane & Kelly, 2003). The majority of educators agree that NCLB (2001) resulted in a new emphasis focused on meeting the needs of special populations such as special education students, minorities, economically disadvantaged, and limited English proficient students (Jones, 2007). Students are provided with tools, such as the state standards and performance results, allowing them to take ownership of their education. Students may be motivated to work harder to achieve a passing standard on state assessments (Lay & Stokes-Brown, 2009; Sloane & Kelly, 2003; Zimmerman & Dibenedetto, 2008). Hanushek and Raymond (2005) reported that while accountability and standardized assessments have narrowed the gap between White students and Hispanic students, the same cannot be stated concerning African American and White students.

Despite the benefits associated with NCLB (2001) and increased accountability, all previously mentioned studies also include negative consequences of high stakes testing. Teacher and student apprehensions outweigh the benefits associated with high-stakes testing. Concerns faced by today's educators are valid and are substantiated with numerous studies conducted subsequent to enactment of current assessment policies and political mandates (Au, 2007; Dworkin, 2005; Grant, 2004; Jones, 2007; Lay & Stokes-Brown, 2009; Marchant, 2004; Nichols, 2007; Nichols & Berliner, 2008; Sloane & Kelly, 2003; Wills & Sandholtz, 2009; Zimmerman & Dibenedetto, 2008). Many teachers report they teach only content that will be included on the annual state assessment and abandon practices that encourage creativity (Grant, 2004; Marchant, 2004). Hands-on activities, cooperative learning, and project-based learning are often substituted for drill-and-practice and lecture-based instruction. Teachers are frequently ostracized if student performance is low, leading to a decrease in morale and motivation (Sloane & Kelly, 2003).

Questionable test practices often result in schools under intense pressure to meet state or federal accountability standards. Threats of poor student performance and the negative effects that result may lead teachers to engage in practices that contradict personal ethical beliefs (Nichols & Berliner, 2008). Schools have been investigated for unethical test preparation practices, providing cues to students when answers are incorrect, and inappropriate use of test data (Marchant, 2004; Moon, 2009). Negative consequences exist for teachers and students. Test-takers often become physically sick because of anxiety associated with testing (Giambo, 2010; McNeil, Coppola, Radigan, & Heilig, 2008). In states that employ high-stakes testing, students may be retained or may not be eligible to graduate because of assessment results. Students who cannot achieve the standard required for graduation will often drop out of school because of frustration and anxiety associated with high-stakes assessments (Marchant, 2004; Nichols & Berliner, 2008; Zinnerman & Dibenedetto, 2008).

Teachers have voiced their opinions of high stakes testing, but one of the greatest concerns for educators is that standardized tests do not accurately measure student achievement (Dworkin, 2005; Jones, 2007; Marchant, 2004; Mason, 2007; Nichols & Berliner, 2008; Sloane & Kelly, 2003; Wills & Sandholtz, 2009). Open-ended questioning strategies provide a better opportunity for students to apply concepts learned. Standardized tests are often flawed, biased, and questions are difficult to understand. In addition, questions often have more than one correct response and students are asked to choose the most appropriate answer. Educators are expected to target individual learning styles when teaching, but standardized tests are given to all students regardless of educational or cultural background. Hess (2004) stated, “Ambiguity undermines test validity, leaves much of the substance of what students need to know to the whims of test designers, and undermines the notion that standards provide clear direction as to what students are to master" (p. 99). Many states use the results of testing to measure the effectiveness of content being mastered from both a student and teacher standpoint. High-stakes testing may be summarized as follows:

> A single test should not be the only criterion for making high-stakes decisions about the total educational experience of a student, or the complex activities and responsibilities of a school and school staff. Test scores are not infallible. (Mason, 2007, p. 37)

Politicians, administrators, and educators continue to disagree on the positive and negative aspects of state mandated testing. However, the majority of politicians and educators agree that if high-stakes testing is to continue, tests must be modified to depict a more accurate portrayal of student capabilities. Changes to existing testing practices are likely to continue in the current educational setting. Political representatives and public constituents demand a quality education in the public school setting. Dwyer (2004) stated, "high stakes standardized testing is likely to remain a prominent feature of public schooling in the USA" (p. 214). Therefore, educators must implement quality instructional practices that challenge all students and prepare them for standardized assessments (McTighe & Brown, 2005).

Federal and state accountability have left many teachers struggling to make changes in the classroom (Assaf, 2008; Obara, 2011). Preparing students for state assessments has become a priority for schools and districts, leading to increased benchmarking, practice assessments, and test-taking strategies. According to Kulm

(2007), “Testing has narrowed the mathematics curriculum, taken time away from instruction, and threatened innovation by creative teachers” (p. 84). Although research-based instructional strategies are emphasized in school districts across the country, many teachers have reverted to direct teaching strategies. Teaching multiple objectives in a condensed period is necessary for acceptable assessment scores. Assessments are not tailored to individual student needs, and traditional drill and kill methods have become the norm in many classrooms (Rush & Scherff, 2012). Hill (2005) stated, “Educators are asked to teach in multiple ways to reach all learners, and then on the big test day, only one format is used” (p. 28). Even educators who strive for success for all students often struggle with quality instructional practices to prepare students for standardized assessments.

The literature emphasizes the connection between measurable progress and differentiated instruction to determine individual skill level. Formative assessments should be ongoing whereas summative assessments provide evidence of content mastery or a need for reteaching. Tomlinson (2000a) clarified instructional challenges associated with mandated assessments as follows:

> There is no contradiction between effective standards-based instruction and differentiation. Curriculum tells us what to teach: Differentiation tells us how. Thus as we elect to teach a standards-based curriculum, differentiation simply suggests ways in which we can make that curriculum work best for varied learners. (p. 8)

Standardized test performance should not be the sole indicator of student success. Levy (2008) stated, “The risk is our focus will shift to the standards and away from the child” (p. 161). However, when teachers incorporate differentiated instructional practices, educators “can keep the focus where it belongs and take each student as far as he or she can go” (Levy, 2008, p. 161). Success depends on the educator’s ability to clarify key concepts, engage all students, and emphasize critical thinking skills. Brimijoin (2005) concurred as follows: “As counterintuitive as it may seem, it is possible for teachers skilled in differentiation to improve student achievement, and . . . make differentiation and high-stakes testing compatible” (p. 260).

Studies of Differentiated Teaching Practices

Several documents validate a correlation between increased student achievement and individualized instructional practices. Research was conducted to identify strategies implemented in three high-performing schools in Virginia where the majority of the student population were minority and impoverished students (Nugent, 2006). Analysis of qualitative interviews and state assessment data revealed several commonalities. The schools’ success was attributed to strong instructional leadership and a technology-driven curriculum. The Virginia-based system decided to use technology to bridge the gap between federal mandates and the growing accountability system. According to Nugent (2006), “Students who are engaged in learning often develop a new attitude towards content areas they had previously not enjoyed” (p. 41).

A 2008 study was conducted to determine if eighth grade mathematics students taught using multiple intelligences (MI) would outperform students taught using direct instruction (Douglas et al., 2008). Results indicated that students in the treatment group scored “approximately 25.48 points higher … compared with 17.25 points [higher for] the control group” (Douglas et al., 2008, p. 187) from pre-test to post-test scores.

Moreover, results indicated behavior improvements when instructional objectives met the needs of a diverse population.

In a similar study of Holland Elementary School, which has almost a 90% poverty rate and 25% English language learners, differentiated instructional practices were implemented campus wide to improve student performance. Data disaggregation, flexible grouping, progress monitoring, collaborative efforts to vertically and horizontally align curriculum, and individualized intervention plans were strategies used to make positive climate and instructional changes. Teachers offered extended school day opportunities for students and received ongoing professional development to assist with strategic implementations. The school has consistently met annual yearly progress goals and is continuously increasing assessment scores. According to Cusumano and Mueller (2007), since the implementation, “there has been a decline in student discipline referrals, teacher morale is higher, and remarkable improvement has been made in students’ reading, writing and math performance levels” (p. 8). The instructional model provides an example of the rewards that can be obtained through passionate teaching and differentiated learning. “Through courageous restructuring, alignment, collaborative professional growth, monitoring, reflection of results, and continuous spirit of renewal, they have made higher student achievement a reality” (Cusumano & Mueller, 2007, p. 8).

Bailey and Williams-Black (2008) initiated a study to determine if teachers were using differentiated instruction in the classroom and the strategies being implemented. The researchers’ focus “was to determine if teachers felt differentiated instruction important enough to use in the classroom and how differentiating the content, the process, and/or the product was incorporated into lesson plans to meet their students’ needs" (Bailey & Williams-Black, 2008, p. 135). Graphic organizers, engaging writing prompts, rotating centers, theater presentations, written scripts, interactive word walls and bulletin boards, literacy centers, and games were used to engage all learners simultaneously and provide an opportunity to engage in multiple learning activities.

Hoover High School in San Diego, California, recognized a need for change in 1999 when the average student was reading at a 5.9 grade level. Student demographics were typical of many low-performing schools. All 2,200 students enrolled were eligible for free lunch and 76% of the students spoke an additional language other than English. Teachers agreed to apply a minimum of seven strategies as a campus initiative to improve literacy rates. The following were implemented: "anticipatory activities, graphic organizers, note taking, read alouds and shared readings, reciprocal teaching, vocabulary instruction, [and] writing to learn" (Fisher et al., 2003, p. 42). In 2003, four years after new strategies were implemented, the average student was reading at a grade level of 8.2. Collaboration, professional development, and a willingness to change were required to implement a program for student improvement. Although the writing never mentioned the term "differentiated instruction," activities were modified, graphic organizers were incorporated, and additional teaching strategies were implemented to individualize instruction (Fisher et al., 2003).

In 1998, North Topsoil Elementary School failed to meet North Carolina's expected growth in reading and math for grades three through five. When assessment results were released, the Title I school had a proficiency rating of 79%. "Five years after beginning the process of differentiation, in 2003-2004, 94.8% of students scored at the proficiency level" (Lewis & Batts, 2005, p. 26). Staff members modified content, process, and product. Professional development and collaboration were ongoing to promote educational growth. Through flexible grouping, learning centers, independent contracts, questioning strategies, thematic units, compacting, independent study, and tiered assignments, student performance increased by approximately 25% over a five-year period. The following principles guided instruction at North Topsoil Elementary School:

- continuing assessment,
- varying teaching strategies,
- flexible grouping,
- modified instruction focusing on individual strengths,
- multiple modes of learning,
- targeted instruction based on student interest, and
- unambiguous leaning goals criteria (Lewis & Batts, 2005).

In addition to the academic gains made by students, discipline incidents dropped, retention percentages decreased, and students became enthusiastic about learning (Lewis & Batts, 2005).

Mathematics is an area in which many students struggle. Numerous studies support the integration of differentiated instruction and hands-on learning to provide students with an optimal opportunity for success. Witzel and Riccomini (2007) confirmed this:

> The 2003 National Association of Education Progress reported that 23% and 32% of students in 4th and 8th grade scored below the basic level. Because 75% of a teacher's instructional decisions regarding content sequence and instructional

> objectives are determined by a district's adopted mathematics textbook, there is a need to develop effective strategies to better implement mathematics curricula and materials. (p. 13)

Quality educators recognize the importance of shifting from traditional whole class lecture to a student-engaged learning environment (Tobin, 2008).

Faced with a diverse classroom of struggling mathematics students and gifted learners, Kimberly Grimes implemented differentiated instruction and documented the action research effects. Using an approach called “glass, bug, and mud” (Brimijoin, Marquissee, & Tomlinson, 2007, p. 678), the researcher focused on flexible grouping, task cards, and peer tutoring (Grimes & Stevens, 2009). Students self-assessed daily to determine their level of understanding based on the following approach:

> - *Glass* means the student can see through the windshield clearly and has a strong understanding of the mathematics concept.
> - *Bug* is a partially covered windshield, indicating the student’s understanding is not completely clear, but there is evidence of knowledge in the subject.
> - *Mud* refers to a windshield completely covered by dirt; the student shows no understanding of the concept. (p. 678)

Varied task cards were used to challenge all student groups at individual levels of understanding with the teacher as the facilitator. Students were allowed a choice of activities, assessments, and all were challenged. The researcher transformed her classroom into a motivated climate of learning focused on assisting all students reach their maximum potential.

Unit test scores improved from 72% to 91%, a 19% increase. Students classified as high achievers improved their performance scores from 88% to 99%, an improvement of 11% (Grimes & Stevens, 2009). The results exhibit the positive effect of differentiation in the classroom. The researcher did not dispute the accuracy of the results obtained in her classroom. However, she did caution educators to assess current instructional practices and begin to differentiate on a small scale to avoid becoming overwhelmed. The educator encouraged others to create instruction targeting individual needs and concluded, "When applied correctly, differentiation in mathematics [instruction] ensures student success" (Grimes & Stevens, 2009, p. 680).

Summary

Research continues to focus on differentiated instruction and the importance of targeting individual academic capabilities. Numerous literature sources support the need for tailored instruction; strategies for modifying content, process, and product; and classroom implementation approaches (Anderson, 2007; Carolan & Guinn, 2007; King-Shaver, 2008; Lewis & Batts, 2005; Tomlinson, 2000a, 2000b, 2005; Witzel & Riccomini, 2007). However, more research is needed to determine how implementing differentiated instructional practices impacts standardized assessment results (Ernest et al., 2011; Logan, 2011). Finding the right balance between effectively educating students while implementing curriculum-based standards is essential for individual achievement (McTighe & Brown, 2005). Although formal research is lacking, many educators personally attest to improved student performance as a result of modified instruction (Bailey & Williams-Black, 2008; Cusumano & Mueller, 2007; Grimes & Stevens, 2009; Lewis & Batts, 2005). The NCAC (2002) reiterated, There is an acknowledged and decided gap in the literature in this area and future research is warranted. While no empirical validation of differentiated instruction as a package was found for this review, there are a generous number of testimonials and classroom examples by authors of several publications and Web sites provide while describing differentiated instruction. Teachers using differentiation have written about improvements in their classrooms. (p. 5)

CHAPER 3: METHODOLOGY

Introduction

Current research supports the need to adapt instruction to meet the varied learning styles and individual needs of students (Bailey & Williams-Black, 2008; Lewis & Batts, 2005; Tomlinson, 2000a, 2000b; Tomlinson & Eidson, 2003). Finding the balance between effectively educating all children, specifically gifted learners, special needs students, and English language learners while implementing curriculum-based standards is essential. The No Child Left Behind (NCLB) Act (2001) impacted the educational setting by mandating that all students succeed, regardless of disability, race, socioeconomic status, or level of English proficiency. Varying needs, learning levels, and diverse backgrounds are present in today's classrooms. Effective integration of differentiated instructional practices allows one to meet the needs of all students in a singular classroom setting (Rock et al., 2008). Although research supports the use of differentiation and its effect on student performance, few studies provide empirical evidence of the effects of differentiation of instruction on standardized testing. Therefore, an empirical investigation of the effects of differentiation on student performance for all populations is necessary to determine the effectiveness of the practice.

This study investigated the effect of differentiated instructional practices on standardized mathematics performance in the middle school mathematics classroom, as measured by district wide benchmark data, targeting the Texas Essential Knowledge and Skills (TEKS). The research context, participants, instrumentation, and research outlined in this chapter attempt to answer the following questions:

Research Question 1: What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS) when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

Corresponding null hypotheses to address the research questions are as follows:

$H_0$1: Implementing differentiated instructional strategies has no significant effect on the performance of students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0$2: Implementing differentiated instructional strategies has no significant effect on the performance of special education students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0$3: Implementing differentiated instructional strategies has no significant effect on the performance of economically disadvantaged students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

$H_0$4: Implementing differentiated instructional strategies has no significant effect on the performance of English language learners (ELL) on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

H_05: Implementing differentiated instructional strategies has no significant effect on the performance of at-risk students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

H_06: Implementing differentiated instructional strategies has no significant effect on the performance of students identified as gifted on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Research Context

Research was conducted in a small urban district, on the outskirts of a large city on the United States/Mexico border. District-wide enrollment for the 2011-2012 school year was 11,689. Demographics were as follows: 94.4% Hispanic, 4.0% Caucasian, 1.1% African American, 0.3% Native American, 0.1% Asian/Pacific Islander, and 0.1% Other as represented in Figure 2. Additionally, 6.9% received special education services, 86.4% of students were economically disadvantaged, 33.8% were English language learners (ELL), 56.5% had at least one factor identifying them as “at-risk” of dropping out of high school, and 3.0% were identified as gifted. Middle school students were the focus for this study; therefore, data was collected from seventh grade students from each of the three middle schools in the target district of study.

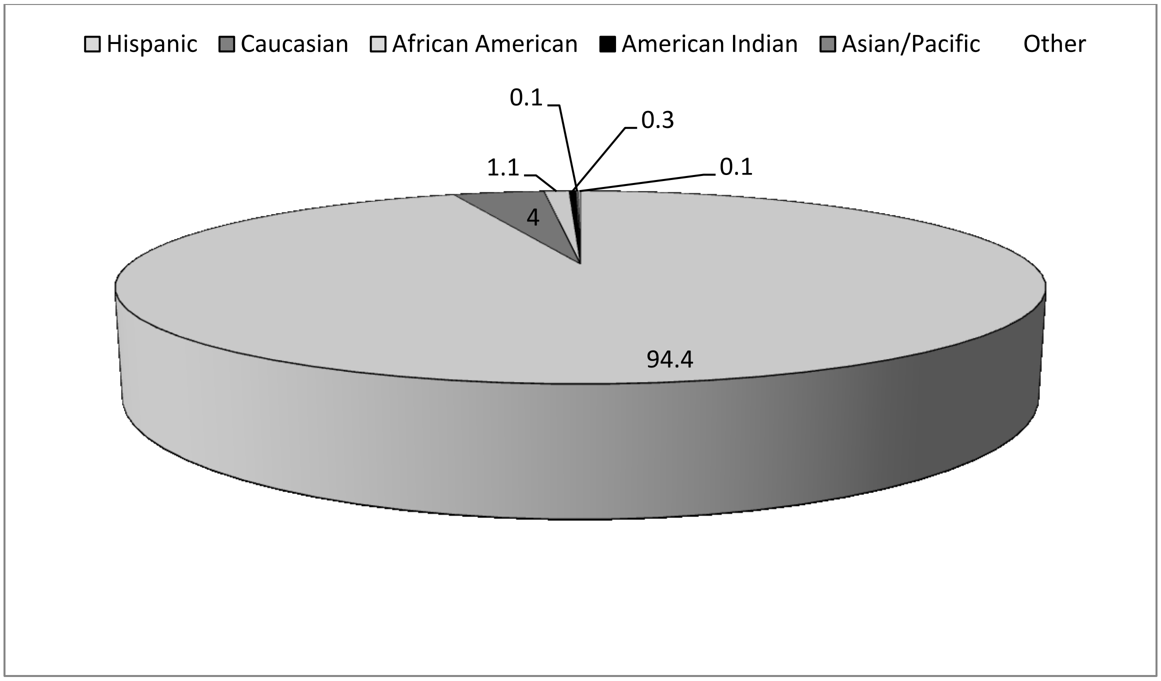


Figure 2. Ethnic makeup for students in the school district in 2011-2012.

Research Participants

Seventh grade enrollment for the 2011-2012 school year was 891 students. Ethnic student makeup was as follows: 854 Hispanic students, 28 Caucasians, six African Americans, two American Indians, and one Asian. Special populations were as follows: 53 special education students, 756 economically disadvantaged students, 237 limited English proficient students, 473 “at-risk” learners, and 36 gifted learners (see Figure 3). In 2011, 79% of seventh grade students met the minimum passing standard for Texas Assessment of Knowledge and Skills (TAKS), including 16% who were commended. However, 21% failed to meet a minimum proficiency standard as shown in Figure 4 (TEA, 2011).

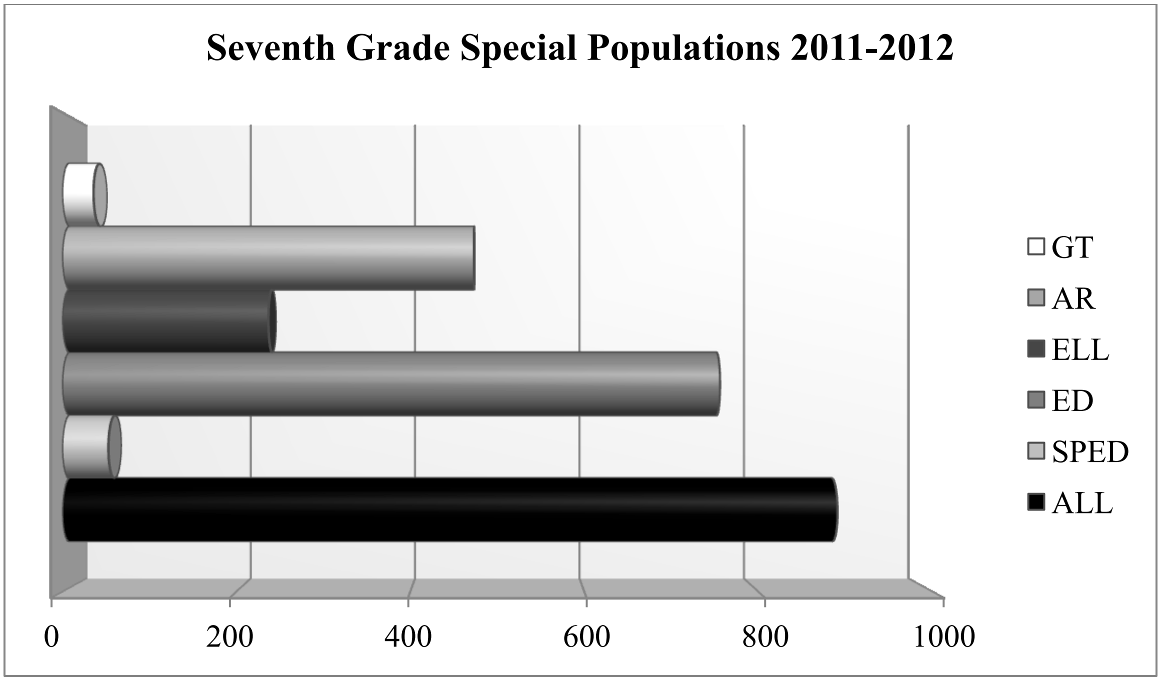


Figure 3. 2011-2012 special populations defined by state demographics (TEA, 2012). ALL = all students enrolled in the research district; SPED = special education; ED = economically disadvantaged; ELL = English Language Learners; AR = at-risk; GT = gifted.

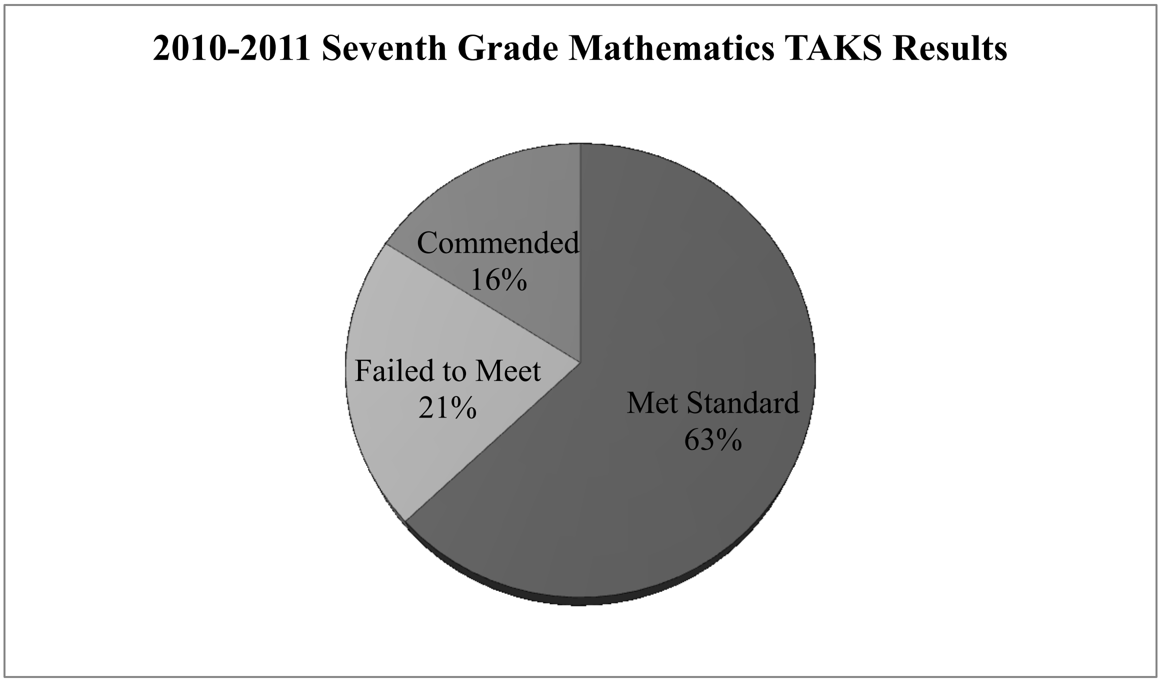


Figure 4. Seventh grade TAKS results from the 2010-2011 school year.

The sample population consisted of 891 seventh grade students and nine seventh grade mathematics teachers. Only students enrolled and present for both five-week periods of the research study were included in the population. Students with extreme physical disabilities, which limit everyday life functions, did not participate in the study. Seventh grade students with a severe learning disability, preventing them from learning at their grade level, were also excluded. In addition, students who did not have a covariant Texas Assessment of Knowledge and Skills (TAKS) score were excluded from the sample population. Students repeating the seventh grade for the 2010-2011 school year were excluded from the sample population because prior exposure to seventh grade content and assessment items posed a threat to reliability and validity.

The target district employed seven general education mathematics teachers and three special education mathematics teachers for seventh grade at the time of the study. Campus A had one seventh grade general education and one special education teacher who served 162 students. Campus B had three seventh grade general education mathematics teachers and one special education mathematics teachers with a student population of 244. Campus C, with 485 students enrolled, employed three general education seventh-grade teachers and one special education mathematics teacher, serving 485 students. Each campus was representative of a diverse student population as presented in Figure 5.

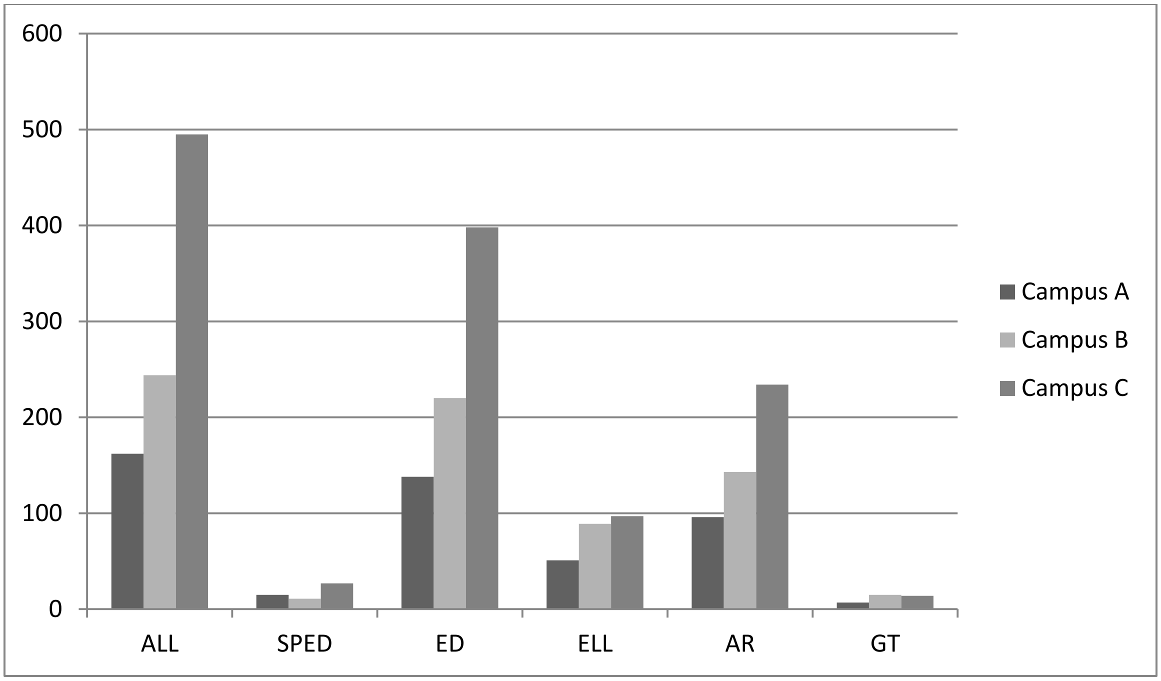


Figure 5. Current demographics of participating schools in the target district. All results were obtained from the district database of student demographics. ALL = all students, including those with multiple coding; SPED = special education students; ED = economically disadvantaged students; ELL = English language learners; AR = at-risk students; and GT = gifted and talented learners.

A repeated-measures design was used to obtain participant data after exposure to each level of the independent variable to eliminate compounding (Howell, 2008). The control group for the initial research period was assigned to the treatment group for the second trial, and the treatment group from the first research period was assigned to the control group for the second research trial. The control group consisted of three general education teachers and one special education teacher. Campus A and Campus B were the control group for the first five weeks of the research period. Lecture-based instruction was delivered to 406 seventh grade mathematics students. Campus C, with three general education teachers and one special education teacher, served as the treatment group for the first five weeks of the research period. Differentiated instruction was provided to 485 seventh grade mathematics students. For the second five-week period, Campuses A and

B delivered differentiated instruction to 406 seventh grade students and Campus C delivered lecture-based instruction to 485 seventh grade students.

Control and treatment groups were divided by campus to maintain the integrity of the investigation. District policy mandates horizontal teacher alignment; therefore, by providing individual teachers at each campus with the same instructional plan, alignment continued without a variation in lesson plans. If teachers had been divided into control and treatment groups by campus, results may have been skewed. All students were involved in the research, but all student results were not included. Stratified random sampling was used to determine student scores for statistical analysis of results. Students were grouped in the following: all students, special education, economically disadvantaged, limited English proficient, at-risk, and gifted. The study was conducted during two five-week periods, followed by data analysis using a paired *t*-test and analysis of covariance (ANCOVA). Student 2011 TAKS results were used as a covariant to control for pre-existing differences in student populations. The use of two independent research trials in conjunction with an ANCOVA minimized extraneous variables and threats to internal validity.

Research Instrumentation

Research was conducted over a ten-week period in a small urban school district in Texas. A quasi-experimental study design was used because student classes were established prior to beginning the research study (Ary et al., 2006). Several quantitative measures were used in this study to enhance validity of the findings. The Teaching Style Inventory (TSI) self-assessment instrument (Silver, Hanson, & Strong, 1980) (see Appendix D), the William and Mary Classroom Observation Scales Revised (COS-R) form (VanTassell-Baska et al., 2003) (see Appendix E), and student performance data, as measured by benchmark assessments targeting student mastery of TEKS (see Appendices F and G), provided the data needed to support or reject each null hypothesis.

Teaching Style Inventory. Determining participants' preferred teaching style prior to beginning research was critical to ascertain potential deviations in instruction. Participants completed a self-assessment using the TSI (Silver et al., 1980) to determine their predominant modes of teaching in the mathematics classroom. The self-diagnostic instrument consisted of 56 items to evaluate the following: (a) planning, (b) implementation, (c) preferred environment, (d) curriculum objectives, (e) teaching objectives, (f) teaching operations, (g) classroom roles, and (h) evaluation (see Appendix D). A personal inventory was provided at the overview of research presentation, and individuals were allowed two weeks to return the anonymous form in a self-addressed stamped envelope. Each participant's teaching style was scored and analyzed using a TSI pre-established criteria. Results determined if each educator portrayed characteristics of a mastery style, interpersonal style, understanding style, or self-expressive style of teaching (Silver et al., 1980). Establishing teaching styles prior to the study provided insight into potential hindrances for teachers to differentiate curriculum. The educator's primary teaching style may have been a factor in the outcome of assessment results. Participants' level of confidence in using differentiated instruction may have impacted student performance as well. Permission was granted to use the TSI as a research instrument for this study (see Appendix H).

A primary reason for choosing the TSI was the reliability of the instrument. The TSI was modified to self-assess teachers based on the Learning Style Inventory for

Students (LSIS) (Carifio & Everritt, 2007). Statistical analysis of the LSIS revealed the following:

> The split half reliability of the ST [sensing-thinking] style total inventory was 0.517, a moderately high reliability coefficient, indicating reasonable consistency of the ST style inventory. The split half reliability of the NT [intuitive-thinking] style total inventory was 0.579, a moderately high reliability coefficient, indicating reasonable consistency of the NT style inventory. The split half reliability of the SF [sensing-feeling] style total inventory was 0.662, a moderately high reliability coefficient, indicating reasonable consistency of the SF style inventory. The split half reliability of the NF [intuitive-feeling] style total inventory was 0.653, a moderately high reliability coefficient, indicating reasonable consistency of the NF style inventory. (Abrams, 2001, pp. 30-36)

Carifio and Everritt (2007) used the Group Embedded Figures Test (GEFT) to further validate the TSI. Limited reliability data on the TSI exists because the instrument is an extension of the original student self-assessment. In a 2007 study, Carifio and Everritt conducted a study to further validate the TSI. They found that "test-retest reliability is estimated at 0.82 for males and females. Predictive validity is reported to be -0.82 for males and -0.63 for females" (p. 171). Construct validity was acceptable with a "concurrent validity coefficient of 0.77 (N = 10)" (p. 172). The reliability is 0.91; however, "due to the very small sample size, this reliability coefficient is inflated, but it still (even with increased sample size shrinkage) indicates a reasonably good level of reliability" (Carifio & Everritt, 2007, p. 173).

William and Mary Classroom Observation Scales Revised. Identifying the differentiated strategies implemented in the mathematics classroom was essential to make certain prescribed lesson plans were being followed for both the control and treatment groups. The COS-R provided quantitative evidence of lesson plan implementation for each teacher involved in the study. The observation form was used as a checklist for specific activities (see Appendix E). Clear guidelines for use of the instrument provided a specific protocol to be followed.

The quantitative COS-R survey instrument focused on the following teacher behaviors: general teaching, differentiated teaching, critical thinking strategies, creative thinking strategies, and research strategies (VanTassel-Baska et al., 2003). A 25-item checklist was scored using a "3" for effective, a "2" for somewhat effective, a "1" for ineffective, or an "N/O" for not observed. The SOS was scored using a Likert-scale format as follows: most is greater than 75% of the time, many is 50% to 75% of the time, some is 25% to 50% of the time, and few is less than 25% of the time. None or not applicable (N/A) are other options on the scoring instrument. Twenty-five items were scored on the following categories: student responses to general teacher behaviors, student responses to differentiated teaching behaviors, engaged in problem-solving strategies, engaged in critical thinking strategies, engaged in creative thinking strategies, and engaged in research strategies.

A rubric clearly delineated the attributes of each rating level: effective, somewhat effective, or ineffective (see Appendix E). The content validity of the observation form is rated at a 0.98 (VanTassel-Baska, Quek, & Feng, 2007). Statistical analysis results are as follows:

> The analyses of the two implementation observation periods showed that overall, the scale was highly reliable (Alpha = .91 to .93). For both observations, the subscale reliability for all of the clusters averaged above .70. These high reliability coefficients across both observations attest to the reliability of the items on the instrument. (Van Tassel-Baska et al., 2007, p. 90)

Teacher and student observation scales were aligned and viewed from both teacher and student standpoints.

To minimize bias, observations were conducted with two-person teams. The district elementary mathematics coordinator and the bilingual coordinator acted as secondary observers for data collection. Each was provided with an overview of the instrument and was given an opportunity to ask clarifying questions prior to scheduled observations. Confidentiality agreements were signed by each of the secondary observers prior to beginning observations (see Appendix I). Any information collected from the classroom observations became the sole property of the researcher. Disclosure of any information pertaining to the observation would have been considered an ethical violation of the confidentiality agreement and would have been reported. Unless required by law, the secondary observers were not permitted to share information with any outside party.

During each observation, a demographics section and a written classroom observation were scripted using detailed notes. Immediately after the lesson, observers met briefly with the teacher to complete the interview questions of the COS-R. Using information from the scripting, a Classroom Observation Scale (COS) and a Student Observation Scale (SOS) were completed by each member of the observation team. Once the COS and SOS were completed individually, the observers completed the teacher and student observation scales together, documenting the decisions on the consensus forms (Van Tassel-Baska et al., 2003). Permission was granted to employ the use of the COS-R in this study (see Appendix J).

Information was recorded in a spreadsheet subsequent to data collection for analysis. Teachers were listed using numerical coding (e.g., Teacher One, Teacher Two, and so on). Two scheduled and two impromptu observations were completed to validate the strategies being employed in the classroom. The mean scores were calculated for each independent trial.

Benchmark examinations. Following implementation of prescribed lesson plans and observations for each research trial, students were assessed using a benchmark examination. Data analysis was conducted for each benchmark assessment to address the research questions and determine if the null hypotheses could be rejected. Assessments were created using released items from previous years' TAKS examinations (see Appendices F and G). Annual review of TAKS assessments are conducted to ensure the reliability and validity of tested objectives. Reliability is defined "in terms of reader agreement and correlation between first and second readings. Validity has been assessed via validity packets composed of responses selected and examined by TEA staff" (TEA, 2010d, p. 47). Reliability scores for 2004-2010 range from 97% to 98.2% as represented in Table 4. Validity results range from 71% to 78.5% as observed in Table 5. Internal consistency was evaluated using the Kuder-Richardson 20 (KR20) for the mathematics portion of the TAKS assessment, as shown in Table 6.

Table 4

Seventh Grade Mathematics TAKS Reliability

Year	Number of Responses Read	Agreement Rate After 2 Readings	Number of Third Readings	Agreement Rate After 3 Readings
2004	298,204	73.0%	76,688	98.2%
2005	300,163	72.0%	83,763	98.7%
2006	305,492	65.0%	107,868	98.2%
2007	300,268	63.0%	109,815	97.8%
2008	324,604	61.0%	126,561	97.0%
2009	325,063	65.0%	115,119	98.0%
2010	353,102	64.0%	121,001	98.0%

Note. "Reader agreement rate is expressed in terms of absolute agreement (the first reader's score equals the second reader's score)" (TEA, 2010d, p. 47). Two out of three readers must agree to determine the validity score; however, when discrepancies are present, a fourth reader will decide the final score (TEA, 2005, 2006, 2007, 2008b, 2009d, 2010d, 2011b).

Table 5

Seventh Grade Mathematics TAKS Validity

Year	**Agreement Rate**
2004	78.5%
2005	77.8%
2006	74.7%
2007	71.0%
2008	76.0%
2009	78.0%
2010	79.0%

Note. Results published annually in *Technical Digest* (TEA, 2005, 2006, 2007, 2008b, 2009d, 2010d, 2011b).

Table 6

Seventh Grade TAKS Mathematics Test Internal Consistency for Total Students

Year	K (Score Points)	N (Number of Students Tested)	Mean	SD (Standard Deviation)	KR-20 Reliability	Mean P-value
2004	48	290,955	30.150	9.251	0.900	62.812
2005	48	294,745	31.178	9.820	0.912	64.954
2006	48	299,160	32.586	9.333	0.906	67.887
2007	48	294,052	34.067	9.162	0.907	70.972
2008	48	318,687	33.807	9.805	0.919	70.431
2009	48	318,922	34.927	9.101	0.908	72.764
2010	48	327,501	34.766	8.930	0.904	74.429

Note. K = score points possible; N = number of students tested; SD = standard deviation; KR-20 = reliability of each assessment; mean P-value is statistically significant (TEA, 2005, 2006, 2007, 2008b, 2009d, 2010d, 2011b).

Research Procedures

Approval process. Prior to beginning the study, the Institutional Review Board (IRB) paperwork was submitted and approved (see Appendix K). Approval was also requested to conduct research in the district of study. A copy of the research proposal and confidentiality agreements were submitted to district administration for authorization. The written request addressed the theoretical basis for research, a description of the methodological procedures, copies of the research instruments, and detailed information explaining how the research would benefit the school district. Submission of an outline specifying the type of research being conducted, the benefits, and a clear description of all procedures was required prior to approval. Additionally, the researcher was informed that strict compliance with district standards was expected and that disruption of the educational environment was not allowed.

The researcher was notified in writing of acceptance of the proposal (see Appendix L). After district approval was granted, an appointment was scheduled to meet with the principals of the campuses involved in the study. The research plan, procedures, and expectations were explained and all questions were answered. District personnel and school administrators agreed for teachers and campuses to participate in the research process, understanding the confidential nature of teacher surveys and classroom observations.

Recruitment of participants. Each of the 10 teachers teaching seventh grade mathematics at the time of the study was identified as a potential participant in the study: three special education teachers and seven general education teachers. All teachers were invited, via e-mail, to attend a presentation explaining the purpose of the study and how research would be conducted. An overview was conducted at each of the middle schools in the district for convenience of the teachers. The presentations outlined participant expectations and contact information for the primary investigator, research consultant, and institutional organization. Discretion of the study was discussed, and participants received a confidentiality agreement. Individuals received informed consent paperwork at the intial meeting and were provided an opportunity to accept or decline the invitation for participation. An alternate early morning makeup session was offered for one individual who expressed interest to participate but could not attend the afternoon session. Presentations were standardized to ensure all participants received uniform information. Individuals who choose not to participate in a formal overview were not considered for the study, to protect the integrity of information presented. Recruitment began immediately after IRB approval.

All participating teachers received informed consent paperwork (see Appendix M), advising them of their right to withdraw from the study at any point. Expectations were clearly established, and participants had a comprehensive understanding of their role in the research study. Teachers were labeled using pseudonyms to protect their identity. The researcher had sole access to documentation, which was secured in a locked file cabinet in her home. Ensuring anonymity for all participants was crucial to the integrity of the research.

Preparation of materials. All lesson plans were created by the researcher and distributed to participants prior to each five-week instructional period. Teachers were provided each instructional unit with ample time to ask clarifying questions before implementation. Detailed instructions, including guiding questions, were provided for each participant. Lesson plans spanned a ten-week period of classroom instruction. Instructional materials were lecture-based or differentiated, depending on the assigned treatment or control group.

CSCOPE curriculum was used as the basis for all lesson plans to ensure district compliance (TESCCC, n.d.). However, lessons were modified using PowerPoint presentations, Interactive White Board flipcharts, vocabulary activities, games, and other components of differentiated instruction. All copies, worksheets, and materials were provided at the beginning of each five-week research period. Participants were observed four times during the research period. Two observations were scheduled and two observations were unscheduled. The William and Mary Classroom Observation Scale Revised (COS-R) (2003) was used to determine general teaching behaviors, differentiated teaching behaviors, and overall student responsiveness. A follow-up conference, as prescribed in the observation, took place after each observation.

Research Design

A post-test-only control group design (Creswell, 2009) was used to determine the cause and effect relationship between differentiated instruction in the mathematics classroom and standardized assessment, as measured by benchmark examinations. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting score on the standardized assessment. Student state assessment scores from 2011 were used as a covariant to adjust for individual academic differences. A repeated-measures design was used as the impetus for this study. Subjects were exposed to each level of the independent variable (Howell, 2008). District wide, nine seventh grade teachers participated in the study, and data was collected from 891 seventh grade students. Schools were divided into a control and treatment group, based on similar demographics. Stratified random sampling was used to create comparable control and treatment groups. The control group received no differentiated instruction, and the treatment group received instruction that had been modified by content, delivery, or product. Teachers were provided with lesson plans to ensure all curriculum materials met the criteria for differentiated or lecture-based instruction. Benchmark examinations were used to assess both student groups.

After the initial five-week period, the initial control group received differentiated instruction and the original treatment group received no differentiated instruction. Students were again assessed using a standardized benchmark assessment at the conclusion of the second five-week period, represented in Table 7 (Creswell, 2009). Although lesson plans were provided for each group of teachers, attitudes, motivational strategies, and student learning styles were varied in the control and treatment groups. Assigning control and treatment groups to individual teachers was not an option in this study. Each participating campus was required to implement consistent lessons for each class of students to ensure district policy compliance. Therefore, to gain a more accurate description of student competencies, results from the second five-week period were used as a second data set of student results to eliminate confounding. Repeating the experiment assisted in eliminating internal validity issues such as the Hawthorne effect or compensatory rivalry (Ary et al., 2006). Manipulation of the independent variable in two distinct research trials minimized extraneous variables, ensuring greater accuracy of statistical results.

Table 7

Post-Test-Only Control-Group Experimental Design

1st Five-Week Period			
Campuses A and B	X1	———	O
Campus C	X2	———	O
2nd Five-Week Period			
Campuses A and B	X2	———	O
Campus C	X1	———	O

Note. X1 = group receiving differentiated instruction; X2 = group receiving lecture-based instruction; O = benchmark assessment to observe progress (Creswell, 2009). Campuses A and B received differentiated instruction during the first five-week period; Campus C received lecture-based instruction. Campuses A and B received lecture-based instruction during the second five-week period; Campus C received differentiated instruction.

Creating a valid and reliable assessment is critical for accurate reporting of data (Myers, 2008). The standardized benchmark examinations were used to determine student performance of the control and treatment groups. Therefore, the instrument was expected to accurately measure the performance objectives with limited bias. Although no test is without some type of error, every attempt was made to ensure a valid and reliable assessment was created. The following process was followed to create the benchmark assessments:

- Each learning objective was identified and documented for the five-week period, based on the district scope-and-sequence, which clearly delineated the TEKS to be taught and at what depth and specificity.

- Target objectives were identified for the testing period, based on the importance of each TEK as a foundational standard and frequency of appearance on the TAKS (see Appendix N).
- An equivalent number of test items was assigned for each target objective, resulting in a testing blueprint for each five-week period (see Appendix O).
- Questions were released Texas Assessment of Knowledge and Skills (TAKS) items from 2004, 2006, 2008, 2009, 2010, and 2011 because of the reliability and validity of each assessment item (Stiggins, Arter, Chappuis, & Chappuis, 2006). Copyright permission was granted from Pearson Publishing and the Texas Education Agency (TEA) to use each of the TAKS released items (see Appendices P and Q).

Data Collection

The TSI (Silver et al., 1980) provided the data needed to determine the predominant modes of teaching in the mathematics classroom. Teachers were provided with the instrument at the initial meeting when informed consent was discussed. Nine out of 10 teachers agreed to participate in the study and were given the inventory and self-addressed stamped envelope. Participants were asked to return the survey within seven days in the packet provided. The inventory was anonymous, and teachers were encouraged to make a copy to keep for their records. After seven days, only four surveys were returned; therefore, teachers were sent an e-mail reminder concerning submission of the surveys. Nine surveys were distributed at the research overview, and 100% were returned for evaluation.

The COS-R (VanTassel-Baska, et al., 2003) provided quantitative data of the types of differentiated instruction being implemented in the mathematics classroom. Although lesson plans were created and provided for each of the participants, the observation tool allowed the observers to determine which strategies were being used and how students responded to each of the strategies. Some teachers may have reverted to previous teaching practices, which were evidenced through classroom visitations. The purpose of conducting classroom observations was to ensure the integrity of the control and treatment groups. Participants did not receive a copy of the instrument until all observations were completed. Ensuring that teachers did not modify their instructional methods to align with the scoring criteria provided more reliable results.

The research questions, “What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS), when differentiated instruction is implemented for all student populations?” and “What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?” were assessed using benchmark examinations. Copies were distributed to each teacher involved in the study. Answer keys were created using a current software program in the participating district. Each question was linked to the targeted TEKS for a detailed analysis of student results. Electronic answer keys provided efficient scoring and minimized human error.

Teachers were not provided with the assessment until the testing window began at the end of each five-week research period. Examinations and answer keys were hand-delivered by the researcher to each participating teacher. Ensuring security of test items increased reliability of data collected. Once students completed the examinations, answer keys were scored at each campus by the testing coordinator using a high-speed scanner. Results were provided immediately, and teachers had the availability to view their students' scores only. Once all documents were scanned into the system, detailed student performance reports were available. The researcher had exclusive access to reports, using a password-protected login.

Student TAKS scores from the previous grade level were used as a covariant to adjust for pre-existing conditions in student differences. Obtaining the confidential information required submission of a written request for records to the District Director of Research and Evaluation. Individual 2011 Texas Assessment of Knowledge and Skills (TAKS) scores, including special population coding, were provided for each seventh grade student enrolled in the district. The password-protected file listed students by district identification (ID) number and removed all student identifers. Benchmark assessment reports were created using student ID numbers only. Ensuring numerical data was accurately assigned to each participant was necessary to maintain integrity of the research. The use of student ID numbers allowed for covariants to be linked to each of the benchmark assessments.

Data Recording

Prior to desegregation to the data, a spreadsheet was created, based on district student identifiers, for compilation of the research components. The initial spreadsheet contained the following information: (a) student ID number, (b) 2011 Texas Assessment of Knowledge and Skills (TAKS) score; (c) benchmark assessment 1 score; (d) instructional method for benchmark assessment 1; (e) benchmark assessment 2 score, and (f) instructional method for benchmark assessment 2; (g) binary coding for special education; (h) binary coding for economically disadvantaged; (i) binary coding for English language learners; (j) binary coding for at-risk, and (k) binary coding for gifted. Special education students received a 1 in the appropriate column and those who were not in special education received a 0. The same procedure applied to students coded as economically disadvantaged, English language learners, at-risk, and gifted. Spreadsheets were created for each of the following categories:

- all students (ALL),
- special education students (SPED),
- economically disadvantaged (ED),
- English language learner (ELL),
- at-risk (AR), and
- gifted and talented (GT).

Upon completion of the categorical classifications, any student who did not have a benchmark score from each research period and a 2011 TAKS score were excluded from the sample population. Numbers were sorted numerically from least to greatest, and every tenth student was chosen as a part of the random sample. Random selection continued for each of the reporting categories until the sample population was reached. Thirty-four students were chosen from differentiated instruction, and 34 from lecture-based instruction for a total of 68 students in each subgroup. Sample populations were consistent for both research periods. Smaller numbers of students are coded for special education or gifted categories; therefore, sample sizes of 16 for each category were significantly smaller than the other subgroups.

District student identification numbers were replaced with an alternate numerical system to assure anonymity. New identifiers were assigned an “a” for the control group and a “b” for the treatment group; numbers ranged between 100 and 634. Numbers were assigned as follows: (a) 100-134 were participant scores representing the overall student population, (b) 200-234 represented special education, (c) 300-334 denoted participant scores for economically disadvantaged results, (d) 400-434 represented English language learners, (e) 500-534 represented at-risk student scores, and (f) 600-634 symbolized gifted participant scores. Random selection followed by assignment of new numerical identifiers eliminated the possibility of students being identified because of their listing order.

Once all sample populations were created, a paired *t*-test was conducted to determine if scores differed significantly based on control and treatment groups. To determine if pre-existing factors had an effect on student scores, an analysis of covariance (ANCOVA) was used to analyze the results to determine if significant differences were present for students exposed to differentiated instruction compared to students not exposed. Groups were not matched exactly; therefore, the covariant to adjust for differences was the student Texas Assessment of Knowledge and Skills (TAKS) scores from 2011. Interaction between students and the researcher did not occur. Numerical data was collected based on benchmark assessment results. Confidential data was stored in a password protected file on my home computer, and survey instruments and classoom observations remained in a locked file cabinet in my home. Original score reports with district student identification numbers were shredded and destroyed, once a spreadsheet with random student identifiers was created.

Data Analysis

Determining the required sample size prior to beginning the study ensured sufficient data collection. A one-tailed or directional test was used to reject the null hypothesis when alpha (α) = .05. The optimal number of participants was computed using a power of .90 or 90% and a medium effect size of .50 as shown in Table 8 (Ary et al., 2006).

Table 8

Determination of Appropriate Sample Size

$$N = \left(\frac{1}{\Delta}\right)^2 (z\alpha + zB)^2$$

$$N = \left(\frac{1}{.50}\right)^2 (1.645 + 1.28)^2 = 34.225$$

Sample Size = 34 Participants for Each Category.

Note. "N = number needed in the sample; Δ = specified effect size; *zα* = *z* score for the level of significance; *zB* = *z* score for the desired probability of rejecting the null hypothesis (1 – *B*)" (Ary et al., 2006, p. 187).

Immediately following random selection of participants, data was analyzed to determine teaching styles, instructional strategies, and statistical significance of benchmark results. Quantitative data collected from the Teaching Style Inventory (TSI) provided insight into predominant modes of instruction in the mathematics classroom. Instruments were scored based on individual responses. Participating teachers self-assessed by assigning a rating of 0, 1, 3, or 5 to four statements in 14 teaching categories. Numerical values from each category provided data to input into the TSI scoring sheet. Teachers' preferred styles were representative of one or more of the following categories:

- mastery (sensing and thinking),
- understanding (intuition and thinking),
- interpersonal (sensing and feeling), or
- self-expressive (intuition and feeling).

Classroom observation data documented the types of differentiated strategies being implemented in the mathematics classroom. Furthermore, the instrument served as evidence that teachers were actively participating in the study. The Classroom Observation Scales Revised (COS-R) is a Likert-style instrument. Each teaching category was scored with the following:

- "3" is effective,
- "2" is somewhat effective,
- "1" is ineffective, and
- "N/O" is not observed.

Data obtained from each observation received a mean score for the following categories: general teaching behaviors, differentiated behaviors, critical thinking strategies, creative thinking strategies, and research strategies (VanTassel-Baska et al., 2003).

The consensus form, which was the final decision of both observers, was used to find the mean score for each category to reduce bias. Data was also collected using the consensus student observation form. Student responses to general classroom teaching behaviors were scored as follows:

- "Most" (Greater than 75% of students) were scored a "4";
- "Many" (50% to 75% of students) were scored a "3";
- "Some" (25% to 50% of students) were scored a "2";
- "Few" (Less than 25% of students) were scored a "1";
- "None" (No students) were scored a "0."

Mean scores were calculated for the following reporting categories: (a) student responses to general classroom teacher behaviors, (b) student responses to differentiated teaching behaviors, (c) self-directed activities, (d) problem-solving, (e) critical thinking, (f) creative thinking, and (g) mean scores for individual teachers. Two scheduled and two unscheduled observations provided evidence of active participation in the study. Benchmark data was evaluated to answer the following: "What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS), when differentiated instruction is implemented for all student populations?" and "What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?"

Research was conducted using a quasi-experimental research design because classes were established prior to the research period and random assignment was not possible. Initially, data was analyzed using a paired *t*-test for independent means to determine if a significant difference was present between student performance on each benchmark. Further analysis was necessary because of pre-existing differences in student populations for the control and treatment groups. A one-way analysis of covariance (ANCOVA) was used to adjust for initial differences. A covariate was used to "remove extraneous variation from the dependent variable, and thereby, increase the precision of the analysis" (Wildt & Ahtola, 1978, p. 8). Texas Assessment of Knowledge and Skills (TAKS) results from the 2010-2011 school year were used as a covariant, due to the extensive field testing and reliability of the state standardized assessment.

Quantitative benchmark data was entered into a Statistical Package for the Social Sciences (SPSS) database for analysis. Using an ANCOVA statistical test, analysis was conducted on the performance of the following groups: (a) all students, (b) special education students, (c) economically disadvantaged, (d) English language learners, (d) at-risk, and (e) gifted. Comparisons between method A (differentiated instruction) and method B (non-differentiated instruction) were conducted for each five-week period to determine if significant differences were present for each population, based on control and treatment groups. A Levene's test was conducted to test for homogeneity of variances for each sample set to ensure the slopes of the regression line did not significantly differ from the slope of the overall within-groups regression (Muijs, 2004). Linearity of each data set was tested using a scatterplot. An alpha level of .05 was used to determine if each null hypothesis could be rejected. Data analysis identified the significance of the type of instruction implemented in the middle school mathematics classroom.

Validity Issues

Several validity issues may have skewed the results of this study. The research focused on analyzing the effects of student performance after teachers implemented differentiated instructional practices. However, if the observed behaviors of teachers were not reflective of typical daily instruction, results may have been misrepresented, threatening the outcome of the study. If teachers incorporated differentiated instructional strategies in the classroom when being observed and reverted to traditional, lecture-based instruction when not being observed, data may be inaccurate. An additional threat to the research was teacher misconception that a certain type of response to the surveys was expected. All participants were encouraged to answer honestly with unbiased responses.

Data may also be biased because students had varying characteristics and levels of intelligence, which may have created extreme scores (Creswell, 2009). The primary limitation of the research was a true random sampling. Focus on a cohort of nine teachers may be problematic if bias is present. A larger scale study using random selection of students and teachers would further validate or dispute the statistical information. Researchers with access to greater financial resources and a larger sample population could support the data or dispute the findings.

An additional threat to validity was a lack of participation from one teacher, limiting the number of students available for random sampling. Moreover, if teachers chose not to include all differentiated activities or made modifications to instruction, without approval from the researcher, the validity of benchmark results are threatened. If the level of difficulty was not consistent on each benchmark examination, results may be skewed. A primary external threat to validity was the possibility that treatment and control groups share lessons, thus impacting the results of the benchmark assessments (Creswell, 2009).

Ethical Issues

The researcher has an ethical responsibility to ensure anonymity for all teacher participants and student data. As an administrator in the focus district, situations occurred when superiors requested access to observation results in an effort to provide assistance needed to teachers and students. However, the researcher had an ethical obligation to protect the anonymity of the participants and, therefore, respectfully declined the request. A prescribed method of data collection was used to minimize personal bias throughout the observation process. Three quantitative data collection instruments were used and compared to minimize bias. The Teaching Style Inventory (TSI) self-assessment instrument (Silver, Hanson, & Strong, 1980) (see Appendix D), the William and Mary Classroom Observation Scales Revised (COS-R) form (VanTassell-Baska et al., 2003) (see Appendix E), and student benchmark performance data assisted in the elimination of partiality. However, one must acknowledge all bias can never be completely eliminated but may be minimized.

Summary

This chapter outlined the methods used in this post-test-only study to determine the effect of differentiated instruction on standardized mathematics assessment performance. A paired *t*-test and an ANCOVA statistical analysis of six independent populations was conducted to determine if significant differences were present between the control and treatment groups using a repeated-measures design. The following chapter presents the results obtained using the methodology previously described.

CHAPTER 4: RESULTS

Purpose of the Study

This purpose of this study was to determine if incorporating differentiated instructional practices in the middle school classroom would affect student performance on standardized assessments, as stated in Chapter 1. In 2011, 21% of seventh grade students and 24% of eighth grade students in the district of study were unsuccessful in meeting a minimum proficiency assessment standard for the state mathematics examination (TEA, 2011a), largely attributed to a lack of differentiation in the middle school mathematics classroom. This chapter presents a chronological analysis of each component of the research plan. Prior to discussion of the research questions and hypotheses, results from the Teaching Style Inventory (TSI) are provided as background information into teaching dispositions prior to the research study. Results from classroom observations are presented to depict instructional components of the research period. The remainder of Chapter 4 will provide statistical analysis for each research question and null hypothesis.

Review of Research Design

This study utilized a post-test-only control group design (Creswell, 2009) to determine the cause-and-effect relationship between differentiated instruction in the mathematics classroom and standardized assessment, as measured by benchmark examinations. Data was analyzed using a paired *t*-test to determine if significant differences were present between control and treatment performance scores for each student population. An ANCOVA was used for further analysis to adjust for initial differences. A repeated-measures design was used as the impetus for this study. Subjects were exposed to each level of the independent variable (Howell, 2008) in two independent research trials.

Schools were divided into a control and treatment group, based on similar demographics. Stratified random sampling was used to create comparable control and treatment groups. The control group received no differentiated instruction, and the treatment group received instruction that was been modified by content, delivery, or product. Teachers were provided with lesson plans to ensure all curriculum materials for the treatment group met the criteria for differentiated instruction. Participants in the control group were also provided curriculum material to ensure consistency of content presented. Students were exposed to 22 days of instruction followed by two days for review and one day for assessment. Following each research period, benchmark examinations were used to assess student performance.

Teaching Style Inventory Results

Prior to beginning the study, teachers completed the Teaching Style Inventory (TSI) (Silver, Hanson, & Strong, 1980) to determine participants' teaching style preferences. Results of the survey indicated wide-ranging preferences for classroom instruction as shown in Figure 6. Four teachers primarily exhibited characteristics of a mastery teaching style, implying they are highly structured and prefer a teacher-centered classroom. Two teachers identified themselves as preferential to the understanding teaching method, encouraging critical thinking and problem-solving. One educator preferred teaching through explorations, encouraging creativity and imagination as a self-expressive teacher. Two teachers represented the interpersonal style of teaching, emphasizing the personal and social aspects of learning. Results indicated that some educators exhibited characteristics from multiple modes of teaching; however, others were predisposed to one primary teaching style.

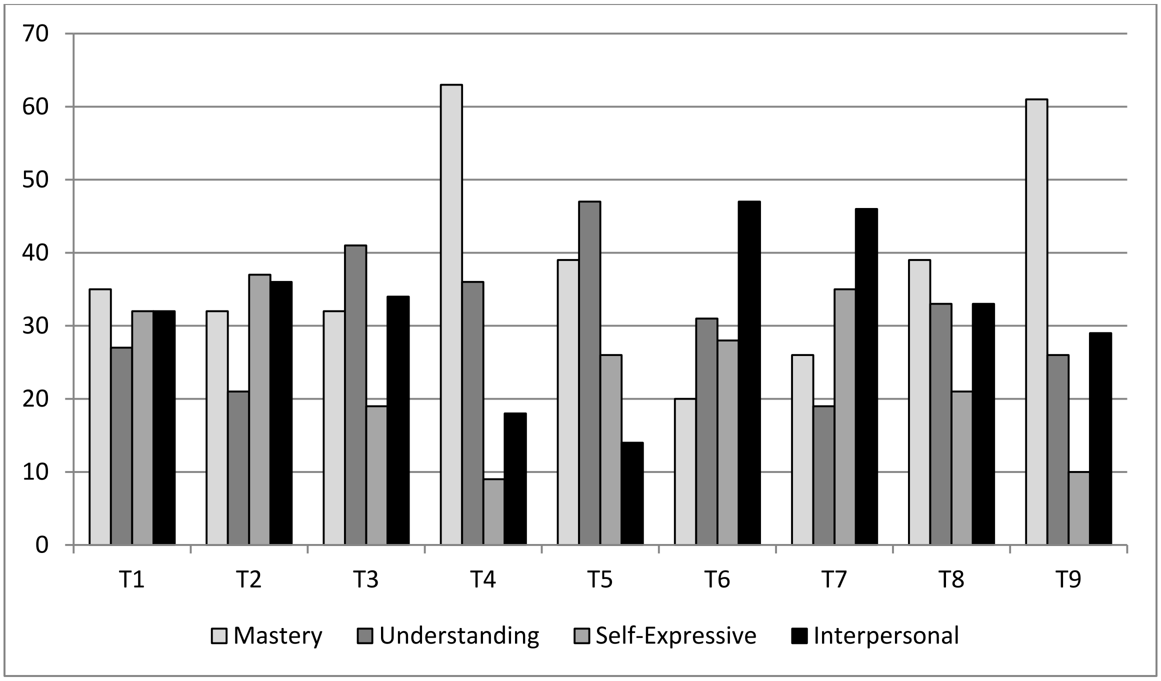


Figure 6. Results of Teaching Style Inventory (TSI, 1980) for participating teachers in the study.

Classroom Observation Results

Four classroom observations were conducted to provide evidence of implementation of instructional practices and to identify areas of deficiency. Following each observation, a consensus form was used to document agreement scores for the evaluating teams. Mean scores were calculated to determine the quality of instructional practices from the instructional viewpoint and in reference to student responses to the strategies (see Appendices R and S). A summary of results, from an instructional viewpoint, is presented in Table 9, followed by student responsiveness to strategies in Table 10. Results for each component were scored on a scale from 1 to 3; strategies that were not observed were labeled as N/O.

Table 9

Summary of Teacher Observation Mean

	Gen. Tch.	Accom.	Prob. Sol.	Crit. Th.	Creat. Th.	Res. Str.
Teacher A						
Treatment	2.0	2.0	1.9	1.9	1.9	2.0
Control	2.0	N/0	2.0	N/O	3	N/O
Teacher B						
Treatment	1.9	2.4	2.3	1.9	1.9	2.2
Control	2.1	1.9	1.5	2.1	1.8	1.7
Teacher C						
Treatment	2.1	2.5	1.9	2.0	1.8	3.0
Control	1.5	1.5	1.7	1.2	1.3	1.7
Teacher D						
Treatment	1.9	1.7	1.9	1.9	1.7	2.7
Control	1.0	1.3	N/O	1.0	N/O	N/O
Teacher E						
Treatment	2.8	2.3	2.7	2.4	2.4	1.7
Control	2.5	2.8	2.5	2.8	3.0	3.0
Teacher F						
Treatment	1.9	1.4	1.8	1.7	2.0	1.0
Control	1.8	1.8	1.8	2.2	1.9	3.0
Teacher G						
Treatment	2.4	2.3	2.7	1.5	2.5	1.5
Control	2.4	2.2	2.5	2.3	2.0	3.0
Teacher H						
Treatment	2.4	1.8	3.8	1.5	1.7	N/O
Control	2.1	1.8	2.0	2.3	2.3	2.3
Teacher I						
Treatment	1.6	1.0	1.3	1.8	1.3	1.6
Control	2.3	2.0	1.5	1.5	1.7	2.0

Note: Gen. Tch. = General Teaching strategies; Accom. = Accommodations for individual differences; Prob. Sol. = Problem Solving; Crit. Th. = Critical Thinking strategies; Creat. Th. = Creative Thinking Strategies; Res. Str. = Research Strategies; N/O represents that the strategy was not observed during the research period. Results are based on a scale from one to three.

Table 10

Summary of Mean Scores for Student Response to Instruction

	Gen. Tch.	Accom.	Prob. Sol.	Crit. Th.	Creat. Th.	Res. Str.
Teacher A						
Treatment	1.7	1.5	2.3	1.5	1.5	1.9
Control	N/O	N/O	N/O	N/O	N/O	N/O
Teacher B						
Treatment	1.8	2.0	1.6	1.8	1.7	1.9
Control	1.2	1.4	1.4	1.3	0.9	2.0
Teacher C						
Treatment	2.3	2.5	1.6	2.3	2.3	3.0
Control	1.4	1.5	1.5	0.8	0.8	1.5
Teacher D						
Treatment	1.4	1.2	1.5	1.2	1.4	2.0
Control	0.8	1.3	0	0	0	N/O
Teacher E						
Treatment	2.3	1.7	1.0	2.1	1.9	1.5
Control	2.4	2.3	3.0	2.4	2.6	3.0
Teacher F						
Treatment	0.9	1.5	1.1	1.5	1.1	1.5
Control	1.4	1.6	1.1	1.6	1.1	3.0
Teacher G						
Treatment	1.1	1.9	1.5	1.1	1.5	0.8
Control	1.6	1.6	1.9	1.7	1.5	3.0
Teacher H						
Treatment	1.8	1.1	2.0	1.6	1.1	3.0
Control	1.7	1.4	1.8	1.4	0.9	2.8
Teacher I						
Treatment	0.7	0.6	0.6	0.5	0.5	0.8
Control	1.1	1.4	1.2	0.6	0.9	1.5

Note: Gen. Tch. = General Teaching strategies; Accom. = Accommodations for individual differences; Prob. Sol. = Problem Solving; Crit. Th. = Critical Thinking strategies; Creat. Th. = Creative Thinking Strategies; Res. Str. = Research Strategies; N/O represents that the strategy was not observed during the research period. Student scores were scaled from a 4-point scoring scale to a 3-point score.

Sample Population

The sample population consisted of 891 seventh grade students and nine seventh grade mathematics teachers. Students with extreme physical disabilities or individuals unable to learn at the same grade level as their peers did not participate in the study. Individuals who did not have a benchmark score for both research periods were not included in the population. In addition, students repeating the seventh grade or those who did not have a covariant TAKS score were not included in the sample population. Stratified random sampling was used to create sample populations for the following: (a) all students, (b) special education students, (c) economically disadvantaged, (d) English language learners, (d) at-risk, and (e) gifted.

Data Analysis

All students were exposed to differentiated and non-differentiated instruction in two independent research trials. A *t*-test was conducted using paired samples to determine if significant differences exists between treatment and control student assessment results. Results are presented in Tables 11 and 12. There was not a significant effect for instruction, t (67) = .158, p = .437, α = .05 for all students (ALL). The type of instruction received for special education (SPED) did not represent a significant effect, t (15) = 1.098, p = .145, α = .05. Similarly, there was no significant effect of instruction, t (67) = .332, p = .371, α = .05 for economically disadvantaged students (ED). No significant effect for instruction was present for English language learners (ELL), t (67) = -1.280, p = .103, α = .05. At-risk (AR) student data did not represent a significant effect, t (67) = -.334, p = .370, α = .05. Furthermore, no significant effect for instruction was present for gifted students (GT), t (15), $p = .381$, $\alpha = .05$.

Table 11

Paired Samples Descriptive Statistics

	Mean	N	Std. Deviation	Std. Error Mean
ALL				
Differentiated	66.35	68	23.25	2.82
Non-differentiated	65.84	68	17.90	17.90
SPED				
Differentiated	70.94	16	23.07	5.77
Non-differentiated	62.63	16	21.74	5.43
ED				
Differentiated	61.37	68	20.12	2.44
Non-differentiated	60.32	68	19.82	2.40
ELL				
Differentiated	60.09	68	20.27	2.46
Non-differentiated	64.24	68	17.76	2.15
AR				
Differentiated	60.47	68	22.56	2.74
Non-differentiated	61.50	68	19.16	2.32
GT				
Differentiated	70.19	16	23.34	5.83
Non-differentiated	72.44	16	13.64	3.41

Note. ALL = overall student population; SPED = special education; ED = economically disadvantaged; ELL = English language learner; AR = at-risk; GT = gifted.

Table 12

Paired Samples t=Test Results

Group	T	Df	Sig.
ALL	.158	67	.437
SPED	1.098	15	.145
ED	.332	67	.371
ELL	-1.280	67	.103
AR	-.334	67	.370
GT	-.309	15	.381

Note. α = .05. ALL = overall student population; SPED = special education; ED = economically disadvantaged; ELL = English language learner; AR = at-risk; GT = gifted.

Results were not statistically significant for any student populations. Therefore, further data analysis was conducted to determine if pre-existing academic factors may have altered student results. An analysis of covariance (ANCOVA) was conducted for each benchmark and population to determine if results were statistically significant when adjusting for initial differences. Benchmark scores were used as the dependent variable, the type of instruction (treatment or control) was the independent variable, and student Texas Assessment of Knowledge and Skills (TAKS) scores were used as the covariant. Use of an ANCOVA equalized differences in ability levels of each group to provide a more accurate description of student performance. The remainder of Chapter 4 will present ANCOVA statistical results for each subgroup of research subjects. Data is provided in reference to each null hypothesis and the research questions guiding the study. Each benchmark examination is reported independently.

Null Hypothesis One and Research Questions

Research Question 1*:* What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS), when differentiated instruction is implemented for all student populations?

Research Question 2*:* What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{01}: Implementing differentiated instructional strategies has no significant effect on the performance of students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Benchmark 1 all students. Table 13 illustrates the ANCOVA results for the first benchmark examination for all students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. Texas Assessment of Knowledge and Skills (TAKS) scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was significant, $F(1, 65) = 6.68$, $p = 0.01$, beyond the .05 level, contradictory to previous results obtained from the paired samples *t*-test. Therefore, the null hypothesis was rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .07$, $p = 0.80$. Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by $r = .55$, indicating a moderate linear relationship between the type of instruction received and standardized benchmark assessment scores. Thirty percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .30$). Adjusted mean scores for the treatment and control groups (T = 74.54, C = 65.31) represented a 9.23 difference.

Table 13

Benchmark 1 Tests of Between-Subjects Effects All Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	5894.31[a]	2	2947.16	13.92	.00
Intercept	95.14	1	95.14	.45	.51
TAKS	3646.06	1	3646.06	17.22	.00
Instruction	1414.97	1	1414.97	6.68	.01
Instruction*TAKS	14.35	1	14.35	.07	.80
Error	13766.32	65	211.79		
Total	352161.00	68			
Corrected Total	19660.63	67			

a. R squared = .30 (Adjusted R squared = .28).

Benchmark 2 all students. ANCOVA results for the second benchmark, based on the entire student population, are shown in Table 14. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The null hypothesis cannot be rejected because the main effect of instruction was not significant, $F(1, 65) = 3.67$, $p = 0.06$. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .01$, $p = 0.92$. Using a one-tailed or directional test, a negative correlation exists between the x and y variables, evidenced by $r = -.22$, indicating a weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Five percent of the variability in benchmark assessments scores is explained by the type of instruction received (r^2 = .05). Adjusted mean scores for the treatment and control groups (T = 56.88, C = 67.65) represent a 10.77 difference.

Table 14

Benchmark 2 Tests of Between-Subjects Effects All Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1929.64[a]	2	964.82	1.84	.17
Intercept	4916.03	1	4916.03	9.36	.00
TAKS	65.88	1	65.88	.125	.72
Instruction	1927.64	1	1927.64	3.67	.06
Instruction*TAKS	5.40	1	5.40	.01	.92
Error	34127.60	65	525.04		
Total	299686.00	68			
Corrected Total	36057.24	67			

a. R squared = .05 (Adjusted R squared = .02).

Null Hypothesis Two and Research Questions

Research Question 1: What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the TEKS, when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{02}: Implementing differentiated instructional strategies has no significant effect on the performance of special education students on standardized mathematics assessment as measured by benchmark examinations utilizing TEKS.

Benchmark 1 special education students. Table 15 illustrates the ANCOVA results for the first benchmark exam for students coded as special education. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was not significant beyond the .05 level, $F(1, 13) = 1.20$, $p = 0.29$; therefore, the null hypothesis could not be rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 13) = .48$, $p = 0.50$. Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by $r = 0.28$, indicating a weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Twenty-eight percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .28$). Adjusted mean scores for the treatment and control groups (T = 69.70, C = 57.30) represented a 12.40 difference.

Table 15

Benchmark 1 Tests of Between-Subjects Effects Special Education Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2573.42[a]	2	1286.71	2.52	.12
Intercept	219.12	1	219.12	.43	.52
TAKS	1789.42	1	1789.42	3.50	.08
Instruction*TAKS	257.11	1	257.11	.48	.50
Instruction	612.07	1	612.071	1.20	.29
Error	6642.59	13	510.97		
Total	73732.00	16			
Corrected Total	9216.00	15			

a. R squared = .28 (Adjusted R squared = .17).

Benchmark 2 special education students. ANCOVA results for the second benchmark are presented in Table 16 for special education students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The null hypothesis cannot be rejected because the main effect of instruction was not significant, $F(1, 13) = .27$, $p = 0.61$, beyond the .05 level. Levene's test for homogeneity of regressions was satisfied, $F(1, 13) = .77$, $p = 0.40$. Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by $r = .62$, indicating a moderate linear relationship between the type of instruction received and standardized benchmark assessment scores. Forty-two percent of the variability in benchmark assessments scores is explained by the type of instruction received (r^2 = .42). Adjusted means for the control and treatment groups represented a 4.42 point difference between the control and treatment groups (T = 72.27, C = 67.85).

Table 16

Benchmark 2 Tests of Between-Subjects Effects Special Education Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2305.81[a]	2	1152.91	3.99	.05
Intercept	302.20	1	302.20	1.05	.33
TAKS	2278.25	1	2278.25	7.89	.02
Instruction	77.86	1	77.86	.27	.61
Instruction*TAKS	225.29	1	225.29	.77	.40
Error	3755.13	13	288.86		
Total	84601.00	16			
Corrected Total	6060.94	15			

a. R squared = .42 (Adjusted R squared = .27).

Null Hypothesis Three and Research Questions

Research Question #1*:* What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the TEKS, when differentiated instruction is implemented for all student populations?

Research Question #2*:* What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{03}: Implementing differentiated instructional strategies has no significant effect on the performance of economically disadvantaged students on standardized mathematics assessment as measured by Benchmark examinations utilizing the TEKS.

Benchmark 1 economically disadvantaged students. Table 17 illustrates the results for the ANCOVA for economically disadvantaged students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was not significant, $F(1, 65) = 3.94$, $p = 0.05$; therefore, the null hypothesis could not be rejected. Using a one-tailed or directional test, a positive correlation existed between the x and y variables, evidenced by $r = .32$, indicating a relatively weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Eleven percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .11$). Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .29$, $p = 0.59$. Adjusted mean scores for the treatment and control groups (T = 60.83, C = 51.93) represented an 8.90 difference.

Table 17

Benchmark 1 Tests of Between-Subjects Effects Economically Disadvantaged Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2561.03[a]	2	1280.51	3.80	.03
Intercept	353.31	1	353.31	1.05	.31
TAKS	920.50	1	920.50	2.73	.10
Instruction	1326.33	1	1326.33	3.94	.05
Instruction*TAKS	341.77	1	341.77	.29	.59
Error	21891.03	65	336.79		
Total	240622.00	68			
Corrected Total	24452.06	67			

a. R squared = .11 (Adjusted R squared = .08).

Benchmark 2 economically disadvantaged students. Table 18 illustrates ANCOVA results for economically disadvantaged students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was not significant, $F(1, 65) = 2.17$, $p = 0.15$; therefore, the null hypothesis could not be rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .42$, $p = 0.52$. Using a one-tailed or directional test, a positive correlation existed between the x and y variables, evidenced by $r = .24$, indicating a weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Six percent of the variability in benchmark assessments scores is explained by the type of instruction received (r^2 = .06). Adjusted mean scores for the treatment and control groups (T = 61.80, C = 68.82) represented a 7.02 difference with increased results for the control group.

Table 18

Benchmark 2 Tests of Between-Subjects Effects Economically Disadvantaged Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1565.07[a]	2	782.54	2.05	.14
Intercept	1118.45	1	1118.45	2.94	.09
TAKS	547.88	1	547.88	1.44	.24
Instruction	825.82	1	825.82	2.17	.15
Instruction*TAKS	161.31	1	161.31	.42	.52
Error	24773.44	65	381.13		
Total	316375.00	68			
Corrected Total	26338.52	67			

a. R squared = .06 (Adjusted R squared = .03).

Null Hypothesis Four and Research Questions

Research Question 1: What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the TEKS, when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{04}: Implementing differentiated instructional strategies has no significant effect on the performance of English language learners (ELL) on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Benchmark 1 English language learners. ANCOVA results for English language learners are represented in Table 19. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. Results indicate that the main effect of instruction was not significant, $F(1, 65) = 1.21$, $p = 0.28$, beyond the .05 level for English language learners; therefore, the null hypothesis cannot be rejected. Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by $r = .18$, indicating a weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Three percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .03$). Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .1.2$, $p = 0.28$. Adjusted mean scores for the treatment and control groups (T = 61.73, C = 53.62) represented an 8.11 difference.

Table 19

Benchmark 1 Tests of Between-Subjects Effects English Language Learners

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	645.10[a]	2	322.55	1.13	.33
Intercept	1118.56	1	1118.56	3.91	.05
TAKS	396.57	1	396.57	1.38	.24
Instruction	346.64	1	346.64	1.21	.28
Instruction*TAKS	341.77	1	341.77	1.2	.28
Error	18618.14	65	286.43		
Total	253852.00	68			
Corrected Total	19263.24	67			

a. R squared = .03 (Adjusted R squared = .00).

Benchmark 2 English language learners. Table 20 presents ANCOVA results for English language learners' second benchmark assessment. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. Results indicate that the main effect of instruction was significant, $F(1, 65) = 7.42$, $p = 0.01$, beyond the .05 level. The null hypothesis was rejected, disputing previous paired *t*-test results. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = 1.74$, $p = 0.19$. Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by $r = .34$, indicating a moderately weak relationship between the type of instruction received and standardized benchmark assessment scores. Twelve percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .12$). Adjusted mean scores for the treatment and control groups (T = 59.02, C = 72.16) represented a 13.14 difference with increased scores for the control group.

Table 20

Benchmark 2 Tests of Between-Subjects Effects English Language Learners

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3250.97[a]	2	1625.49	4.20	.02
Intercept	1033.22	1	1033.22	2.67	.11
TAKS	754.74	1	754.74	1.95	.17
Instruction	2869.58	1	2869.58	7.42	.01
Instruction*TAKS	665.65	1	665.65	1.74	.19
Error	25137.50	65	386.73		
Total	320912.00	68			
Corrected Total	28388.47	67			

a. R squared = .12 (Adjusted R squared = .09).

Null Hypothesis Five and Research Questions

Research Question 1*:* What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the TEKS, when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{05}: Implementing differentiated instructional strategies has no significant effect on the performance of at-risk students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Benchmark 1 at-risk students. Table 21 illustrates the first set of ANCOVA results for at-risk students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. Results indicate that the main effect of instruction was not significant, $F(1, 65) = 1.21$, $p = 0.28$, at the .05 level; therefore, the null hypothesis could not be rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .09$, $p = 0.77$. Using a one-tailed or directional test, a positive correlation existed between the x and y variables, evidenced by $r = .18$, indicating a weak linear relationship between the type of instruction received and standardized benchmark assessment scores. Twelve percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .12$). Adjusted mean scores for the treatment and control groups (T = 61.02, C = 56.45) represented a 4.57 difference.

Table 21

Benchmark 1 Tests of Between-Subjects Effects At-Risk Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	2895.46[a]	2	1447.73	4.61	.01
Intercept	4.00	1	4.00	.01	.91
TAKS	2076.40	1	2076.40	6.61	.01
Instruction	1107.28	1	1107.28	3.52	.07
Instruction*TAKS	28.02	1	28.02	.09	.77
Error	20431.43	65	314.33		
Total	249534.00	68			
Corrected Total	23326.88	67			

a. R squared = .12 (Adjusted R Squared = .10).

Benchmark 2 at-risk students. Table 22 illustrates the ANCOVA results for second benchmark for at-risk students. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was not significant, $F(1, 65) = 3.01$, $p = 0.09$, beyond the .05 level. As a result, the null hypothesis could not be rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 65) = .39$, $p = 0.53$, indicating a moderate linear relationship between the type of instruction received and standardized benchmark assessment scores. Five percent of the variability in benchmark assessments scores is explained by the type of instruction received (r^2 = .05). Using a one-tailed or directional test, a positive correlation existed between the *x* and *y* variables, evidenced by *r* = .22. Adjusted mean scores for the treatment and control groups (T = 59.58, C = 69.01) represented a 9.43 difference with increased scores for the control group.

Table 22

Benchmark 2 Tests of Between-Subjects Effects At-Risk Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1651.33[a]	2	825.67	1.66	.20
Intercept	1317.09	1	1317.09	2.65	.11
TAKS	274.33	1	274.33	17.22	.00
Instruction	1493.89	1	1493.89	6.68	.01
Instruction*TAKS	194.54	1	194.54	.39	.53
Error	32276.79	65	496.57		
Total	315022.00	68			
Corrected Total	33928.12	67			

a. R squared = .05 (Adjusted R squared = .02).

Null Hypothesis Six and Research Questions

Research Question 1*:* What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the TEKS, when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

H_{06}: Implementing differentiated instructional strategies has no significant effect on the performance of students identified as gifted on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS.

Benchmark 1 gifted students. ANCOVA results reflected in Table 23 illustrate gifted student differences for the first benchmark. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. The main effect of instruction was not significant, $F(1, 13) = 1.59$, $p = 0.23$, beyond the .05 level; consequently, the null hypothesis was not rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 13) = .02$, $p = 0.89$. Using a one-tailed or directional test, a negative correlation existed between the x and y variables, evidenced by $r = -.34$, indicating a moderately weak negative linear relationship between the type of instruction received and standardized benchmark assessment scores. Eleven percent of the variability in benchmark assessments scores is explained by the type of instruction received ($r^2 = .11$). Adjusted mean scores for the treatment and control groups (T = 82.59, C = 75.66) represented a 6.93 difference in scores.

Table 23

Benchmark 1 Tests of Between-Subjects Effects Gifted Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	164.20[a]	2	82.10	.84	.46
Intercept	1195.38	1	1195.38	.00	.48
TAKS	7.95	1	7.95	.08	.78
Instruction	155.86	1	155.86	1.59	.23
Instruction*TAKS	2.33	1	2.33	.02	.89
Error	1275.55	13	98.12		
Total	10612.00	16			
Corrected Total	1439.75	15			

a. R squared = .11 (Adjusted R Squared = -.02).

Benchmark 2 gifted students. ANCOVA results for the second benchmark assessment of gifted students are presented in Table 24. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting scores on the benchmark assessment. TAKS scores from 2011 were used as a covariant to adjust for pre-existing differences in academic achievement. Results illustrate that the main effect of instruction was not significant, $F(1, 13) = 1.72$, $p = 0.12$, at the .05 level; therefore, the null hypothesis could not be rejected. Levene's test for homogeneity of regressions was satisfied, $F(1, 13) = 1.17$, $p = 0.30$. Using a one-tailed or directional test, a negative correlation existed between the *x* and *y* variables, evidenced by r = -.28, indicating a moderately weak negative linear relationship between the type of instruction received and standardized benchmark assessment scores. Thirteen percent of the variability in benchmark assessments scores is explained by the type of instruction received (r^2 = .13). Adjusted mean scores for the treatment and control groups (T = 56.88, C = 67.65) represented a 10.77 difference, exhibiting greater scores for the control group.

Table 24

Benchmark 2 Tests of Between-Subjects Effects Gifted Students

Dependent Variable: Benchmark Score					
Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	1008.48[a]	2	2947.16	13.92	.00
Intercept	2376.47	1	95.14	.45	.51
TAKS	546.23	1	3646.06	17.22	.00
Instruction	871.19	1	1414.97	6.68	.01
Instruction*TAKS	588.00	1	588.00	1.17	.30
Error	6597.52	13	211.79		
Total	72122.00	16			
Corrected Total	7606.00	15			

a. R squared = .13 (Adjusted R squared = -.001).

Summary

Two independent research trials were conducted to determine if benchmark assessment scores, utilizing the Texas Essential Knowledge and Skills (TEKS), differed significantly for students who received differentiated instruction compared to those who did not. All students received a differentiated benchmark score and a non-differentiated benchmark score. A paired *t*-test was performed for each student population to determine if significant differences were present between control and treatment scores. Each result was not significant. An ANCOVA was used to determine if initial academic differences affected the statistical results. Students' 2011 TAKS scores were used as a covariant to adjust for group differences. ANCOVA results established that a significant effect was not present between student results and the type of instruction received with two exceptions. The group incorporating all student populations for the first benchmark and the ELL population for the second benchmark represented significant results for student scores and instruction received, disputing original paired samples *t*-test results. Chapter 5 provides detailed discussion and further insight into future implications of the research.

CHAPTER 5: SIGNIFICANCE OF THE STUDY AND CONCLUSIONS

This concluding chapter of the dissertation reiterates the research problem, reviews the methodology of the study, and summarizes the research results presented in the previous chapter. Significance of the results provides insight into the key findings of the study. Also, an examination of the current study in reference to prior research is reviewed to validate the importance of the study. Finally, implications for practice, limitations of the study, and suggestions for future research are evaluated.

Restatement of the Problem

The problem is 21% of seventh grade students and 24% of eighth grade students in the district of study failed to meet the minimum standard on the 2011 state mathematics assessment (TEA, 2011a), which was largely attributed to a lack of differentiation in the middle school mathematics classroom. Many teachers are failing to meet the diverse needs of students and are not providing a differentiated environment for learners (Tomlinson, 2000a, 2000b, 2005). Current data from the TAKS statewide assessment system represents a substantial difference in student performance in elementary grades compared to middle school grades (TEA, 2008a, 2009a, 2010a, 2011a). Special population results, with the exception of gifted learners, indicate a decline or lack of substantial improvement from grades five through eight (TEA, 2008a, 2009a, 2010a, 2011a). At the time of the study, seventh grade students represented a 68% passing standard as sixth grade students compared to an 84% passing rate as fifth grade students.

Study Summary

The purpose of this study was to determine if incorporating differentiated instructional practices in the middle school classroom would have an effect on student performance on standardized assessments. The research focused on the following questions:

Research Question 1: What is the effect on student performance in the middle school mathematics classroom, as measured by benchmark assessments targeting the Texas Essential Knowledge and Skills (TEKS), when differentiated instruction is implemented for all student populations?

Research Question 2: What is the difference between student performance of those who have received differentiated instruction in mathematics compared to student performance of those who have not received differentiated instruction in mathematics as measured by benchmark assessments utilizing the TEKS?

A post-test-only control group design (Creswell, 2009) was used to determine the cause-and-effect relationship between differentiated instruction in the mathematics classroom and standardized assessment, measured by benchmark assessments. The independent variable was the type of instruction received by each student group; the dependent variable was the resulting score on the standardized assessment. Student state assessment scores from 2011 were used as a covariant to adjust for individual academic differences. A repeated-measures design, using two independent research trials, was used for this study. Subjects were exposed to each level of the independent variable (Howell, 2008).

District wide, all seventh grade students and nine seventh grade teachers from the three middle schools in the district of study participated. Nine out of 10 teachers agreed to participate, and data was collected from 891 students. Schools were divided into a control and treatment group, based on similar demographics. Stratified random sampling was used to create comparable control and treatment groups. The control group received no differentiated instruction, and the treatment group received instruction that was modified by content, delivery, or product (Tomlinson, 2000a, 2000b, 2005) for the first five-week period of the research. To eliminate confounding and obtain more reliable results, a second research trial was conducted, exposing the control group to the treatment variable. The control group for the initial research period was assigned to the treatment group for the second trial, and the treatment group from the first research period was assigned to the control group for the second research trial. Moreover, repeating the experiment assisted in eliminating internal validity issues such as the Hawthorne effect or compensatory rivalry (Ary et al., 2006). Manipulation of the independent variable in two distinct research trials minimized extraneous variables, ensuring greater accuracy of statistical results. Teachers were provided with lesson plans to ensure integrity of content delivery and to make certain the treatment group was using strategies that met the criteria for differentiated instruction. Benchmark examinations were used to assess both student groups at the conclusion of each research period.

Prior to beginning the study, teachers self-evaluated their teaching style using the TSI (Silver et. al, 1980). The anonymous survey providing quantitative data of the predominant instructional modes in the mathematics classroom was returned in a self-addressed stamped envelope. Instruments were scored based on individual responses to provide insight into variations in teaching styles. In addition to determining instructional styles, ensuring effective delivery of prescribed lessons was essential to the research process. Therefore, classroom observations were conducted to make sure teachers were effectively implementing lesson plans. Two scheduled and two unscheduled observations were conducted during the research period. I performed all observations with assistance from the Secondary English as Second Language (ESL) Coordinator and the Elementary Mathematics and Science Coordinator. Quantitative data was collected using the COS-R (VanTassel-Baska et al., 2003), documenting the types of differentiated instruction being implemented in the mathematics classroom. A consensus score was determined for each observation, and mean scores were calculated for each.

Benchmark assessments were provided for each participant at the conclusion of each research period. Examinations and answer keys were created using the current software program in the participating district for each testing period. Each question was linked to the targeted TEKS for a detailed analysis of student results. Copies of the assessment instruments were hand-delivered to each campus and answer keys were scored by the testing coordinator using a high-speed scanner. Detailed student reports and performance data were provided immediately. Data was viewed using student identification numbers only to protect the identity of participants. The researcher had exclusive access to reports, using a password-protected login.

Individual differences were evident for the treatment and control groups; therefore, an analysis of covariance (ANCOVA) was used to analyze the results to determine if significant differences were present. Student Texas Assessment of Knowledge and Skills (TAKS) scores from 2011 were used as a covariant to adjust for initial differences. A request for records was submitted to the District Director of Research and Evaluation. Individual student 2011 Texas Assessment of Knowledge and Skills (TAKS) scores, listed only by a numerical identifier, were provided for each seventh grade student enrolled in the district. Special population coding was included in the database. The sample population was selected using stratified random sampling. Participants were randomly selected for the following subgroups: (a) all students, (b) special education, (c) economically disadvantaged, (d) English language learners, (e) at-risk, and (f) gifted and talented. Students who did not have a score from Benchmark 1, Benchmark 2, and TAKS were not included in the sample population. An ANCOVA was conducted for each benchmark, based on specific populations using SPSS.

Summary of Findings

The results of the present study, conducted during two independent research trials, provide insight into the effects of differentiating instruction at the middle school level. Primary focus of the research was to determine if standardized assessment scores differed significantly for students instructed using differentiated strategies compared to students not exposed to differentiated instruction. Research was conducted at the middle school level because of decreasing standardized assessment scores as students progressed from the elementary level to middle school grades. The literature validates the value of differentiated instruction in the classroom from a qualitative viewpoint. However, limited studies have been conducted validating the effect of differentiated instruction on standardized assessments (Dee, 2011; Ernest et al., 2011; McTigue & Brown, 2005; NCAC, 2002). This study emphasizes the importance of continued research to fuse standards-based curriculum to quality instructional programs in today's era of standardized testing and accountability associated with NCLB (2001). Although each research trial provided inconsistent results, observations provided insight into instructional practices that prove beneficial to student learning.

This study tested six null hypotheses for two independent research trials to determine the effects of differentiated instruction on (a) overall student performance, (b) achievement levels of students coded as special education, (c) economically disadvantaged students, (d) English language learners, (e) individuals identified as at-risk of dropping out of school, and (f) gifted and talented learners. A paried *t*-test was applied to the first and second benchmark assessments and determined that no significant differences were present for any of the subgroups using an alpha level of .05. However, pre-existing differences were present for the control and treatment groups, requiring additional statistical analysis. An ANCOVA was used to test each null hypothesis using a p-value with an alpha level of .05.

The research questions addressed the effect of differentiated instruction on standardized assessment scores for students. Each null hypothesis was correlated to the research questions for each subpopulation. The first null hypothesis that implementing differentiated instruction has no significant effect on the performance of students on standardized mathematics assessment as measured by benchmark examinations utilizing the Texas Essential Knowledge and Skills was rejected for the first benchmark assessment, but it was not rejected for the second benchmark assessment.

The second null hypothesis that implementing differentiated instructional strategies has no significant effect on the performance of special education students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS was not rejected for the first benchmark nor the second benchmark.

The third null hypothesis that implementing differentiated instructional strategies has no significant effect on the performance of economically disadvantaged students on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS was not rejected for either benchmark assessment.

The fourth null hypothesis that implementing differentiated instructional strategies has no significant effect on the performance of English language learners (ELL) on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS was not rejected for the first benchmark, but it was rejected for the second benchmark.

The fifth null hypothesis that implementing differentiated instructional strategies has no significant effect on the performance of at-risk students as measured by benchmark examinations utilizing the TEKS was not rejected for either benchmark assessment.

The sixth null hypothesis that implementing differentiated instructional strategies has no significant effect on the performance of students identified as gifted on standardized mathematics assessment as measured by benchmark examinations utilizing the TEKS was not rejected for either benchmark assessment.

A significant difference was not established for all student populations in each research trial of this study. Although the null hypotheses were rejected for the overall student population for the first benchmark assessment and ELL students for the second benchmark assessment, the results are inconsistent. Irregularly in results and small populations of special education students and gifted learners create reservations about precision of the study. One must consider the factors that may have affected the outcome of the study to understand possible barriers of reliable results. Additionally, placing an emphasis on controlling these obstacles may provide future researchers with a more systematic approach for enhanced data collection methodology.

Discussion of Results

Determining the effect of differentiated instruction on level of student achievement on standardized assessment cannot be determined by this study alone because of inconsistency in student data. However, several fundamental principles of classroom instruction can be gleaned from the research. Teaching styles are diverse, and the methods for integrating differentiated strategies were varied based on teacher perception, evidenced through classroom visits. Lesson plans were provided for all teachers participating in the study with explicit instructions to ensure optimum instructional delivery. Vocabulary, objectives, guiding questions, group activities, games, and group strategies were furnished with precise guidelines. However, the influence of each participant's teaching style was evident in classroom observations.

Each teaching style has specific characteristics including instructional strategies and preferred student activities (Silver et al., 1980). Four teachers self-evaluated as mastery teachers, characterized as instructional managers who emphasize organization, memorizing, and providing information to students. Primary student activities for this teaching style include workbooks, demonstrations, and drill. Two educators identified themselves as possessing an understanding teaching style, focusing on theoretical inquiry and challenging student intellect. This style emphasizes critical thinking and concept development through discovery and independent learning. One teacher was considered self-expressive, concentrating on serving as a facilitator through open-ended and creative activities. The interpersonal teaching style was demonstrated by two participants. Nurturing and supporting students through games, sharing of personal experiences, and group projects are characteristic of this teaching style. Differentiation of content may have proven more difficult for participants who prefer a mastery teaching style when compared to other favored modes. In contrast, some teachers provided additional differentiation when assigned to the control group because of their pedagogical principles. Each situation may have occurred, leading to skewed performance results.

Classroom observations revealed adherence to and deviations from the prescribed units of study. Integration of specific differentiated activities was evidenced throughout the observations as follows:

- The use of hands-on activities was evident for all teachers, in each of the research periods.
- Video clips and music were incorporated into lessons for student engagement as prescribed in classroom lessons.
- Worksheets that incorporated scaffolded instruction were used in every classroom.
- Foldable activities to present students with hands-on graphic organizers and vocabulary instruction were used in each treatment group.

Prominent areas of concerns were as follows:

- Group activities were used for individual instruction.

- A review lesson of content from the first 5-week instructional period was implemented by one teacher in the control group.
- Only one teacher completed the prescribed outdoor hands-on activity in the treatment group.
- Real-world scenarios were read to students without allowing them to reflect on the situation presented. The critical thinking and brainstorming components of the lesson were omitted.
- Classroom games, intended for assessment review, were omitted.
- Flipcharts created for the Interactive White Board (IWB) were omitted or were not used as a student tool for learning.
- Class discussion and partner activities were lacking in the majority of classrooms.

Classroom observations revealed that the treatment group for the first research period used the IWB flipcharts provided by the researcher to provide visual mathematical representations. However, there was no evidence that the treatment group for the second research period incorporated any IWB activities or flipcharts. Evidence of differentiated activities was scarce for the treatment group, which may account for the variations in assessment results. The second independent research trial revealed that teachers in the control group had higher student scores than teachers in the treatment control, indicating the results from the initial research trial were more valid, which demonstrated improved performance of students exposed to differentiated instruction.

Reflection of the study reveals several aspects that could be improved for future research. First, 16 differentiated strategies were included in each research period, which may have proven overwhelming for the participants. Repetition of this study, focusing on fewer differentiated strategies, may provide enhanced reliability of student performance results. Second, more time was needed to communicate effectively and model step-by-step instructions for each activity. Finally, more time needs to be dedicated to classroom observations. Time constraints limited the observation teams to a maximum of four classroom visits, but increased observations would provide greater insight into participants' adherence to mandatory activities.

Relationship of the current study to prior research. Each of the previously mentioned inconsistencies reinforced the support structures necessary for effective curriculum delivery, supported throughout the literature. VanSciver (2005) stated, "Differentiated instruction is time-consuming, resource-intensive, and complex" (p. 39). Therefore, implementation requires dedication, commitment, and a desire for change in the classroom from educators (Beecher & Sweeney, 2008; Douglas et al., 2008; Rock et al., 2008). For the current study, this researcher acknowledged that without instructional support, collaboration, and ongoing professional development, differentiated instruction will not be successful.

The literature emphasizes specific areas of deficiency associated with standardized assessments and special populations of students. Data analysis determined the performance of various student groups on standardized assessments, following the implementation of differentiated instruction. Results from the second benchmark assessment were comparable for all categories; however, the first benchmark revealed that economically disadvantaged students, English language learners, and at-risk students received adjusted mean scores that were approximately 10 points lower than the overall student population, typical of current trends. A 7-year study by McNeil, Coppola, Radigan, and Helig (2008) determined the following: "In the state of Texas, whose standardized, high-stakes test-based accountability system became the model for our nation's most comprehensive federal education policy, more than 135,000 youth are lost from the state's high schools every year" (p. 2). Standardized testing has created a system of inequity for those students struggling with academic barriers and does not accurately measure student learning (Duran, 2008; Giambo, 2010; Lavadenz & Armas, 2008; Nichols, 2007; Solorzano, 2008; Tan, 2011).

Gifted learners attained adjusted mean scores that were approximately 10 points higher than other categories for the first benchmark assessment but were the lowest performing category for the second assessment, substantiating the need for enrichment and challenge for this group of students. All students are required to be proficient in mathematics by 2014 (NCLB, 2001); however, "there are no penalties for schools failing to meet the needs of those students performing above or far exceeding the standard" (McAllister & Plourde, 2008, p. 41). Enrichment activities were provided for this group of students, but one cannot ensure the materials were implemented. Modifying instructional practices to meet the needs of all students requires time and preparation. If teachers do not find value in enrichment, gifted learners will not reach their full academic potential (French et al., 2011; Manning et al., 2010; Matthews & Farmer, 2008; McAllister & Plourde, 2008; Powers, 2008; Scot et al., 2009; Wormeli, 2011).

Treatment and control results did not differ significantly for special education students; however, data revealed that the treatment groups had higher adjusted mean scores for both benchmark assessments. The majority of special education participants were enrolled in a resource mathematics class, with approximately six students per class. Classroom observations indicated consistent use of the IWB, manipulatives, scaffolded instruction, vocabulary strategies, instructional foldables, group activities, and hands-on instruction. Each activity was research-based, supporting increased performance for special education students (Acrey et al., 2005; Broderick et al., 2005; Goldsby, 2009; McDuffie, Mastropieri, & Scruggs, 2009; Tieso, 2003).

Analysis of the data provided inconclusive results; however, one specific research-based activity was prevalent in classes where students exhibited higher performance, which may be directly correlated to current research studies. Through classroom observation evidence, two regular education teachers repeatedly engaged students through the use of the Interactive White Board (IWB). Adjusted student mean scores were considerably higher for those teachers in both the treatment and control groups. Increased scores may be positively correlated with use of this type of technology to engage students, provide visual representations, and enhance the learning of complex mathematics (Hofer & Swan, 2008; Many-Ikan et al., 2011; Moore, 2008; Oleksiw, 2007; Starkman, 2006; Swan 2007).

Increased demands and accountability have become overwhelming for many professionals as described in the following quote: “A rigorous schedule impinges on coplanning time, while paperwork consumes what little planning time is available. Limited support, scant resources, and inadequate professional development further hinder efforts to serve the needs of students” (Rock et al., 2008, p. 31). Overcoming these challenges is no easy task but success is possible with the right attitude and training. In summary, NCLB (2001) requires that high expectations become the norm for all students and educators must ensure that all students are successful.

Implications for practice. The intent of this study was to determine the effects of differentiated instruction on standardized assessment performance. Assessment results were ambiguous, and a valid conclusion could not be established from the data. However, three distinct implications for practice were derived from quantitative teacher inventories and classroom observation results, supported throughout the literature. First, differentiated instruction is a not only a teaching strategy, but an attitude toward helping all students achieve success. Second, ongoing professional development is a critical component of implementing differentiated instruction. Third, without collaboration and support, teachers will become overwhelmed and become discouraged when trying to meet the varied needs of a diverse population.

Teaching styles and attitudes vary among teachers; therefore, without recognizing the value of modifying curriculum by content, process, and product, transformation will not happen (Douglas et al., 2008). Change can be achieved by creating a positive campus climate focused on individual student achievement. Educators must evaluate their current instructional practices, critically analyzing the students benefitting from current strategies, and determine how instruction can be modified to meet specific needs (Broderick et al., 2005). Differentiation is a pedagogical approach to teaching and often requires veteran and novice teachers to change their mindset toward structured learning (Hofer & Swan, 2008). Each of the above changes can take place but require support from administrators and district personnel (Asaf, 2008; Lawrence-Brown, 2004; Manning et al., 2010).

Continuing staff development is needed for effective implementation of differentiated instruction (Beecher & Sweeney, 2008; Logan, 2011; Moss et al., 2011). Teachers are encouraged to challenge students to think critically, continually assess learning, and collaborate with parents and colleagues for success. Implementing varied instructional practices requires productive, ongoing staff development. Tomlinson (2005) stressed, “Staff development is reflective, informed, diagnostic, connective, application-oriented, problem-focused, quality-concerned, collaborative, supportive, sustained, and differentiated” (p. 11). Professional training is essential to empower teachers and provide a pathway for successful implementation.

Collaboration is a critical component of creating a quality differentiated curriculum (Lewis & Batts, 2005; Rock et al., 2008; Sherman, 2009; Swan, 2007). Teachers are often overwhelmed by lesson planning and finding resources to meet the needs of all learners. Established support systems assist teachers in becoming productive, valued members of the educational setting. Teachers overwhelmed with the concept of differentiating instruction would benefit from the following:

- Assign teachers experienced in differentiated instruction to mentor a teacher who is a novice in reference to differentiation. Collaboration, observations, lesson planning, and an opportunity for personal reflection provide a strong support system.
- Allow teachers an opportunity to observe effective differentiated lessons in person, via technology, or through recorded lessons.

Many schools already have peer mentors in place to assist new teachers. Revising existing programs would provide educators with the support needed to create a more productive learning environment (Carolan & Guinn, 2007; Latz et al., 2009).

Teachers who have never differentiated instruction must understand that creating a modified classroom cannot be perfected immediately; change requires time, patience, and practice. One is not expected to apply numerous strategies overnight, and teachers must take small steps toward implementation. Most teachers are already using strategies in their classroom that can be tailored to maximize student learning. Technology, visual aids such as diagrams or concept maps, and hands-on projects should already be components of the curriculum. Each of these tools can be modified to allow for differentiation in the classroom. Flexible, motivated, and enthusiastic teachers will transfer this impetus to students.

Limitations of the Study

Several limitations were encountered throughout this study, threatening validity of the findings. Research was conducted in two independent trials to minimize extraneous variables; however, results were inconclusive. The lack of continuity is largely attributed to human behavior. All lesson plans were created for participants; however, the researcher had no control over lesson plan implementation. Although each classroom observation revealed information about events taking place in the classroom, documenting specific details of the research period was not possible with time constraints. If one research trial had been conducted, results would be misrepresented, evidenced from the variability in the treatment and control groups. A difference in each of the research trials could have been attributed to many factors.

Primary limitations of the research were variations in participants' teaching styles and attitudes concerning differentiated instruction. Incorporation of differentiated instructional strategies may have proven more difficult for participants who favored lecture-based teaching methods. Additionally, participants who consistently use differentiated strategies may have had difficulty using a more direct-teach approach when assigned to the control group. Effective implementation of differentiation requires a positive attitude from teachers. Teachers who believe in the concept of providing multiple modes of learning for students will become an impetus for change; otherwise, the practice will be unsuccessful. Some activities were not used by participants, indicating they did not see the value of the instructional methods. For example, only one teacher out of four used prescribed outside activities because of a lack of time. The naturalist approach to learning was not considered a vital instructional component, supporting the principle that a differentiated pedagogical belief is critical for effective classroom implementation.

An additional limitation of this study was a small sample population. Nine out of 10 teachers volunteered to participate. Some may have been enticed by receiving ready-made lesson plans, classroom supplies, or the idea of having someone else complete all classroom preparation materials. Random student data was selected for analysis using stratified random sampling. However, student diversity was varied in the participating schools, which may have affected the sample data. Potential confounding variables such as differences in classroom and school environments, socio-economic status, parental support, and administration expectations presented further limitations. The impact of other stakeholders outside of the classroom environment was beyond the scope of this study.

A final limitation of this study was the amount of time available to train teachers on effective lesson plan implementation. Although each teacher in the study previously received training on differentiated instruction, allowing more time to model each lesson would have been beneficial. The primary investigator met with all teachers prior to each research period to examine lesson plans, review non-negotiable strategies, and answer questions pertaining to the curriculum documents. Although the sessions were deemed successful at the time, hindsight revealed that each lesson should have been modeled to ensure research expectations were met. Each of the aforementioned limitations may have affected results of the study and may account for the control group scoring higher than the treatment group on the second benchmark examinations.

Suggestions for Future Research

Additional research into the effects of differentiated instruction on standardized assessments is needed for empirical validation, based on the inconsistency of results in this study. Although significant differences were only noted for two subpopulations of students, the difference in adjusted mean scores cannot be ignored. Adjusted treatment mean scores for the first benchmark assessment are considerably higher than the students exposed to non-differentiated instruction. In contrast, with the exception of special education students, results from the second benchmark exhibit that the adjusted mean scores for all other populations were higher for the control group than the treatment group. Future studies would benefit from having a larger participant pool and increased data samples. Research that incorporates a training period for participants may considerably alter the outcome of results. Replication of this study's methodology, incorporating additional classroom observations and training, would potentially provide empirical evidence concerning the effects of differentiated instruction on student performance on standardized mathematics assessments.

Conclusion

Teachers face immense accountability pressure because of standardized testing. Recognizing that differentiated instruction does not impede student progress on standardized assessment may challenge some of the current perceptions of classroom instruction. Creating an environment in which all students can achieve success must become the focus of educational initiatives. Teachers who implement differentiated instruction can provide the tools needed to achieve this goal. Numerous sources document the need for modified instruction and implementation strategies. However, research is limited validating or nullifying the impact of differentiated instruction on academic achievement, which demonstrates the need for additional inquiry and exploration in this domain.

Successful implementation of differentiated instruction requires a positive teacher mindset, professional development, and mentoring for strategies to be successfully integrated. Educators who differentiate learning are focused on varying activities, allowing student choice, promoting personal connections to the learning, and challenging all students to achieve high expectations. Psychological discoveries, an increased focus on testing, and educational policy have transformed instructional principles and views of curriculum development. High-stakes testing is a reality for educators in the Texas education system. Guaranteeing quality instruction while ensuring students are adequately prepared to successfully meet a minimum state standard remains a concern for educators faced with increased accountability. Walker (2002) assessed, “The message American society often unwittingly sends to students is to aim for academic adequacy, not academic excellence” (p. 13). Differentiation focuses on all learners and individual capabilities rather than mid-level instruction. The No Child Left Behind Act (2001) required equity for all student populations. Therefore, one cannot justify allowing individuals capable of academic or creative excellence to achieve mediocrity; all must be challenged to achieve their maximum potential. In summary, new obstacles will present themselves in education on a continuing basis. Finding effective ways of creating 21st century learners, capable of excelling globally, must be the motivating force of today’s education system.

REFERENCES

Abrams, P. A. (2001). *Learning style inventory for students: Statistical analysis.* Retrieved from http://www.thoughtfulclassroom.com/Lsis_research_report.pdf

Activities Integrating Math and Science (AIMS) Foundation. (2009). *Proportional reasoning: Algebraic thinking series*. Fresno, CA: AIMS Education Foundation.

Acrey, C., Johnstone, C., & Milligan, C. (2005). Using universal design to unlock the potential for academic achievement of at-risk learners. *Teaching Exceptional Children, 38*(2), 22-31.

Adaramola, O. M., & Alamina, J. I. (2008). Effect of mathematical games on Nigerian students' performance in mathematics in secondary schools in Port Harcourt Metropolis. *European Journal of Scientific Research, 20*(2), 255-264.

Anderson, K. M. (2007) Tips for teaching: Differentiating instruction to include all students. *Preventing School Failure, 51*(3), 49-54.

Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2006). *Introduction to research in education* (7th ed.). Belmont, CA: Thomson Wadsworth.

Assaf, L. C. (2008). Professional identity of a reading teacher: Responding to high-stakes testing pressures. *Teachers and Teaching: Theory and Practice, 14*(3), 239-252. doi: 10.1080/13540600802006137

Au, W. (2007). High-stakes testing and curricular control: A qualitative metasynthesis. *Educational Researcher, 36*(5), 258-267. doi: 10.3102/0013189X07306523

Bailey, J. P., & Williams-Black, T. H. (2008). Differentiated instruction: Three teachers' perspectives. *College Reading Association Yearbook, 29*, 133-151.

Beecher, M., & Sweeny, S. M. (2008). Closing the achievement gap with curriculum and differentiation: One school's story. *Journal of Advanced Academics, 19*(3), 502-530.

Belenky, D. M., & Nokes, T. J. (2009). Examining the role of manipulatives and metacognition on engagement, learning, and transfer. *The Journal of Problem Solving, 2*(2), 102-129.

Beyond Entertainment (Producer). (2010). *Cricket chirps*. [Video segment]. Retrieved from http://www.discoveryeducation.com/

Brimijoin, K. (2005). Differentiation and high-stakes testing: An oxymoron? *Theory Into Practice, 44*(3), 254-261.

Brimijoin, K., Marquissee, E., & Tomlinson, C. A. (2007). Using data to differentiate instruction. In K. M. Cauley, J. McMillan, & G. Pannozzo (Eds.), *Educational Psychology 06/*07 (pp. 137-139). Dubuque, IA: McGraw-Hill Contemporary Learning Services

British Educational Communications and Technology Agency. (2008). *Harnessing Technology Schools Survey 2007: Analysis and key findings.* Retrieved from http://www.bee-it.co.uk/Guidance%20Docs/Becta%20Files/Reports%20and%20publications/Becta%20Research/46a%20Harnessing%20Technology%20schools%20survey%202007%20-%20Survey.pdf

Broderick, A., Mehta-Parekh, H. & Reid, D. K. (2005). Differentiating instruction for disabled students in inclusive classrooms. *Theory Into Practice, 44*(3), 194-202.

Burnett, B., & Lampert, J. (2011). Teacher education and the targeting of disadvantage. *Creative Education, 2*(5), 446-451. doi: 10.4236/ce.2011.25064

Butzin, S. M. (2007). NCLB: Fix it, don't nix it. *Phi Delta Kappan, 88*(10), 768-769.

Campbell, B. (2008). *Handbook of differentiated instruction using the multiple intelligences.* Boston, MA: Pearson Education.

Carifio, J., & Everritt, A. (2007). Further validation of Hanson's learning profile indicator and Silver, Hanson, and Strong's teaching style inventory. *IOS Press, Work 29*, 165-174.

Carolan, J., & Guinn, A. (2007). Differentiation: Lessons from master teachers. *Educational Leadership, 64*(5), 44-47.

Cass, M., Cates, D., Smith, M., & Jackson, C. (2003). Effects of manipulative instruction on solving area and perimeter problems by students with learning disabilities. *Learning Disabilities Research & Practice, 18*(2), 112-120.

Celedon-Pattichis, S. (2010). Implementing reform curriculum: Voicing the experiences of an ESL/mathematics teacher. *Middle Grades Research Journal, 5*(4), 185-198.

Chapman, L. H. (2007). An update on No Child Left Behind and national trends in education. *Arts Education Policy Review, 109*(1), 25-36.

Cirillo, M., Bruna, K. R., & Herbel-Eisenmann, B. (2010). Acquisition of mathematical language: Suggestions and activities for English language learners. *Multicultural Perspectives, 12*(1), 34-41. doi: 10.1080/15210961003641385

Clark, A. C., & Ernest, J. (2009). Gaming research for technology education. *Journal of STEM Education: Innovations & Research, 10*(1), 25-30.

Crawford, C., & Brown, E. (2003). Integrating Internet-based mathematical manipulatives within a learning environment. *Journal of Computers in Mathematics and Science Teaching, 22*(2), 169-180.

Creswell, J. W. (2009). *Research design* (3rd ed.). Thousand Oaks, CA: Sage Publications.

Crews, A. (2011). Getting teachers on “board.” *Knowledge Quest, 40*(1), 10-13.

Curtain-Phillips, M. (n.d.). *Manipulatives: The missing link in high school math.* Retrieved from http://www.mathgoodies.com/articles/manipulatives.html

Cusumano, C., & Mueller, J. (2007). How differentiated instruction helps struggling students: This school’s reorganization to support differentiated instruction has resulted in a remarkable improvement in student performance levels. (Holland Elementary School). *Leadership, 36*(4)*,* 8.

Dee, A. L. (2011). Preservice teacher application of differentiated instruction. *The Teacher Educator, 46*, 53-70. doi: 10.1080/08878730.2010.529987

Discovery Studios (Producer). (2005). *Example 1: Translations, or slides--Dinosaur walking***.** [Video segment]. Retrieved from http://www.discoveryeducation.com/

Discovery Studios (Producer). (2006a). *Example 2: Graphical representation--Geyser eruption heights*. [Video segment]. Retrieved from http://www.discoveryeducati on.com/

Discovery Studios (Producer). (2006b). *Example 3: Proportions--Pandas*. [Video segment]. Retrieved from http://www.discoveryeducation.com/

Douglas, O., Burton, K. S., & Reese-Durham, N. (2008). The effects of the Multiple Intelligence teaching strategy on the academic achievement of eighth grade math students. *Journal of Instructional Psychology, 35*(2), 182-187.

Duran, R. P. (2008). Assessing English-language learner’s achievement. *Review of Research in Education, 78*, 292-327. doi: 10.3102/0091732X07309372

Dworkin, A. G. (2005). The No Child Left Behind Act: Accountability, high stakes testing, and roles for sociologists. *Sociology of Education, 78*(2), 170-174.

Dwyer, J. G. (2004). School accountability and high stakes testing. *Theory and Research in Education, 2*(3), 211-217.

E Learn. (2009). Interactive white board: The way to teach now is digital. *Digital Learning.* Retrieved from ProQuest database.

Ellis, M. (2008). Leaving no child behind et allowing none too far ahead: Ensuring (in)equity in mathematics education through the science of measurement and instruction. *Teachers College Record, 110*(6), 1330-1356.

Ernest, J. M., Thompson, S. E., Heckaman, K. A., Hull, K., & Yates, J. (2011). Effects and social validity of differentiated instruction on student outcomes for special educators. *Journal of the International Association of Special Education, 12*(1), 33-41.

Ernst-Slavit, G., & Slavit, D. (2007). Educational reform, mathematics, & diverse learners: Meeting the needs of all students. *Multicultural Education, 14*(4), 20-27.

ETA Cuisenaire. (n.d.). Manipulatives use and understanding in mathematics. Retrieved from http://www.etacuisenaire.com/pdf/research/Manipulatives%20Use%20and%20Understanding%20in%20Mathematics.pdf

ETA Cuisenaire. (2007). *Super source.* Vernon Hills, IL: ETA Cuisenaire Publishing.

Fisher, D., Frey, N., & Williams, D. (2003). It takes us all. *Principal Leadership, 4*(3), 41-44.

French, L. R., Walker, C., & Shore, B. M. (2011). Do gifted students really prefer to work alone? *Roeper Review, 33*(3), 145-159. doi: 10.1080/02783193.2011580497

Furner, J. M., Yahya, N., & Duffy, M. L. (2005). Teach mathematics: Strategies to reach all students. *Intervention in School and Clinic, 41*(1), 16-23.

Gardner, H. (1983). *Frames of mind*. New York: Basic Books.

Gardner, H. (1993). *Multiple Intelligences: New horizons*. New York: Basic Books.

Gardner, H. (2003, April 21). *Multiple Intelligences after twenty years.* Paper presented at the American Educational Research Association.

Gasser, K. W. (2011). Five ideas for 21st century math classrooms. *American Secondary Education, 39*(3). 108-116.

Giambo, D. A. (2010). High-stakes testing, high school graduation, and limited English proficient students: A case study. *American Secondary Education, 38*(2), 44-56.

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

Grant, C. A. (2004). Oppression, privilege, and high-stakes testing. *Multicultural Perspectives, 6*(1), 3-11.

Grimes, K. J., & Stevens, D. D. (2009). Glass, bug, mud. *Phi Delta Kappan, 90*(9), 677-680.

Hansen-Thomas, H. (2008). Sheltered instruction: Best practices for ELLs in the mainstream. *Kappa Delta Pi Record, 44*(4), 165-169.

Hanushek, E., & Raymond, M. E. (2005). Does school accountability lead to improved student performance? *Journal of Policy Analysis and Management, 24*(2), 297-327.

Harper, C., & de Jong, E. (2004). Misconceptions about teaching English-language learners. *Journal of Adolescent & Adult Literacy, 48*(2). 152-162. doi: 10.1598/JAAL.48.2.6

Harrell, P. E. (2009). Do state examinations measure teacher quality? *Educational Studies, 35*(1), 65-79. doi:10.1080/03055690802470274

Helding, L. (2009). Howard Gardner's Theory of Multiple Intelligences. *Journal of Singing, 66*(2), 193-199.

Hess, F. M. (2004). Inclusive ambiguity: Multicultural conflict in an era of accountability. *Educational Policy, 18*(1), 95-115.

Hill, B. (2005). Learning styles and standardized test scores: Is there a connection? *The Delta Kappa Gamma Bulletin, 71*(3), 27-30.

Hirsh, S. (2011). What makes a good teacher? *Journal of Staff Development, 32*(6), 18-22.

Hofer, M., & Swan, K. O. (2008). Technological pedagogical content knowledge in action: A case study of a middle school digital documentary project. *Journal of Research on Technology in Education, 41*(2), 179-200.

Houghton Mifflin Harcourt. (n.d.). *Math jingles: Keeping it true*. Retrieved from http://www.harcourtschool.com/jingles/jingles_all/3keeping_it_true.html

Howell, D. C. (2008). *Fundamental statistics for the behavioral sciences* (6th ed.). Belmont, CA: Thomson Wadsworth.

Hyerle, D., Alper, L., & Curtis, S. (2004). *Student successes with thinking maps.* Thousand Oaks, CA: Corwin Press.

Jensen, E. (2000). *Brain-based learning*. San Diego, CA: The Brain Store Publishing.

Jones, B. D. (2007). The unintended outcomes of high-stakes testing. *Journal of Applied*

School Psychology, 23(2), 65-86. doi:10.1300/J370v23n02_05

Jones, S. (n.d.). *The role of manipulatives in introducing and developing mathematical concepts in elementary and middle grades*. Retrieved from http://www.resource room.net/math/Jones_mathmanip.asp

Kagan, S., & Kagan, M. (2009). *Kagan cooperative learning*. San Clemente, CA: Kagan Publishing.

King-Shaver, B. (2008). Differentiated instruction: The new and not so new. *California English, 13*(4), 6-8.

Kingore, B. (2007). *Reaching all learners: Making differentiation work.* Austin, TX: Professional Associates Publishing.

Kuehn, L. (2010). So long, constructivism. Hello smart! *Our Schools/Our Selves, 19*(2), 129-134.

Kulm, G. (2007). The great American education pastime: High stakes testing. *School Science & Mathematics, 107*(3), 84-85.

Lack, T. M. (2005). Let's do math. Wanna play? *Mathematics Teaching in the Middle School*, *11*(4)*,* 172-176.

Lai, E. R., & Waltman, K. (2008). Test preparation: Teacher perceptions and practices. *Educational Measurement: Issues and Practice, 27*(2), 28-45.

Latz, A. O., Neumeister, K. L., Adams, C. M., & Pierce, R. L. (2009). Peer coaching to improve classroom differentiation: Perspectives from Project CLUE. *Roeper Review, 31*, 27-39. doi: 10.1080/02783190802527356

Lavadenz, M., & Armas, E. (2008). Differentiated instruction for English learners. *California English 13*(4), 16-20.

Lawrence-Brown, D. (2004). Differentiated instruction: Inclusive strategies for standards-based learning that benefit the whole class. *American Secondary Education, 32*(3), 34-62.

Lay, J. C., & Stokes-Brown, A. K. (2009). Put to the test: Understanding differences in support for high-stakes testing. *American Politics Research, 37*(3), 429-448. doi:10.1177/1532673X08320843

Lee, H., & Jung, W. S. (2004). Mathematical understanding. *Mathematics Teaching in the Middle School, 9*(5), 269-272.

Levy, H. M. (2008). Meeting the needs of all students through differentiated instruction: Helping every child reach and exceed standards. *The Clearing House, 81*(4), 161.

Lewis, B. (n.d.). NCLB – No Child Left Behind. About.com. Retrieved from http://k6educators.about.com/od/educationglossary/g/gnclb.htm

Lewis, S., & Batts, K. (2005). How to implement differentiated instruction? Adjust, adjust, adjust. *Journal of Staff Development, 26*(4), 26-31.

Lightfoot, L. (2012). Who's bored by the whiteboard?: Pedagogy. *The Times Educational Supplement Scotland, 2247*, 24.

Logan, B. (2011). Examining differentiated instruction: Teachers respond. *Research in Higher Education Journal, 13*, 1-14.

Luterbach, K. H., & Brown, C. (2011). Education for the 21st century. *International Journal of Applied Educational Studies, 10*(2), 14-32.

Lynch, S., Taymans, J., Watson, W. A., Ochsendorg, R. J., Pyke, C., & Szesze, M. J. (2007). Effectiveness of a highly rated science curriculum unit for students with disabilities in general education classrooms. *Exceptional Children, 73*(2), 202-

223.

Maccini, P., & Gagnon, J. C. (2000). Best practices for teaching mathematics to secondary students with special needs. *Focus on Exceptional Children, 32*(5), 1-21.

Maccini, P., & Hughes, C. A. (2000). Effects of a problem solving strategy on the introductory algebra performance of secondary students with learning disabilities. *Learning Disabilities Research and Practice, 15*(1), 10-21.

Madaus, G., Russel, M. (2010). Paradoxes of high-stakes testing. *Journal of Education, 190,* (1/2), 21-30.

Manning, S., Stanford, B. & Reeves, S. (2010). Valuing the advanced learner: Differentiating up. *The Clearing House, 83*(4), 145-149.

Manny-Ikan, E., Dagan, O., Tikochinski, T. B., & Zorman, R. (2011). Using the interactive white board in teaching and learning – An evaluation of the SMART classroom pilot project. *Interdisciplinary Journal of E-Learning & Learning Objects, 7*, 249-273.

Marchant, G. J. (2004). What is at stake with high stakes testing? A discussion of issues and research. *Ohio Journal of Science, 104*(2), 2-7.

Martin, H. (1996). *Multiple Intelligences in the mathematics classroom.* Palatine, IL: IRI/Skylight Training and Publishing.

Marzano, R. J., & Pickering, D. J. (2005). *Building academic vocabulary.* Alexandria, VA: Association for Supervision and Curriculum Development (ASCD). Development (ASCD).

Mason, E. J. (2007). Measurement issues in high stakes testing: Validity and reliability.

Journal of Applied School Psychology, 23(2), 27-46. doi: 10.1300/J370v23n02_03

Matthews, M. S., & Farmer, J. L. (2008). Factors affecting the Algebra I achievement of academically talented learners. *Journal of Advanced Academics, 19*(3), 472-501.

McAllister, B. A., & Plourde, L. A. (2008). Enrichment curriculum: Essential for mathematically gifted students. *Education, 129*(1), 40-49.

McCoog, I. J. (2007). Integrated instruction: Multiple intelligences and technology. *The Clearing House, 81*(1), 25-28.

McDuffie, K. A., Mastropieri, M. A., & Scruggs, T. E. (2009). Differential effects of peer Tutoring in co-taught and non-co-taught classes: Results for content learning and student-teacher interactions. *Exceptional Children, 75*(4), 493-510.

McNeil, L. M., Coppola, E., Radigan, J., & Heilig, J. V. (2008). Avoidable losses: High-stakes accountability and the dropout crisis. *Education Policy Analysis Archives, 16*(3), 1-45.

McTighe, J., & Brown, J. L. (2005). Differentiated instruction and educational standards: Is détente possible? *Theory Into Practice, 44*(3), 234-244.

Moon, T. R. (2009). Myth 16: High-stakes tests are synonymous with rigor and difficulty. *Gifted Child Quarterly, 53*(4), 277-279. doi: 10.1177/0016986209346945

Moore, D. (2008, January 21). Smart boards help to make the classroom interactive. *Capital*, pp. B6.

Moss, A., Mayfield, R., Shellman, D., & Eury, D. (2011). *A study of teachers using 21st century tools in a rural South Carolina school district.* (Doctoral dissertation). Retrieved from ProQuest Dissertations & Theses database. (Order No. 3457620)

Moyer, P. S. (2001). Are we having fun yet? How teachers use manipulatives to teach mathematics. *Educational Studies in Mathematics, 47*(2)*,* 175-197.

Moyer, P. S., & Jones, M. G. (2004). Controlling choice: Teachers, students, and manipulatives in mathematics classrooms. *School Science and Mathematics, 104*(1), 16-31.

Muijs, D. (2004). *Doing quantitative research in education with SPSS*. Thousand Oaks, CA: SAGE Publications.

Muller, C., & Schiller, K. S. (2000). External examinations and accountability, educational expectations, and high school graduation. *American Journal of Education, 108*(2), 73.

Muschla, J. A., & Muschla, G. M. (2004). *Math games.* San Francisco: Jossey-Bass.

Myers, S. (2008). Test reliability. *Research Starters Education.* 1-6.

National Association for Gifted Children. (n.d.). *How many gifted children are there in the U.S.?* Retrieved from http://www.nagc.org/index2.aspx?id=548

National Center on Accessing the General Curriculum. (2002). *Differentiated instruction.* Retrieved from http://www.cast.org/system/galleries/download/ncac/DifInstruc.pdf

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics*. Reston, VA: Author.

National Dissemination Center for Children with Disabilities (NICHCY). (2008). *Key terms to know in special education*. Retrieved from http://www.nichcy.org/SchoolsAndAdministrators/Pages/KeyTerms.aspx#child

New Teacher Center. (2005). *Six key strategies for teachers of English-language learners.* Retrieved from http://www.suu.edu/ed/resource/ESLSixKeyStrategies .pdf

Nichols, S. L. (2007). High-stakes testing: Does it increase achievement? *Journal of Applied School Psychology, 23*(2), 47-64. doi: 10.1300/J370v23n02_04

Nichols, S. L., & Berliner, D. C. (2008). Why has high-stakes testing so easily slipped into contemporary American life? *Phi Delta Kappan, 89*(9), 672-276.

No Child Left Behind Act. (2001). 20 USC 6301, P.L. 107-110. Retrieved from http://www.ed.gov/policy/elsec/leg/esea02/107-110.pdf

Nugent, L. (2006). When technology met accountability. *T H E Journal, 33*(12), 41.

Obara, S. (2011). School accountability: Mathematics teachers struggling with change. *Journal of Case Studies in Education, 2*, 1-15.

Oleksiw, T. (2007). *Increasing math test scores with the SMART board interactive white board.* Retrieved from http://downloads01.smarttech.com/media/sitecore/en/pdf/ research_library/math/the_effect_of_the_smart_board_interactive_whiteboard_on _raising_state_test_scores.pdf

Pedulla, J. J. (2003). State-mandated testing, what do teachers think? *Educational Leadership, 61*(3), 43.

Perritt, D. C. (2010). Including professional practice in professional development while improving middle school teaching in math. *National Teacher Education Journal, 3*(3), 73-76.

Powers, E. (2008). The use of independent study as a viable differentiation technique for gifted learners in the regular classroom. *Gifted Child Today, 31*(3), 57-65.

Promethean. (2011). *Promethean planet.* Retrieved from http://www.prometheanplanet.com/en-us/

Quinones, D. (2010). Digital media (including video!) *Knowledge Quest, 39*(2), 28-32.

Raymond, A. M., & Leinenbach, M. (2000). Collaborative action research on the learning and teaching of algebra: A story of one mathematics teacher's development. *Educational Studies in Mathematics, 41*. 283-307.

Rayneri, L. J., Gerber, B. L., & Wiley, L. P. (2003). Gifted achievers and gifted Underachievers: The impact of learning style preferences in the classroom. *Journal of Secondary Gifted Education*, *14*(4), 197.

Rock, M. L., Gregg, M., Ellis, E., & Gable, R. A. (2008). REACH: A Framework for differentiating classroom instruction. *Preventing School Failure, 52*(2), 31-47.

Rush, L. S., & Scherff, L. (2012). NCLB 10 years later. *English Education, 44*(2), 91-101.

Scanlon, M., Buckingham, D., & Burn, A. (2005). Motivating maths? Digital games and mathematical learning. *Technology, Pedagogy, and Education, 14*(1), 127-139.

Schott Foundation for Public Education. (2009). *Defining the opportunity*. Retrieved from http://www.otlstatereport.org/defining-the-opportunity

Schweder, W., & Wissick, C. A. (2008). Teaching content with interactive whiteboards. *Journal of Special Education Technology, 23*(1), 54-58.

Schweizer, H., & Kossow, B. (2007). WebQuests: Tools for differentiation. *Gifted Child Today, 30*(1)*,* 29-35.

Scot, T. P., Callahan, C. M., & Urquhart, J. (2009). Paint-by-number teachers and cookie-cutter students: The unintended effects of high-stakes testing on the education of gifted students. *Roeper Review, 31*(1), 40-52.

Sherman, S. (2009). Haven't we seen this before? Sustaining a vision in teacher education for progressive teaching practice. *Teacher Education Quarterly, 36*(4), 41-60.

Short, D. J., Echevarria, J., & Richards-Tutor. (2011). Research on academic literacy development in sheltered instruction classrooms. *Language Teaching Research, 15*(3), 363-380. doi:10.1177/13622168811401155

Silver, H. F., Hanson, R., & Strong, R. W. (1980). *Teaching Style Inventory (TSI)*. Ho-Ho-Kus, NJ: The Thoughtful Education Press, LLC.

Slavit, D., & Ernst-Slavit. (2007). Teaching mathematics and English to English language learners simultaneously. *Middle School Journal, 39*(2), 4-11.

Sloane, F. C., & Kelly, A. E. (2003). Issues in high-stakes testing programs. *Theory Into Practice, 42*(1), 13-17.

Snyder, R. (1999). The relationship between learning styles/multiple intelligences and academic achievement of high school students. *High School Journal*, *83*(2), 11.

Solorzano, R. W. (2008). High stakes testing: Issues, implications, and remedies for English language learners. *Review of Educational Research, 78*(2), 260-329. doi: 10.3102/0034654308317845

Songs for Teaching. (n.d.). *Proportion song.* Retrieved from http://www.songsforteaching.com/mathsongs.htm

Southeast Regional Educational Laboratory (2008). *State policies and procedures and selected local implementation practices in Response to Intervention in the six Southeast region states, 63*, 1-2.

Starkman, N. (2006). The wonders of interactive whiteboards. *T. H. E. Journal, 33*(10), 36-38.

Stein, M. K., & Bovalino, J. W. (2001). Manipulatives: One piece of the puzzle. *Mathematics Teaching in the Middle School, 6*(6), 356-359.

Swan, M. (2007). Reflections. *Mathematics Teaching, 200,* 2-3.

Tan, M. (2011). Mathematics and science teachers' beliefs and practices regarding the teaching of language in content learning. *Language Teaching Research, 15*(3), 325-342. doi: 10.1177/1362168811401153

Tate, M. L. (2003). *Worksheets don't grow dendrites.* Thousand Oaks, CA: Corwin Press.

Teacher Created Materials. (2005). *Differentiation strategies for mathematics.* Huntington Beach, CA: Teacher Created Materials.

Temur, O. D. (2007). The effects of teaching activities prepared according to the Multiple Intelligences Theory on mathematics achievements and permanence of information learned by 4th grade students. *International Journal of Environmental & Science Education, 2*(4), 86-91.

Texas Association for the Gifted and Talented. (n. d.). *Parent resources: What is giftedness*? Retrieved from http://www.txgifted.org/gifted-glossary

Texas Education Agency. (2004). *Sesquicentennial Handbook*. Retrieved from http://www.tea.state.tx.us/index4.aspx?id=6499

Texas Education Agency. (2005). *Technical Digest for the Academic Year 2003-2004.* Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0304/

Texas Education Agency. (2006). *Technical Digest for the Academic Year 2004-*

2005. Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0405/

Texas Education Agency. (2007). *Technical Digest for the Academic Year 2005-2006*. Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0506/

Texas Education Agency. (2008a). *Academic Excellence Indicator System.* Retrieved from http://ritter.tea.state.tx.us/perfreport/aeis/

Texas Education Agency. (2008b). *Technical Digest for the Academic Year 2006-2007*. Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0607/

Texas Education Agency. (2009a). *Academic Excellence Indicator System.* Retrieved from http://ritter.tea.state.tx.us/perfreport/aeis/

Texas Education Agency. (2009b). *2010 Adequate Yearly Progress Guide: Sections II – V*. Retrieved from http:ritter.tea.state.tx.us/ayp/2010/guide/sec2_5.pdf

Texas Education Agency. (2009c). *Growth Model Pilot Application for Adequate Yearly Progress Determinations Under the No Child Left Behind Act*. Retrieved from http://www.tea.state.tx.us/index3.aspx?id=3688&menu_id3=793

Texas Education Agency. (2009d). *Technical Digest for the Academic Year 2007-2008*. Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0708/

Texas Education Agency. (2010a). *Academic Excellence Indicator System.* Retrieved from http://ritter.tea.state.tx.us/perfreport/aeis/

Texas Education Agency. (2010b). District Accountability Summary. Retrieved from http://ritter.tea.state.tx.us/perfreport/account/2010/districtlist.srch.html

Texas Education Agency (2010c). News releases online. STAAR to replace TAKS. Retrieved from http://www.tea.state.tx.us/index4.aspx?id=7874

Texas Education Agency. (2010d). *Technical Digest for the Academic Year 2008-2009.* Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0809/

Texas Education Agency. (2011a). *Academic Excellence Indicator System.* Retrieved from http://ritter.tea.state.tx.us/perfreport/aeis/

Texas Education Agency. (2011b). *Technical Digest for the Academic Year 2009-2010.* Retrieved from http://www.tea.state.tx.us/student.assessment/techdigest/yr0910/

Texas Education Agency. (2012). *Adequate yearly progress.* Retrieved from http://ritter.tea.state.tx.us/ayp/

Texas Education Agency Department of Assessment, Accountability, and Data Quality; Performance-Based Monitoring Division. (2011). *Performance-Based Monitoring Analysis System 2011 Manual*. Retrieved from http://www.tea.state.tx.us/pbm/PBMASManuals.aspx

Texas Education Service Center Curriculum Collaborative. (n.d.). CSCOPE. Retrieved from http://www.cscope.us/staar.html

The Education Alliance, Brown University. (n. d.). *English language learners.* Retrieved from http://www.alliance.brown.edu/ae_ells.php

Thompson, D. R., & Rubenstein, R. N. (2000). Learning mathematics vocabulary:

Potential pitfalls and instructional strategies. *The Mathematics Teacher, 93*(7), 568-574.

Tieso, C. L., (2003). Ability grouping is not just tracking anymore. *Roeper Review, 26*(1), 1.

Tilton, L. (2009). *The teacher's toolbox for differentiating instruction.* Shorewood, MN: Covington Cove Publications.

Tobin, R. (2008). Conundrums in the differentiated literacy classroom. *Reading Improvement, 45*(4). 159-169.

Tomlinson, C. A. (2000a). Reconcilable differences? Standards-based teaching and differentiation. *Educational Leadership, 58*(1), 6-11.

Tomlinson, C. A. (2000b). *The differentiated classroom: Responding to the needs of all learners.* Alexandria, VA: Association for Supervision and Curriculum Development.

Tomlinson, C. A. (2005). Traveling the road to differentiation in staff development. *National Staff Development Council, 26*(4), 8-12.

Tomlinson, C. A., & Eidson, C. C. (2003). *Differentiation in practice: A resource guide for differentiating curriculum*. Alexandria, VA: Association for Supervision and Curriculum Development.

VanSciver, J. H. (2005). NCLB fitfully fits differentiated instruction. *Phi Delta Kappan, 86*, 37-39.

VanTassel-Baska, J., Avery, L., Struck, J., Feng, A., Bracken, B., Drummond, D., & Stambaugh, T. (2003). *The William and Mary Classroom Observation Scales*

Revised. School of Education Center for Gifted Education, The College of William and Mary, Williamsburg, Virginia.

VanTassel-Baska, J., Quek, C., & Feng, A. X. (2007). The development and use of a structured teacher observation scale to assess differentiated best practice. *Roeper Review, 29*(2), 84-92.

Walker, S. Y. (2002). *The survival guide for parents of gifted kids*. Minneapolis, MN: Free Spirit Publishing Inc.

Wildt, A. R., & Ahtola, O. T. (1978). *Analysis of covariance.* Beverly Hills, CA: Sage Publications.

Wills, J. S., & Sandholtz, J. H. (2009). Constrained professionalism: Dilemmas of teaching in the face of test-based accountability. *Teachers College Record, 111*(4), 1065-1114.

Witzel, B. S., & Riccomini, P. J. (2007). Optimizing math curriculum to meet the learning needs of students. *Preventing School Failure, 52*(1), 13-18.

Wormeli, R. (2010). Teaching in the middle. *Middle Ground,* 13(3), 31-32.

Wormeli, R. (2011). Differentiated instruction: Setting the pedagogy straight. *Middle Ground, 15*(2), 39-40.

Yoder, E., & Yoder, N. (2010). *One Minute Mysteries: 65 Short Mysteries You Solve With Math!* Washington, DC: Science, Naturally!

Zike, D. (1998). *Big book of math for middle school and high school.* San Antonio, TX: Dinah-Might Adventures.

Zimmerman, B. J., & Dibenedetto, M. K. (2008). Mastery learning and assessment: Implications for students and teachers in an era of high-stakes testing. *Psychology* *in the Schools, 45*(3), 206-216. doi: 10.1002/pits.20291

Zittle, F. J. (2004). *Enhancing Native American mathematics learning: The use of Smartboard-generated virtual manipulatives for conceptual understanding.* Retrieved from http://downloads01.smarttech.com/media/research/international_Research/usa/ceerzittle.pdf

APPENDIX A: SEVENTH GRADE MATHEMATICS EXAMPLE LESSON

Introduction to Ratios and Proportions

Targeted Texas Essential Knowledge and Skills (TEKS):	Lesson Duration:
7.1B, 7.2A, 7.2D, 7.3A	3Days

Content Objective:	Language Objective:
1. Students will use experience and reasoning skills to develop equivalent ratios (Engage).	1. Students will define equivalent ratios in their foldable (Engage).
2. Students will explore ratio tables with multiplicative reasoning to investigate equivalent ratios (Explore/Explain).	2. Students will identify and explain equivalent ratios and define proportions to their groups (Explore/Explain).
3. Students will apply multiplication and division of fractions and decimals to ratios in real-world problem situations (Elaborate/Evaluate).	3. Students will demonstrate their understanding of ratios and proportions through verbal and written explanations to the teacher (Elaborate/Evaluate).

Vocabulary	Materials	Advance Preparation
ratio proportion equivalent	*ALL* Copie**s:** Ratio Table Samples, Applications for Ratio Tables *Differentiated Only* Copies: Party Favors, *Mystery Ratios*, Paper and colored pencils for foldable, centimeter cubes for hands-on activity	1. Have copies available. 2. Have a foldable example for students to follow 3. Make sure video clip and song are loud enough for all students to hear and are working properly.

Instructional Phase	Whole Class Instruction Procedures	Differentiated Components
Engage	1. Transparency or flipchart: Chocolate Chip Recipe. Work through the Guided Questions. 2. Review meaning of vocabulary: ratio and proportion.	1. Show the video clip *Proportions and Pandas* 2. Make a vocabulary foldable and use throughout the lesson as new vocabulary is introduced.
Explore/Explain	1. Use Ratio Table Samples to review ratios and proportions. Model each example and have students work along.	1. Representing Equivalent Ratios: Party Favors; Students work in groups using centimeter cubes. 2. IWB Flipchart for Ratio and Proportion 3. Line Up Song 4. *Mystery Ratios* for assessment 5. Thinking Map Double Bubble to represent similarities and differences in ratio and proportion in student notebooks.
Elaborate/Evaluate	1. Students complete Applications for Ratio Tables independently.	1. Students complete Applications for Ratio Tables with partners or in groups.

APPENDIX B: DIFFERENTIATED INSTRUCTION RUBRIC

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Texas Essential Knowledge and Skills (TEKS)	1) TEKS are not identified. 2) TEKS are not aligned with district scope and sequence.	1) TEKS are clearly stated. 2) TEKS are aligned to district scope and sequence.	1) TEKS are clearly stated with explanation of any ambiguities. 2) TEKS are appropriate for grade level and content. 3) TEKS are directly correlated and aligned to district scope and sequence.
Content Objective	1) Content objective is not stated in detailed or quantifiable terms. 2) Content objective is somewhat aligned with TEKS. 3) Content objective is not described. 4) Content objective is inappropriate for time constraints.	1) Content objective is stated in detailed terms 2) Content objective is aligned with TEKS. 3) Content objective is described in formal language. 4) Content objective is appropriate for time constraints.	1) Content objective is stated in detailed quantifiable terms. 2) Content objective is directly aligned with TEKS. 3) Content objective is described in formal language and student-friendly terms. 4) Content objective is appropriate for time constraints.
Language Objective	1) Language objective is not stated in detailed or quantifiable terms. 2) Language objective is somewhat aligned with TEKS. 3) Language objective is not described. 4) Language objective is not aligned to the English Language Proficiency Standards (ELPS).	1) Language objective is stated in detailed terms. 2) Language objective is aligned with TEKS. 3) Language objective is described in formal language. 4) Language objective is aligned to the English Language Proficiency Standards (ELPS).	1) Language objective is stated in detailed quantifiable terms. 2) Language objective is directly aligned with TEKS. 3) Language objective is described in formal language and student-friendly terms. 4) Language objective is directly aligned to the English Language Proficiency Standards (ELPS).

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Vocabulary	1) Key vocabulary is introduced prior to the lesson. 2) Vocabulary is recorded in student notes or verbally reviewed in the content area.	1) Key vocabulary is introduced prior to the lesson. 2) Research-based strategies are used to build academic vocabulary in the content area. 3) Vocabulary is reviewed at the conclusion of the lesson.	1) Key vocabulary is introduced prior to the lesson. 2) Research-based strategies are used to build academic vocabulary in the content area. 3) Vocabulary is used throughout the lesson, reinforcing the value of terminology.
Materials	1) Materials needed for lesson are not listed. 2) Resources and manipulatives needed are not identified.	1) Materials needed for lesson are listed in their entirety. 2) Resources and manipulatives needed are clearly identified.	1) Materials needed for lesson are listed in their entirety. 2) Resources and manipulatives needed are clearly identified with specific numbers and types of materials.
Advance Preparation	1) All steps are not described. 2) Materials are not organized.	1) All steps are described. 2) Materials are organized.	1) All steps are described in easy-to-follow instructions. 2) Materials are organized in order of presentation.
Engage	1) No engagement activity is incorporated or is unrelated to the content objective.	1) Students connect prior learning to content objective. 2) Students are focused on the upcoming lesson.	1) Students connect prior learning to content objective through higher-order thinking. 2) Engagement stimulates student interest in the lesson objective.

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Explore/Explain	1) Limited explanation is provided. 2) No variations of student explanation are incorporated. 3) Learning activities are not present or are not student-centered. 4) No checks for understanding are incorporated. 5) No modifications for special populations are presented.	1) Explanation of procedures is detailed. 2) Some presentation modes of explanation are incorporated. 3) Learning activities are student-centered. 4) Checks for understanding are included. 5) Modifications for special populations are presented.	1) Explanation of procedures is detailed and allows the lesson to be replicated with ease. 2) Multiple presentation modes for explanation are incorporated. 3) Learning activities are student-centered. 4) Continuous checks for understanding are incorporated. 5) Modifications for special populations are presented throughout.
Elaborate	1) Provides minimal opportunity for students to apply new content. 2) Vocabulary is not a factor in elaboration. 3) Teacher provides direct instruction.	1) Provides examples and activities for students to apply current content. 2) New vocabulary is applied to current content. 3) All students are involved in the elaboration process.	1) Provides examples and activities for students to apply current content to new situations. 2) New vocabulary and definitions are applied to content objective with minimal teacher support. 3) All students are involved in the elaboration process.

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Evaluate	1) Evaluation is somewhat aligned to content objective. 2) Real-world applications are not evident. 3) No alternative assessment are included. 4) No modifications for special populations are included. 5) Formative assessments are not evident.	1) Evaluation is aligned to content objective, TEKS, and Texas Assessment of Knowledge and Skills (TAKS). 2) Real-world applications are applied. 3) Alternative assessment methods are identified. 4) Modifications for special populations are identified. 5) Some formative assessments are presented in the lesson.	1) Evaluation is aligned to content objective, TEKS, and Texas Assessment of Knowledge and Skills (TAKS). 2) Real-world applications are applied. 3) Clearly articulated alternative methods of assessment are included. 4) Modifications for special populations are clearly articulated. 5) Formative assessments are evident throughout the lesson.
Accommodations	1) Accommodations for special education students, English as second language learners, and accelerated students are not identified.	1) Accommodations for special education students, English as second language learners, and accelerated students are identified.	1) Accommodations for special education students, English as second language learners, and accelerated students are included throughout the lesson.
Extension	1) Extensions activities are not identified.	1) Extension activities are identified. 2) Extension activities target one learning style.	1) Extension activities are identified. 2) Extension activities target multiple learning styles.
Content Differentiation	1) One methods for content differentiation is included in the lesson.	1) Two methods for content differentiation are included in the lesson.	1) Three or more methods for content differentiation are included in the lesson.

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Process Differentiation	1) One varied tasks for process differentiation is integrated in the lesson.	1) Two varied tasks for process differentiation are integrated in the lesson.	1) Three or more varied tasks for process differentiation are integrated in the lesson.
Product Differentiation	1) One product option is included in the lesson.	1) Two product options are included in the lesson.	1) Three or more product options are included in the lesson.
Student Learning Styles	1) One student intelligence preference choice is incorporated in the lesson.	1) Two student intelligence preference choices are incorporated in the lesson.	1) Three or more student intelligence preference choices are incorporated in the lesson.

APPENDIX C: NON-DIFFERENTIATED INSTRUCTION RUBRIC

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Texas Essential Knowledge and Skills (TEKS)	1) TEKS are not identified. 2) TEKS are not aligned with district scope and sequence.	1) TEKS are clearly stated. 2) TEKS are aligned to district scope and sequence.	1) TEKS are clearly stated with explanation of any ambiguities. 2) TEKS are appropriate for grade level and content. 3) TEKS are directly correlated and aligned to district scope and sequence.
Content Objective	1) Content objective is not stated in detailed or quantifiable terms. 2) Content objective is somewhat aligned with TEKS. 3) Content objective is not described. 4) Content objective is inappropriate for time constraints.	1) Content objective is stated in detailed terms 2) Content objective is aligned with TEKS. 3) Content objective is described in formal language. 4) Content objective is appropriate for time constraints.	1) Content objective is stated in detailed quantifiable terms. 2) Content objective is directly aligned with TEKS. 3) Content objective is described in formal language and student-friendly terms. 4) Content objective is appropriate for time constraints.
Language Objective	1) Language objective is not stated in detailed or quantifiable terms. 2) Language objective is somewhat aligned with TEKS. 3) Language objective is not described. 4) Language objective is not aligned to the English Language Proficiency Standards (ELPS).	1) Language objective is stated in detailed terms. 2) Language objective is aligned with TEKS. 3) Language objective is described in formal language. 4) Language objective is aligned to the English Language Proficiency Standards (ELPS).	1) Language objective is stated in detailed quantifiable terms. 2) Language objective is directly aligned with TEKS. 3) Language objective is described in formal language and student-friendly terms. 4) Language objective is directly aligned to the English Language Proficiency Standards (ELPS).

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Vocabulary	1) Key vocabulary is introduced prior to the lesson. 2) Vocabulary is recorded in student notes or verbally reviewed in the content area.	1) Key vocabulary is introduced prior to the lesson. 2) Research-based strategies are used to build academic vocabulary in the content area. 3) Vocabulary is reviewed at the conclusion of the lesson.	1) Key vocabulary is introduced prior to the lesson. 2) Research-based strategies are used to build academic vocabulary in the content area. 3) Vocabulary is used throughout the lesson, reinforcing the value of terminology.
Materials	1) Materials needed for lesson are not listed. 2) Resources and manipulatives needed are not identified.	1) Materials needed for lesson are listed in their entirety. 2) Resources and manipulatives needed are clearly identified.	1) Materials needed for lesson are listed in their entirety. 2) Resources and manipulatives needed are clearly identified with specific numbers and types of materials.
Advance Preparation	1) All steps are not described. 2) Materials are not organized.	1) All steps are described. 2) Materials are organized.	1) All steps are described in easy-to-follow instructions. 2) Materials are organized in order of presentation.
Engage	1) No engagement activity is incorporated or is unrelated to the content objective.	1) Students connect prior learning to content objective. 2) Students are focused on the upcoming lesson.	1) Students connect prior learning to content objective through higher-order thinking. 2) Engagement stimulates student interest in the lesson objective.

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Explore/Explain	1) Limited explanation is provided. 2) No instruction mode is provided. 3) Learning activities are not present. 4) No checks for understanding are incorporated. 5) No modifications for special populations are presented.	1) Explanation of procedures is detailed. 2) Presentation mode is lecture-based direct instruction. 3) Learning activities are teacher-centered. 4) Checks for understanding are included. 5) Modifications for special populations are presented.	1) Explanation of procedures is detailed and allows the lesson to be replicated with ease. 2) Presentation mode is lecture-based direct instruction. 3) Learning activities are teacher-centered. 4) Continuous checks for understanding are incorporated. 5) Modifications for special populations are presented throughout.
Elaborate	1) Provides minimal opportunity for students to apply new content. 2) Vocabulary is not a factor in elaboration. 3) Teacher provides direct instruction.	1) Provides examples and activities for students to apply current content. 2) New vocabulary is applied to current content. 3) All students are involved in the elaboration process.	1) Provides examples and activities for students to apply current content to new situations. 2) New vocabulary and definitions are applied to content objective with minimal teacher support. 3) All students are involved in the elaboration process.

Components	Does Not Meet Expectations	Meets Expectations	Exemplary
Evaluate	1) Evaluation is somewhat aligned to content objective. 2) Real-world applications are not evident. 3) No assessment is identified. 4) No modifications for special populations are included. 5) Formative assessments are not evident.	1) Evaluation is aligned to content objective, TEKS, and Texas Assessment of Knowledge and Skills (TAKS). 2) Real-world applications are applied. 3) One assessment mode is identified. 4) Modifications for special populations are identified. 5) Some formative assessments are presented in the lesson.	1) Evaluation is aligned to content objective, TEKS, and Texas Assessment of Knowledge and Skills (TAKS). 2) Real-world applications are applied. 3) One assessment mode is identified. 4) Modifications for special populations are clearly articulated. 5) Formative assessments are evident throughout the lesson.
Accommodations	2) Accommodations for special education students, English as second language learners, and accelerated students are not identified.	2) Accommodations for special education students, English as second language learners, and accelerated students are identified.	2) Accommodations for special education students, English as second language learners, and accelerated students are included throughout the lesson.

APPENDIX D: TEACHING STYLE INVENTORY

Choosing Teaching Preferences

Directions: In each of the following fourteen (A-N) sets of behaviors, rank the four responses as follows:

Give the response that **best** describes your teaching preferences .... **5 points**
Give the response that describes your teaching preferences **second best** ..... **3 points**
Give the response that describes your teaching preferences **third best** .... **1 point**
Give the response that **least** describes your teaching preferences .... **0 points**

Be sure to assign a different weighted number (5, 3, 1, or 0) to each of the four responses in sets A-N. Do not make ties. Rank the responses according to those which best describe you and how you approach teaching. If a set of responses is hard to rank at first reading, go to the next set. Complete the missing set after you've finished all the other items. Note that a rank of 0 does not mean a response does not apply to you—it only means that response is your least preferred. Please answer every item and keep in mind that there are no right or wrong answers.

The aim of this inventory is to increase your self-awareness through conscious reflection on your decision-making processes both in and beyond the classroom, ***not*** to evaluate your teaching ability or to assign labels.

I. Planning

A. *I am most comfortable when my plans are based on...*

1. _____ key concepts and major themes
2. _____ established curriculum guides and test outlines
3. _____ the emotional and social needs of my students
4. _____ open-ended essential questions and project work

B. *My plans frequently include...*

5. _____ specific and well-defined tasks
6. _____ a wide variety of materials, activities, and projects with opportunities for students to make choices
7. _____ important issues to be analyzed and addressed
8. _____ activities intended to enhance self-understanding, social interaction, and group learning

II. Implementing

C. *When applying my plans to the classroom, I work hard to...*

9. _____ follow my plans in an orderly and prescribed manner
10. _____ focus classroom interaction on essential questions and deep understanding
11. _____ connect my activities to my students' life experiences
12. _____ coach and stimulate my students to think divergently and be creative

III. Setting

D. *The classroom atmosphere in which I am most comfortable emphasizes...*

13. _____ interaction, collaboration, cooperation, and conversation
14. _____ variety, stimulation, creative activity, and project work
15. _____ intellectual challenge, serious inquiry, and debate
16. _____ organization, clear tasks, and purposeful activity to achieve mastery

E. *I prefer my physical setting to be...*

17. _____ a friendly, comfortable place that provides opportunities for students to converse and work together
18. _____ an inspiring and engaging place that is colorful and has lots of interesting artifacts
19. _____ an orderly, well-structured environment where the teacher is the primary focus
20. _____ an intellectually stimulating room that has numerous books and resources for students to conduct independent study and extend their knowledge

IV. Curriculum Objectives

F. *In general, the major focus of the curriculum should be on...*

21. _____ mastering skills and acquiring specific information
22. _____ developing a healthy self-concept and social skills
23. _____ interpreting and applying ideas and theories
24. _____ developing creative potential in all academic areas

www.ThoughtfulEd.com
(800) 962-4432

V. Operations

G. *The tasks I assign my students tend to focus on...*

25. _____ workbooks, worksheets, recitation of information, practice exercises, and direct instruction
26. _____ essays, research projects, readings, investigations, debates, and discussion of big ideas
27. _____ small group discussions, personal sharing, role playing, simulations, group projects, team games, and other cooperative learning activities
28. _____ creative problem solving, long-range projects, divergent expression, use of metaphor and artistic elements to express ideas

H. *The work my students are required to do emphasizes...*

29. _____ acquiring specific knowledge and skills
30. _____ understanding and explaining big ideas
31. _____ self-expression and synthesizing ideas
32. _____ cooperation and personal reflection

VI. Roles

I. *As a teacher, I tend to play the role of...*

33. _____ creativity stimulator and partner in imagination
34. _____ intellectual challenger and content expert
35. _____ information provider and assigner of tasks
36. _____ nurturer and group facilitator

J. *Strategies I frequently use emphasize...*

37. _____ non-traditional problem solving, metaphorical expression, creative writing, and imaginative or inventive work
38. _____ debate, experiment, investigation, and inquiry
39. _____ practice games, seatwork, short lectures, frequent exercises, and hands-on demonstrations
40. _____ circle talks, students working as partners, and group projects that emphasize helping ourselves and others

K. *I enjoy it most when my students play the role of...*

41. _____ questioners and researchers
42. _____ group members and community contributors
43. _____ innovators and creative problem solvers
44. _____ hard workers and pragmatists

L. *Qualities I most look for in my students include...*

45. _____ logical analysis, pleasure in thought, and a tolerance for abstraction or ambiguity
46. _____ patience with others and a willingness to share feelings and work
47. _____ ingenuity, a sense of what's possible, and aesthetics
48. _____ a sense of order, patience with clearly-defined tasks, and a willingness to work hard and take pride in achievement

VII. Assessment

M. *In assessing students' learning, I tend to rely heavily on...*

49. _____ short answer exercises that ask students to remember what they have learned in class
50. _____ essays, projects, and problems that require explanations, evidence, and proof
51. _____ personal qualities such as attention to detail, ability to concentrate, and cooperation
52. _____ projects and tasks requiring creative expression, imagination, and the extension of learning to new contexts

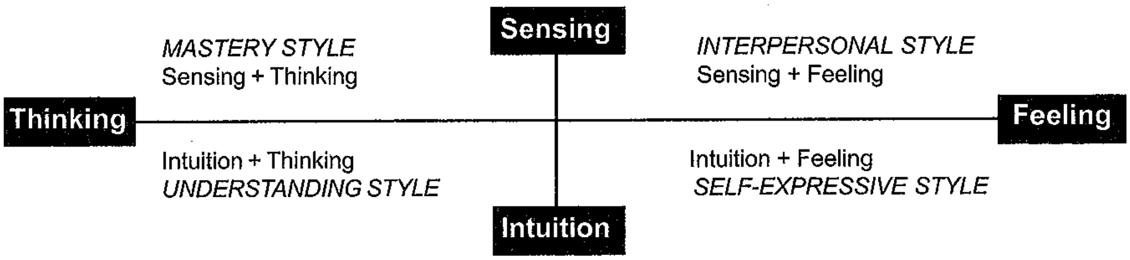
N. *In reviewing students' work, I tend to reward...*

53. _____ accuracy and precision
54. _____ ideas that are soundly reasoned and interesting in formulation
55. _____ the amount of individual effort and student progress
56. _____ ingenuity, creativity, craftsmanship, the unusual, and the unique

www.ThoughtfulEd.com
(800) 962-4432

Understanding Decision-Making as Teaching Behavior

In each of the fourteen sets that you just ranked, the four responses correspond to four different teaching styles. The teaching styles are based on the different ways people prefer to use their perception (sensing vs. intuition) and their judgment (thinking vs. feeling). The preference for sensing or intuition is independent of the preference for thinking or feeling. As a result, four distinct combinations occur:



SUBJECTIVE RANKING

Before scoring your *Teaching Style Inventory*, rank order the styles based upon your own immediate perceptions of your dominant teaching style. Please carefully read the style descriptions that follow and then determine which description is most characteristic, second-most characteristic, third-most, and least characteristic. Remember that everyone operates in all four styles, but that we tend to favor one or two styles over the others.

The Four Teaching Styles

Mastery Style Teachers (Sensing + Thinking) focus on clear outcomes (skills learned, projects completed). They maintain highly-structured, well-organized classroom environments. Work is purposeful, emphasizing the acquisition of skills and information. Plans are clear and concise. Discipline is firm but fair. Teachers serve as the primary information source and give detailed directions for student learning.
(Preference______)

Interpersonal Style Teachers (Sensing + Feeling) emphasize the personal and social aspects of learning, often by exploring students' personal life experiences and building feelings of positive self-worth. The teacher shares personal feelings and experiences with students and attempts to forge personal connections between real life and the content students are learning. The teacher believes that school should be fun and often introduces learning through activities that involve the students actively and physically or that allow them to work cooperatively. Plans often change to meet the mood of the class or the feelings of the teacher.
(Preference______)

Understanding Style Teachers (Intuition + Thinking) place primary importance on students' intellectual development. The teacher provides time and intellectual challenges to encourage students to develop skills in critical thinking, problem solving, logic, research techniques, and independent study. Curriculum planning emphasizes concepts and is frequently centered around a series of questions or themes. Assessment is often based on open-ended questions, debates, essays, or position papers.
(Preference______)

Self-Expressive Style Teachers (Intuition + Feeling) encourage students to explore their creative abilities. Insights and imagination are highly valued. Discussions revolve around generating possibilities and finding new and interesting connections. The classroom environment is often full of creative clutter, while curriculum focuses on creative thinking, moral development, values, and flexible, imaginative approaches to learning. Curiosity, unique and interesting approaches to problem solving, and artistic expression are always welcome.
(Preference______)

Subjective Ranking Preferences

1. Most characteristic: ______
2. Second-most characteristic: ______
3. Third-most characteristic: ______
4. Least characteristic: ______

Scoring Your *TSI*

To determine your results, transfer your rank numbers from your answer sheet (pages 2 and 3) to the scoring sheet below. Compute your score by adding the rank numbers down each column.

If you'd like to see how your overall style compares with your style in individual dimensions like planning, implementing, setting, curriculum objectives, etc., you can total your rank numbers separately for each Roman numeral.

	Mastery	Understanding	Self-Expressive	Interpersonal
I. Planning				
A	2 ______	1 ______	4 ______	3 ______
B	5 ______	7 ______	6 ______	8 ______
II. Implementing				
C	9 ______	10 ______	12 ______	11 ______
III. Setting				
D	16 ______	15 ______	14 ______	13 ______
E	19 ______	20 ______	18 ______	17 ______
IV. Curriculum Objectives				
F	21 ______	23 ______	24 ______	22 ______
V. Operations				
G	25 ______	26 ______	28 ______	27 ______
H	29 ______	30 ______	31 ______	32 ______
VI. Roles				
I	35 ______	34 ______	33 ______	36 ______
J	39 ______	38 ______	37 ______	40 ______
K	44 ______	41 ______	43 ______	42 ______
L	48 ______	45 ______	47 ______	46 ______
VII. Assessment				
M	49 ______	50 ______	52 ______	51 ______
N	53 ______	54 ______	56 ______	55 ______
TOTALS:	______	______	______	______

Analyzing Your Teaching Preferences

No single style adequately represents the complexity of our teaching behavior. Particular teaching and learning challenges often cause us to "flex" or compensate by using other, often less-preferred, styles. It's important, therefore, to identify not just your dominant style, but also your entire profile. It is the full profile that provides the truest picture of how you teach.

Your teaching style profile consists of four styles in a descending order of strength, from dominant to least preferred. To build your profile, complete the table below. First, write in the "Score" column your style scores from the bottom of page 5, listing them from highest to lowest. Next, identify the corresponding style for each of the four scores and the comfort level based on the *Comfort Level Scale* below. Finally, write in your subjective ranking for each style from page 4. How do your results compare with your initial subjective rankings?

Order	Score	Style	Comfort Level *(see scale below)*	Subjective Ranking *(page 4)*
1. Dominant				
2. Secondary				
3. Tertiary				
4. Least Preferred				

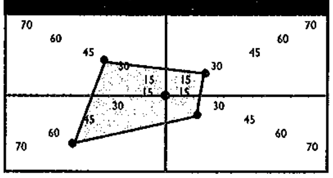
Comfort Level Scale

57 - 70	***Very comfortable*** in the style
43 - 56	***Comfortable*** in the style
29 - 42	***Moderate comfort*** in the style
15 - 28	***Low comfort*** in the style
0 - 14	***Very low comfort*** in the style

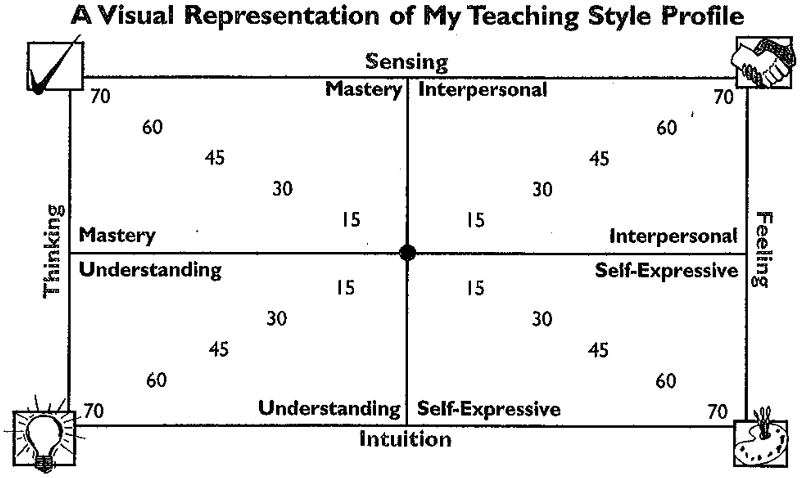
Visualizing Your Teaching Style Profile

The final step in profile-building is to create a visual representation, which will show you, at a glance, the relative strength of all four styles that make up your teaching style profile. To create a visual representation of your profile, take your point totals for each style and chart them on the profile graph below. For example, if you received a score of 38 for the Mastery style, you would make a mark along the diagonal line roughly halfway between the 30-mark and the 45-mark in the Mastery box. Repeat this process for all four styles. Once you have made your four marks, connect all four dots with straight lines to create a four-sided polygon. (See *Sample Profile* at left for an example.)

Sample Profile



A Visual Representation of My Teaching Style Profile



www.ThoughtfulEd.com
(800) 962-4432

Questions for Reflection

The following questions will help you to reflect upon your results from the *Teaching Style Inventory*. Take a moment to review your results, then respond to the following questions:

1. Which style is your dominant style? How is it an asset to you in your teaching?

2. Which is your least-used style? In what ways could your students benefit if you made greater use of this style in your teaching?

3. What should your students know about your teaching style and profile that would help them to be more successful in your class?

4. What changes would you like to make in your teaching profile? What knowledge, skills, and attitudes would you need to further develop to make this change?

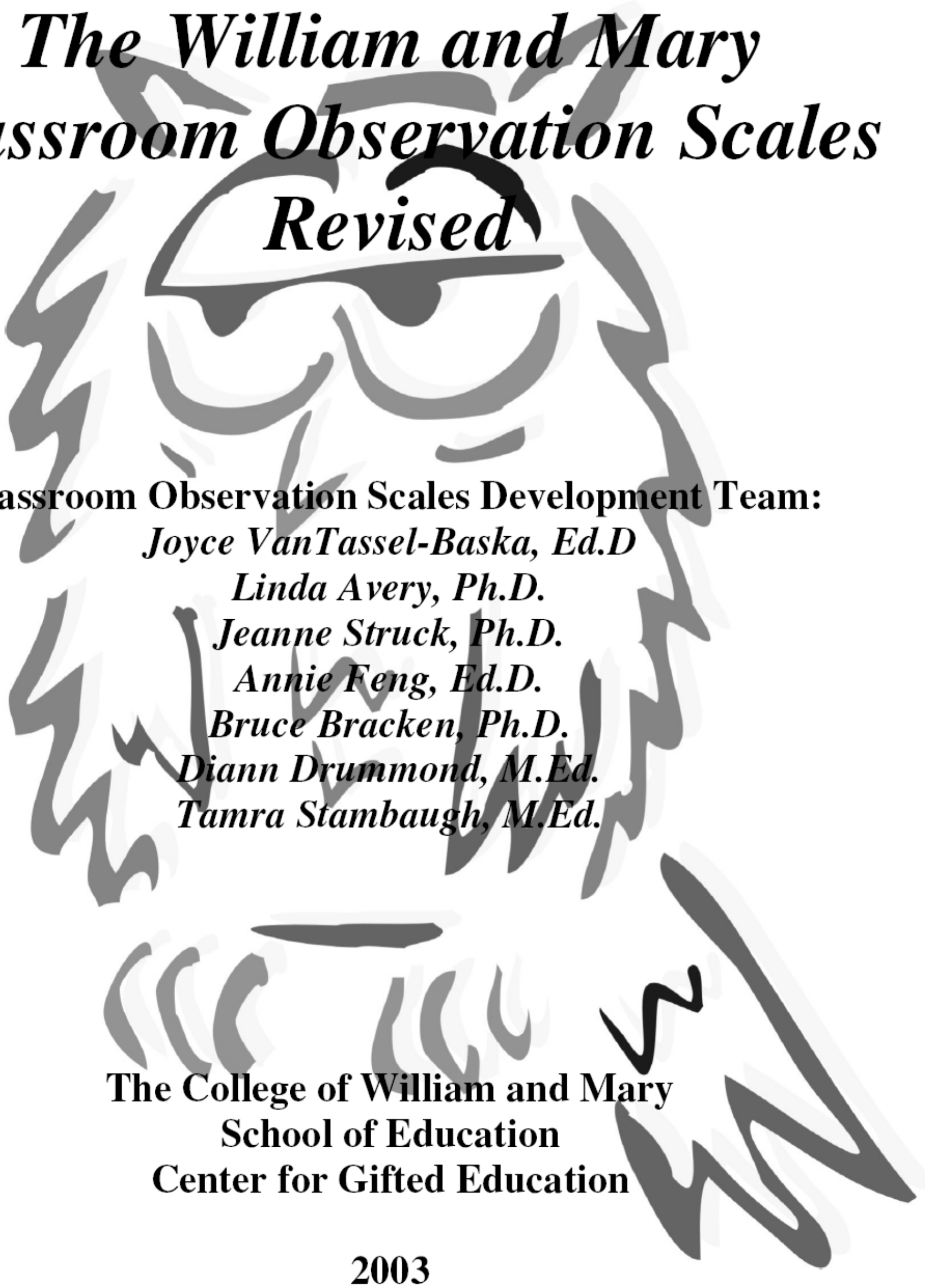
To learn more about all 4 Teaching Styles and how to get the most out of your own Teaching Style Profile, go to www.ThoughtfulEd.com/tsiextras.

Learning Behaviors and Activities by Style

Mastery	Understanding	Self-Expressive	Interpersonal
TEACHERS MAY BE CHARACTERIZED AS:			
Trainers Information providers Instructional managers	Intellectual challengers Theoreticians Inquirers	Facilitators Stimulators Creators/originators	Nurturers Supporters Empathizers
LEARNERS MAY BE CHARACTERIZED AS:			
Realistic Practical Pragmatic	Logical Intellectual Knowledge-oriented	Curious Insightful Imaginative	Sympathetic Friendly Interpersonal
CURRICULUM OBJECTIVES EMPHASIZE:			
Knowledge Skills	Concept development Critical thinking	Creative expression Moral development	Positive self-concept Socialization
SETTINGS (Learning Environments) EMPHASIZE:			
Purposeful work Organization/competition	Discovery Inquiry/independence	Originality Flexibility/imagination	Personal warmth Interaction/collaboration
OPERATIONS (Thinking and Feeling Processes) INCLUDE:			
Observing Describing Memorizing Translating Categorizing	Classifying Applying Comparing/contrasting Analyzing Evaluating	Hypothesizing Synthesizing Metaphorical expression Divergent thinking Creating	Describing feelings Empathizing Responding Valuing
TEACHING STRATEGIES INCLUDE:			
Command Read and Retell Graduated Difficulty Direct Instruction Interactive Lecture	Concept Attainment Inquiry Multiple Document Learning Reading for Meaning Compare and Contrast Mystery	Metaphorical Expression Inductive Learning Pattern Maker/Extrapolation Mind's Eye Etch-A-Sketch	Reciprocal Learning Decision Making Jigsaw Team Games Tournament Community Circle
STUDENT ACTIVITIES INCLUDE:			
Workbooks Drill and repetition Demonstrations Dioramas Competitions	Independent study Essays Logic problems Debates Hypothesizing	Creative art activities Imagining Boundary breaking Dramatics Open-ended discussions	Group projects "Show and Tell" Team games Directed art activities Personal sharing
ASSESSMENT TASKS CALL FOR:			
Making charts/maps Developing sequences/timelines Repairing/debugging Reporting Constructing Defining/describing	Comparing/contrasting Making a case Conducting an inquiry Explaining Analyzing Classifying Debating Interpreting	Speculating—What if? Hypothesizing Creating metaphors Inventing/designing Using artistic media to express ideas	Performing community service Decision making Relating Reflecting Empathizing Keeping a journal

www.ThoughtfulEd.com
(800) 962-4432

APPENDIX E: THE WILLIAM AND MARY CLASSROOM OBSERVATION SCALES REVISED



The William and Mary Classroom Observation Scales Revised

Classroom Observation Scales Development Team:

Joyce VanTassel-Baska, Ed.D
Linda Avery, Ph.D.
Jeanne Struck, Ph.D.
Annie Feng, Ed.D.
Bruce Bracken, Ph.D.
Diann Drummond, M.Ed.
Tamra Stambaugh, M.Ed.

The College of William and Mary
School of Education
Center for Gifted Education

2003

Funded by the Jacob Javits Grant,
United States Department of Education

The William and Mary Project Athena Observation Scales Guidelines

Please review and follow the protocol outlined below when conducting Project Athena classroom observations.

- Introduce yourself and your partner to the classroom teacher.
- Ask where he/she would like for you to sit during the observation.
- Confirm your meeting time after the lesson.
- Complete the demographics section (except the service delivery model) on the Classroom Observation Scale (COS) as available. Confirm the service delivery model with the coordinator.
- Complete the COS script sheet during the observation.
- Meet with the teacher to ask the *Teacher Interview Questions*. Write responses on page 14. (Remember, you have less than 15 minutes to meet with the teacher.)
- Using the results of your script and teacher response data, complete the COS checklist by yourself. Make sure there are no blank items on the COS.
- Using the results of your script regarding student participation and response, complete the Student Observation Scale (SOS) by yourself.
- Meet with your partner and reach consensus on the teacher and student observation scales. Together, complete the consensus forms for the teacher observation and student observation. Write the same information in each packet.
- Together, complete the Treatment Fidelity Form. Write the same information in each packet.
- Paper clip and submit your packet and your partner's packet for each observation.
- SMILE AND REPEAT THE PROCEDURE!
- Note: *It is imperative that all forms be completed on the same day of the observation. However, it is highly improbable that forms can be completed immediately after each observation due to the timing of scheduled observations. Be sure your script is as complete as possible for later reference.*

The William and Mary Classroom Observation Scales, Revised (Part 1)
Teacher Observation

Joyce VanTassel-Baska, Ed.D. *Linda Avery, Ph.D.* *Jeanne Struck, Ph.D.* *Annie Feng, Ed.D.*
Bruce Bracken, Ph.D. *Dianne Drummond, M.Ed.* *Tamra Stambaugh, M.Ed.*

Observer_____________________________ **Date**_________ **# of minutes observed**____________

School________________________________ **Grade**___________________

Teacher______________________________ **Course/lesson Observed**________________________

Student Information: Total #______

Observed Gender: #Boys_____ #Girls_____

Observed Ethnicity: #White______ #African American______ #Hispanic_____

#Asian American______ #Other______

Gifted: #Identified Gifted ______

Classroom Desk Arrangement: Desks in rows and columns ____ Desks in groups____ Desks in circle_____

Other (specify) ____

Service Delivery Model: *(as designated by the coordinator)*

Self-contained ____ Inclusion ____ Cluster group ____ Pullout ____ Other________

Please outline what you have observed in the classroom with respect to curriculum and instruction-related activities. Describe the specific lesson, its organization, instructional methods used, characteristics of the learning experience and environment, texts and materials used, questions asked by the teacher, and any other relevant observations and impressions that may influence your completion of the attached checklist.

Lesson Outline: *(See attached lesson plan script, pp. 11-13)*

Texts and Materials: *(List any materials, novels, texts, etc. used by students and/or the teacher.)*

Teacher Interview Questions

Discuss the following questions with the teacher observed after each observation period. (Approximate time: 15 minutes)

1. Did you have a written lesson plan for this lesson? ___ yes ___ no
2. How would you characterize the purpose of the lesson?
3. What were your instructional objectives for the previous lesson with this class?
4. What content will you cover in your subsequent lesson?
5. What plans do you have to address homework or extensions of this lesson?
6. How do you intend to assess outcomes for this lesson? Final outcomes for the unit?
7. Are there any aspects of the lesson you would like to clarify before this observation is finalized?

Write responses on page 14.

The William and Mary Classroom Observation Scales, Revised (Part 2)
Teacher Observation

Joyce VanTassel-Baska, Ed.D. *Linda Avery, Ph.D.* *Jeanne Struck, Ph.D.* *Annie Feng, Ed.D.*
Bruce Bracken, Ph.D. *Dianne Drummond, M.Ed.* *Tamra Stambaugh, M.Ed.*

Directions: Please employ the following scale as you rate each of the checklist items. Rate each item according to how well the teacher characteristic or behavior was demonstrated during the observed instructional activity. Each item is judged on an individual, self-contained basis, regardless of its relationship to an overall set of behaviors relevant to the cluster heading.

3=Effective	2=Somewhat Effective	1=Ineffective	N/O = Not Observed
The teacher evidenced careful planning and classroom flexibility in implementation of the behavior, eliciting many appropriate student responses. The teacher was clear, and sustained focus on the purposes of learning.	The teacher evidenced some planning and/or classroom flexibility in implementation of the behavior, eliciting some appropriate student responses. The teacher was sometimes clear and focused on the purposes of learning.	The teacher evidenced little or no planning and/or classroom flexibility in implementation of the behavior, eliciting minimal appropriate student responses. The teacher was unclear and unfocused regarding the purpose of learning.	The listed behavior was not demonstrated during the time of the observation. (NOTE: There must be an obvious attempt made for the certain behavior to be rated "ineffective" instead of "not observed".)

General Teaching Behaviors

Curriculum Planning and Delivery	3	2	1	N/O
The teacher…				
1. set high expectations for student performance.				
2. incorporated activities for students to apply new knowledge.				
3. engaged students in planning, monitoring or assessing their learning.				
4. encouraged students to express their thoughts.				
5. had students reflect on what they had learned.				

Comments:

Differentiated Teaching Behaviors

Accommodations for Individual Differences	3	2	1	N/O
The teacher…				
6. provided opportunities for independent or group learning to promote depth in understanding content.				
7. accommodated individual or subgroup differences (e.g., through individual conferencing, student or teacher choice in material selection and task assignments.)				
8. encouraged multiple interpretations of events and situations.				
9. allowed students to discover key ideas individually through structured activities and/or questions.				

Comments:

Problem Solving	3	2	1	N/O
The teacher…				
10. employed brainstorming techniques.				
11. engaged students in problem identification and definition				
12. engaged students in solution-finding activities and comprehensive solution articulation.				

Comments:

Critical Thinking Strategies	3	2	1	N/O
The teacher…				
13. encouraged students to judge or evaluate situations, problems, or issues				
14. engaged students in comparing and contrasting ideas (e.g., analyze generated ideas)				
15. provided opportunities for students to generalize from concrete data or information to the abstract.				
16. encouraged student synthesis or summary of information within or across disciplines.				
Comments:				

Creative Thinking Strategies	3	2	1	N/O
The teacher…				
17. solicited many diverse thoughts about issues or ideas.				
18. engaged students in the exploration of diverse points of view to reframe ideas.				
19. encouraged students to demonstrate open-mindedness and tolerance of imaginative, sometimes playful solutions to problems.				
20. provided opportunities for students to develop and elaborate on their ideas.				
Comments:				

Research Strategies	3	2	1	N/O
(It is atypical for these to be observed in one session. Some teachers, however, may use Items #21-25 within a single period to illustrate the full research process to students. Please note those observations in the comments section.)				
The teacher…				
21. required students to gather evidence from multiple sources through research-based techniques (e.g., print, non-print, internet, self-investigation via surveys, interviews, etc.).				
22. provided opportunities for students to analyze data and represent it in appropriate charts, graphs, or tables.				
23. asked questions to assist students in making inferences from data and drawing conclusions.				
24. encouraged students to determine implications and consequences of findings.				
25. provided time for students to communicate research study findings to relevant audiences in a formal report and/or presentation.				
Comments:				

Additional Comments:

The William and Mary Classroom Observation Scales, Revised (Part 3)
Student Observation

Joyce VanTassel-Baska, Ed.D.; Bruce Bracken, Ph.D.; Diann Drummond, M.Ed

Student Responses to General Classroom Teacher Behaviors

Engaged in General Classroom Behaviors **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
1. demonstrated a high level of performance.						
2. applied new learning.						
3. demonstrated planful, monitoring, or evaluating behavior.						
4. articulated thinking process (e.g., verbal mediation).						
5. reflected on learning						
Comments:						

Student Responses to Differentiated Teaching Behaviors

Engaged in Diverse Self-selected or Self-paced Activities **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
6. worked on projects individually or in pairs/groups.						
7. worked on tiered assignments or tasks of choice.						
8. explored multiple interpretations.						
9. discovered central ideas through structured activities and/or questions asked.						
Comments:						

Engaged in Problem-solving Strategies **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
10. brainstormed ideas or alternative possibilities.						
11. defined problems.						
12. identified and implemented solutions to problems.						
Comments:						

Engaged in Critical Thinking Strategies **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
13. made judgments about or evaluated situations, problems, or issues.						
14. compared and contrasted ideas and concepts.						
15. generalized from specific to abstract data or information.						
16. synthesized or summarized information within or across disciplines.						
Comments:						

Engaged in Creative Thinking Strategies **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
17. demonstrated ideational fluency.						
18. explored diverse ways to think about a situation/object/event.						
19. offered imaginative, sometimes playful, suggestions as solutions to problems.						
20. provided examples and illustrations of ideas.						
Comments:						

Engaged in Research Strategies **Students:**	**Most** >75%	**Many** 50-75%	**Some** 25-50%	**Few** <25%	**None**	**N/A**
21. gathered evidence through research techniques (e.g., surveys, interviews, analysis of primary and secondary source documents).						
22. manipulated and transformed data to be interpreted.						
23. made inferences from data and drew conclusions.						
24. determined the implications and consequences of situations.						
25. communicated findings (e.g., report, oral presentation).						
Comments:						

Consensus Form

The William and Mary Classroom Observation Scales, Revised (Part 4)
Treatment Fidelity

Directions: The following observation scale addresses the fidelity of implementation in the William and Mary Language Arts units. After reaching consensus with your observation partner, please check the relevant category describing the teacher's implementation of key instructional models.

Lesson # ____					
The teacher…	**Effective**	**Somewhat Effective**	**Ineffective**	**N/A**	**Comments**
Content:					
1. instructed/practiced literary analysis and interpretation (literature web).					
2. instructed/practiced word analysis (vocabulary web).					
3. instructed/practiced persuasive writing (hamburger model).					
4. instructed/practiced grammar activities.					
5. structured questions for discussion of readings.					
6. enhanced oral communication.					
Process					
7. instructed/practiced the reasoning model.					
8. instructed/practiced the research model.					
Concept					
9. instructed/practiced concept mapping.					
10. emphasized "change" in instruction and assignments.					
11. instructed/applied unit generalizations about change.					
12. emphasized relevant concepts, themes, or ideas in instruction and assignments.					

Consensus Form

The William and Mary Classroom Observation Scales, Revised (Part 2)
Teacher Observation

Joyce VanTassel-Baska, Ed.D. *Linda Avery, Ph.D.* *Jeanne Struck, Ph.D.* *Annie Feng, Ed.D.*
Bruce Bracken, Ph.D. *Dianne Drummond, M.Ed.* *Tamra Stambaugh, M.Ed.*

Directions: Please employ the following scale as you rate each of the checklist items. Rate each item according to how well the teacher characteristic or behavior was demonstrated during the observed instructional activity. Each item is judged on an individual, self-contained basis, regardless of its relationship to an overall set of behaviors relevant to the cluster heading.

3=Effective	2=Somewhat Effective	1=Ineffective	N/O = Not Observed
The teacher evidenced careful planning and classroom flexibility in implementation of the behavior, eliciting many appropriate student responses. The teacher was clear, and sustained focus on the purposes of learning.	The teacher evidenced some planning and/or classroom flexibility in implementation of the behavior, eliciting some appropriate student responses. The teacher was sometimes clear and focused on the purposes of learning.	The teacher evidenced little or no planning and/or classroom flexibility in implementation of the behavior, eliciting minimal appropriate student responses. The teacher was unclear and unfocused regarding the purpose of learning.	The listed behavior was not demonstrated during the time of the observation. (NOTE: There must be an obvious attempt made for the certain behavior to be rated "ineffective" instead of "not observed".)

General Teaching Behaviors

Curriculum Planning and Delivery	3	2	1	N/O
The teacher…				
1. set high expectations for student performance.				
2. incorporated activities for students to apply new knowledge.				
3. engaged students in planning, monitoring or assessing their learning.				
4. encouraged students to express their thoughts.				
5. had students reflect on what they had learned.				

Comments:

Differentiated Teaching Behaviors

Accommodations for Individual Differences	3	2	1	N/O
The teacher…				
6. provided opportunities for independent or group learning to promote depth in understanding content.				
7. accommodated individual or subgroup differences (e.g., through individual conferencing, student or teacher choice in material selection and task assignments.)				
8. encouraged multiple interpretations of events and situations.				
9. allowed students to discover key ideas individually through structured activities and/or questions.				

Comments:

Problem Solving	3	2	1	N/O
The teacher…				
10. employed brainstorming techniques.				
11. engaged students in problem identification and definition				
12. engaged students in solution-finding activities and comprehensive solution articulation.				

Comments:

Critical Thinking Strategies	3	2	1	N/O
The teacher…				
13. encouraged students to judge or evaluate situations, problems, or issues				
14. engaged students in comparing and contrasting ideas (e.g., analyze generated ideas)				
15. provided opportunities for students to generalize from concrete data or information to the abstract.				
16. encouraged student synthesis or summary of information within or across disciplines.				
Comments:				

Creative Thinking Strategies	3	2	1	N/O
The teacher…				
17. solicited many diverse thoughts about issues or ideas.				
18. engaged students in the exploration of diverse points of view to reframe ideas.				
19. encouraged students to demonstrate open-mindedness and tolerance of imaginative, sometimes playful solutions to problems.				
20. provided opportunities for students to develop and elaborate on their ideas.				
Comments:				

Research Strategies	3	2	1	N/O
(It is atypical for these to be observed in one session. Some teachers, however, may use Items #21-25 within a single period to illustrate the full research process to students. Please note those observations in the comments section.)				
The teacher…				
21. required students to gather evidence from multiple sources through research-based techniques (e.g., print, non-print, internet, self-investigation via surveys, interviews, etc.).				
22. provided opportunities for students to analyze data and represent it in appropriate charts, graphs, or tables.				
23. asked questions to assist students in making inferences from data and drawing conclusions.				
24. encouraged students to determine implications and consequences of findings.				
25. provided time for students to communicate research study findings to relevant audiences in a formal report and/or presentation.				
Comments:				

Additional Comments:

Consensus Form
The William and Mary Classroom Observation Scales, Revised (Part 3)
Student Observation
Joyce VanTassel-Baska, Ed.D.; Bruce Bracken, Ph.D.; Diann Drummond, M.Ed

Student Responses to General Classroom Teacher Behaviors

Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
26. demonstrated a high level of performance.						
27. applied new learning.						
28. demonstrated planful, monitoring, or evaluating behavior.						
29. articulated thinking process (e.g., verbal mediation).						
30. reflected on learning						
Comments:						

Student Responses to Differentiated Teaching Behaviors

Engaged in Diverse Self-selected or Self-paced Activities Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
31. worked on projects individually or in pairs/groups.						
32. worked on tiered assignments or tasks of choice.						
33. explored multiple interpretations.						
34. discovered central ideas through structured activities and/or questions asked.						
Comments:						

Engaged in Problem-solving Strategies Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
35. brainstormed ideas or alternative possibilities.						
36. defined problems.						
37. identified and implemented solutions to problems.						
Comments:						

Engaged in Critical Thinking Strategies Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
38. made judgments about or evaluated situations, problems, or issues.						
39. compared and contrasted ideas and concepts.						
40. generalized from specific to abstract data or information.						
41. synthesized or summarized information within or across disciplines.						
Comments:						

Engaged in Creative Thinking Strategies Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
42. demonstrated ideational fluency.						
43. explored diverse ways to think about a situation/object/event.						
44. offered imaginative, sometimes playful, suggestions as solutions to problems.						
45. provided examples and illustrations of ideas.						
Comments:						

Engaged in Research Strategies Students:	**Most**	**Many**	**Some**	**Few**	**None**	**N/A**
46. gathered evidence through research techniques (e.g., surveys, interviews, analysis of primary and secondary source documents).						
47. manipulated and transformed data to be interpreted.						
48. made inferences from data and drew conclusions.						
49. determined the implications and consequences of situations.						
50. communicated findings (e.g., report, oral presentation).						
Comments:						

The William and Mary Classroom Observation Scales
Lesson Plan Script Sheet

What's Going On? *(Methods and Organization)*	**# of Minutes**	**Questions or Comments** *(Specific Quotes)*		**Other Observations** *(include # of students answering or involved)*
		Teacher	**Student**	

Unanticipated Student Behaviors Observed:

The William and Mary Classroom Observation Scales
Lesson Plan Script Sheet (cont.)

What's Going On? *(Methods and Organization)*	**# of Minutes**	**Questions or Comments** *(Specific Quotes)*		**Other Observations** *(include # of students answering or involved)*
		Teacher	**Student**	

Unanticipated Student Behaviors Observed:

The William and Mary Classroom Observation Scales
Lesson Plan Script Sheet (cont.)

What's Going On? *(Methods and Organization)*	**# of Minutes**	**Questions or Comments** *(Specific Quotes)*		**Other Observations** *(include # of students answering or involved)*
		Teacher	**Student**	

Unanticipated Student Behaviors Observed:

William and Mary Classroom Observation Scales, Revised
Teacher Interview Form

Questions	Teacher Responses
Did you have a written lesson plan for this lesson?	_____ yes _____ no
How would you characterize the purpose of the lesson?	
What were your instructional objectives for the previous lesson with this class?	
What content will you cover in your subsequent lesson?	
What plans do you have to address homework or extensions of this lesson?	
How do you intend to assess the outcomes for this lesson? Final outcomes for the unit?	
Are there any aspects of the lesson you would like to clarify before this observation is finalized?	

APPENDIX F: RESEARCH PERIOD ONE BENCHMARK ASSESSMENT

Name ____________________________

Date _____________________________

Period ___________________________

7^{th} Grade Mathematics
Research Period 1
Benchmark Assessment

1 The names of 5 students and their scores on their last science test are shown in the table below.

Science Test Scores

Student	Score
Gretchen	$\frac{21}{25}$
Hector	$\frac{23}{25}$
Isabella	$\frac{22}{25}$
Jocelyn	$\frac{19}{25}$
Katy	$\frac{20}{25}$

Which students each earned a score above 85%?

A Gretchen

B Hector and Isabella

C Isabella and Katy

D Gretchen, Hector, and Jocelyn

2 A generator can run for 11 hours on 3 gallons of gasoline. If the gasoline costs $3 per gallon, which is closest to the cost per hour to run the generator?

A $9.00

B $33.00

C $0.82

D $1.22

3 A customer bought 5.5 pounds of tomatoes from a local produce store. How many ounces of tomatoes did the customer buy?

A 80

B 88

C 96

D Not here

4 A 24,000-gallon pool is being filled at a rate of 40 gallons per minute. At this rate, how many minutes will it take to fill this pool $\frac{3}{4}$ full?

A 450 min

B 560 min

C 600 min

D 150 min

5 There are 280 students in the seventh grade at Oak Middle School. If 15% of the seventh graders belong to the school choir, how many seventh graders at Oak Middle School belong to the choir?

A 19

B 28

C 42

D 56

6 Mike got a 45% discount when he bought a new jacket. Which of the following is NOT equivalent to 45%?

A $\frac{9}{20}$

B $\frac{4}{5}$

C 0.45

D $\frac{45}{100}$

7 The seventh-grade students at Alaniz Middle School went on a field trip. At lunch 17 students drank lemonade. This represented 20% of the students on the field trip. How many students were on the field trip?

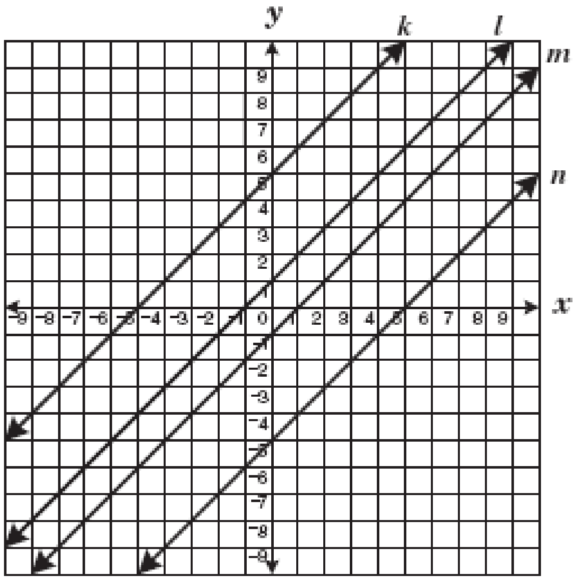
A 20

B 37

C 85

D 117

8 Which line contains the ordered pair (2, −3)?



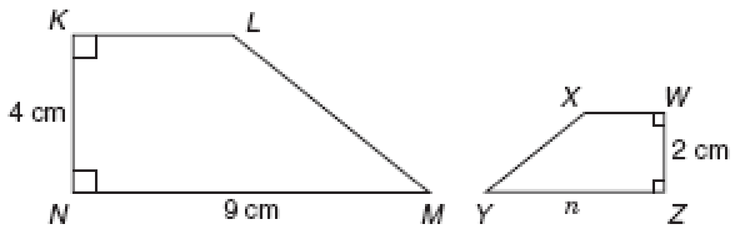
A Line *k*

B Line *l*

C Line *m*

D Line *n*

9 In the diagram below, figure *KLMN* is similar to figure *WXYZ*.



Which of the following proportions can be used to find the value of *n*?

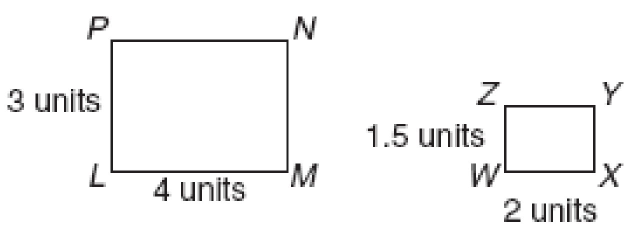
A $\frac{4}{n} = \frac{2}{9}$

B $\frac{2}{n} = \frac{9}{4}$

C $\frac{13}{n} = \frac{2}{4}$

D $\frac{4}{2} = \frac{9}{n}$

10 Look at the 2 rectangles below.



Which method could be used to prove that the rectangles are similar?

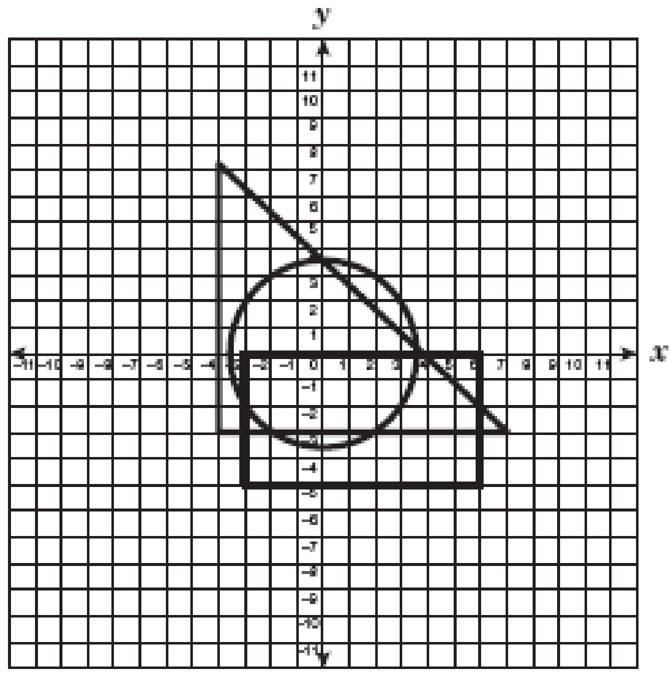
A Divide 3 by 2 and 4 by 1.5 to see whether the quotients are the same

B Divide 1.5 by 4 and 2 by 3 to see whether the quotients are the same

C Divide 4 by 1.5 and 2 by 3 to see whether the quotients are the same

D Divide 3 by 1.5 and 4 by 2 to see whether the quotients are the same

11 Which ordered pair in quadrant III is contained within the circle, triangle, and rectangle?



A (3, −1)

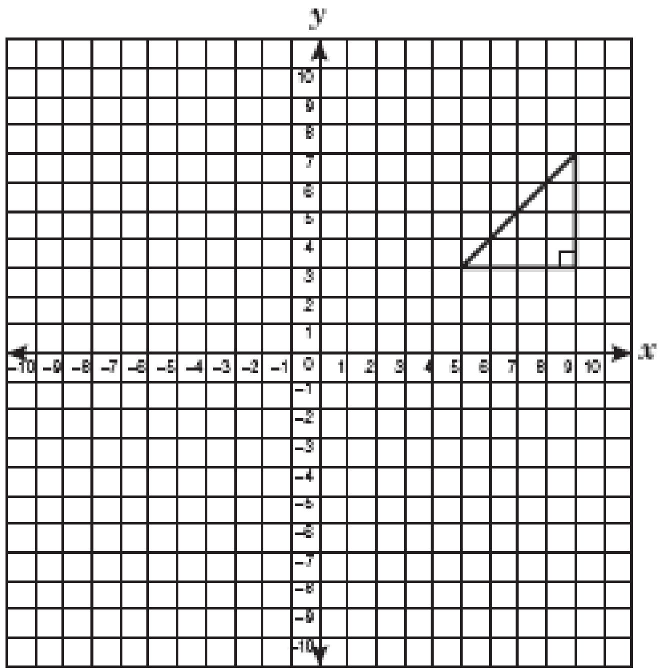
B (−4, −1)

C (−1, −2)

D (1, −6)

12 A right triangle is shown on the coordinate plane below

.



If the triangle is translated 11 units to the left and 2 units up, which of the following best represents the coordinates of one of its vertices?

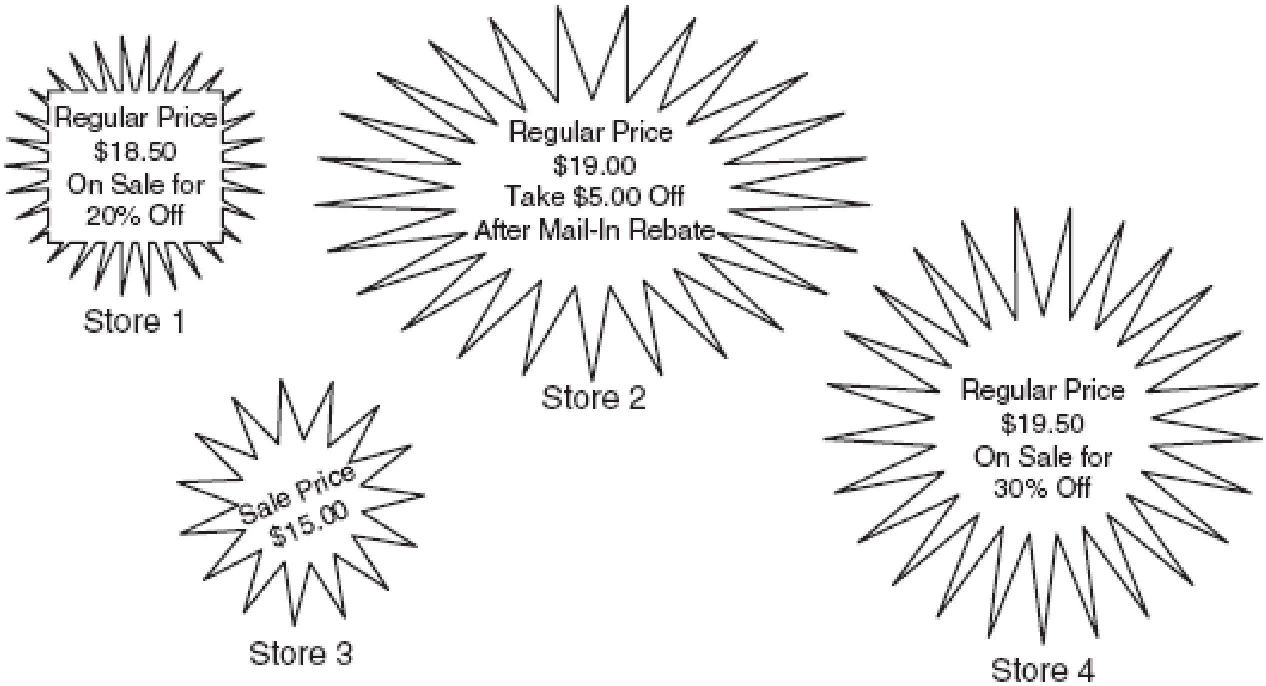
A (−6, 5)

B (−6, 3)

C (5, 5)

D (5, 3)

13 As Matilda shopped for a new calculator, she found four newspaper advertisements for four stores that had the calculator she wanted.



Which store had the lowest price for the calculator Matilda wanted?

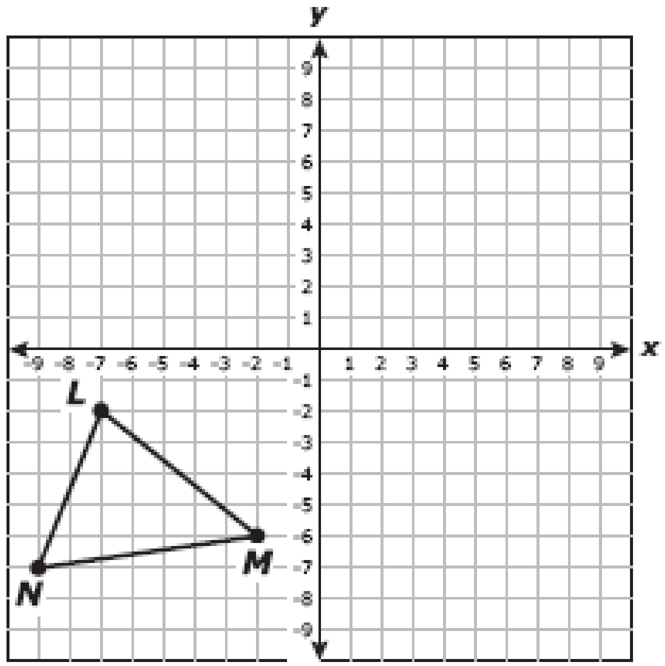
A Store 1

B Store 2

C Store 3

D Store 4

14 Triangle *LMN* is shown on the coordinate grid below.



If triangle *LMN* is reflected across the *y*-axis, which of the following best represents a vertex of the resulting triangle?

A (2, −6)

B (−9, −7)

C (−7, 2)

D (−2, 6)

APPENDIX G: RESEARCH PERIOD TWO BENCHMARK ASSESSMENT

Name ____________________________

Date ______________________________

Period ___________________________

7^{th} Grade Mathematics
Research Period 2
Benchmark Assessment

1 Which situation is best represented by the equation below?

$$3x = 27$$

A The total cost of a dinner and tip was $27. If a $3 tip was included in the total cost, what is *x*, the cost of the dinner?

B The total cost of a dinner and dessert was $27. The cost of the dinner was 3 times the cost of the dessert. What is *x*, the cost of the dessert?

C Three friends went to dinner, and each paid $27. What is *x*, the total amount they spent on dinner?

D Three friends went to dinner and paid a total of $27. If they divided the bill evenly, what is *x*, the amount each friend paid?

2 What is the value of the expression below?

$$5 + 5(9 \div 3)\,2$$

A 35

B 90

C 50

D 230

3 Which rule can be used to find the value of the *n*th term in the sequence below, where *n* represents the position of the term?

Position	Value of Term
1	$\frac{3}{4}$
2	$1\frac{1}{2}$
3	$2\frac{1}{4}$
4	3
5	$3\frac{3}{4}$
n	

A $\frac{n+2}{4}$

B $\frac{n+1}{2}$

C $\frac{2n+5}{4}$

D $\frac{3n}{4}$

4 Quentin's school has 2 identical rectangular flower beds that are each 5 feet wide and 50 feet long. A 20-pound bag of mulch covers 100 square feet 1 inch deep. Which equation shows the number of bags of mulch needed to cover both flower beds with 1 inch of mulch?

A $2 \cdot 5 \cdot 100 \div 50 = 20$

B $2 \cdot 5 \cdot 50 \div 100 = 5$

C $5 \cdot 50 \cdot 20 = 5{,}000$

D $5 \cdot 50 \cdot 20 \div 100 = 50$

5 Mrs. Penn has a circular tablecloth with a circumference of 29 feet. Which expression could be used to find the radius of the tablecloth?

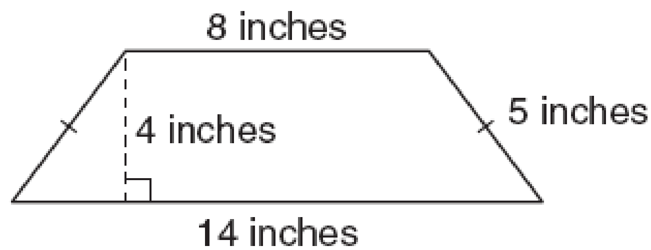
A $29 - 2\pi$

B $\frac{29}{2\pi}$

C $\frac{29}{\pi}$

D $29 + 2\pi$

6 Peter wants to find the perimeter of the isosceles trapezoid shown below. Which equation could Peter use to find *P*, the perimeter of the trapezoid?



A $P = 8 \cdot 14 + 5$

B $P = 8 + 14 + (2 \cdot 5)$

C $P = (8 + 14) \cdot 4 \div 2$

D $P = 8 + 5 + 14 + 4$

7 Tina's Boats rents rowboats at the rate of $2 for every half hour, plus a $5 service charge. Which equation shows the amount Tina's Boats will charge for renting a rowboat for 3 hours?

A $(2 \cdot 3 + 5) \div \frac{1}{2} = 22$

B $5 + 2(3 \div \frac{1}{2}) = 17$

C $5 + 2(3 \cdot \frac{1}{2}) = 8$

D $(5 + 2 + 3) \cdot \frac{1}{2} = 5$

8 Ethan wrote the equation below to solve a word problem.

$$3 \cdot m = 54$$

Which word problem is best represented by Ethan's equation?

A Angela had some candies and ate 3 of them. Now she has 54 candies. What is *m*, the number of candies she originally had?

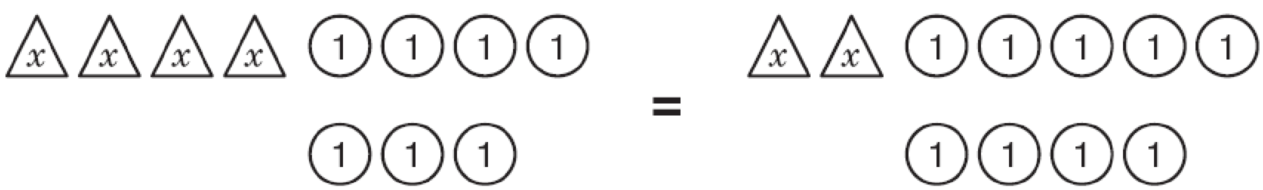
B A babysitter earns $3.00 each hour. One weekend she earned $54.00. What is *m*, the number of hours she worked that weekend?

C Ursula has $3.00 more than Bill. Together they have $54.00. What is *m*, the amount of money Bill has?

D A teacher set aside 54 minutes to spend teaching a topic. She has already used 3 minutes. What is *m*, the number of minutes she has left?

---

9 The equation $4x + 7 = 2x + 9$ is modeled below.



Which value of *x* would make the equation true?

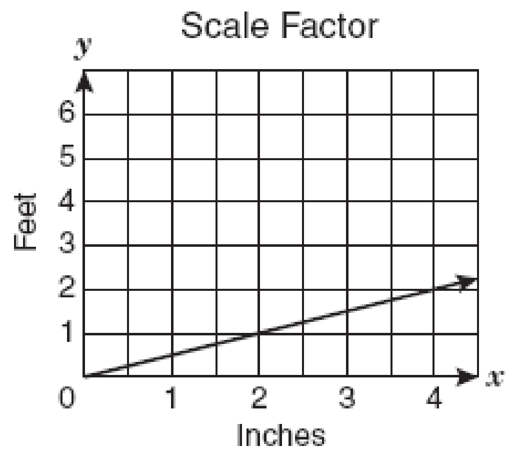
A $x = 1$

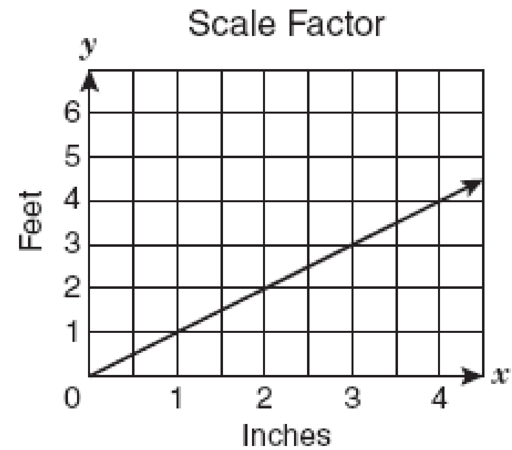
B $x = 2$

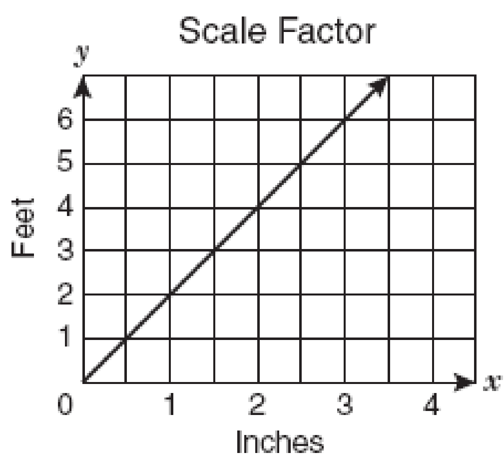
C $x = 8$

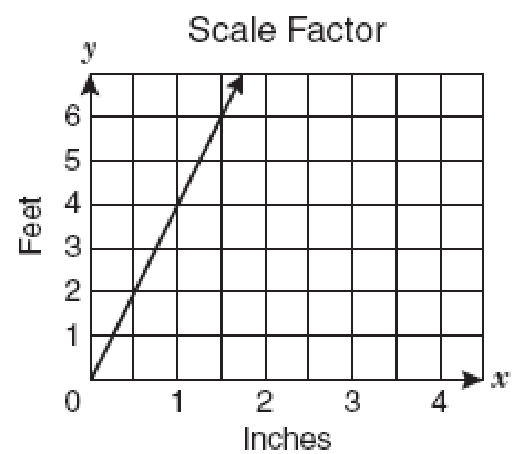
D $x = 16$

10 Mr. Ward used a scale factor where ½ inch represents 1 foot to make a drawing of his house. Which graph best represents this relationship?

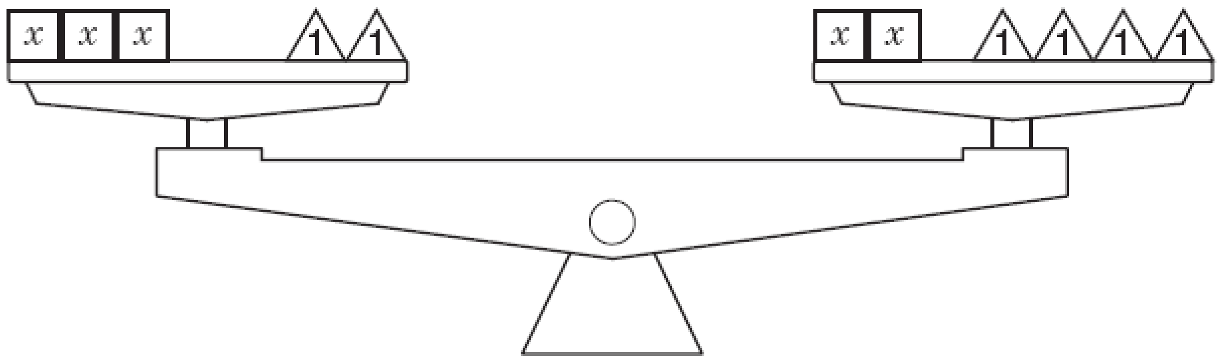
A


C


B


D


11 The model below represents the equation $3x + 2 = 2x + 4$.



What is the value of x?

A $x = 5$

B $x = 1$

C $x = 6$

D $x = 2$

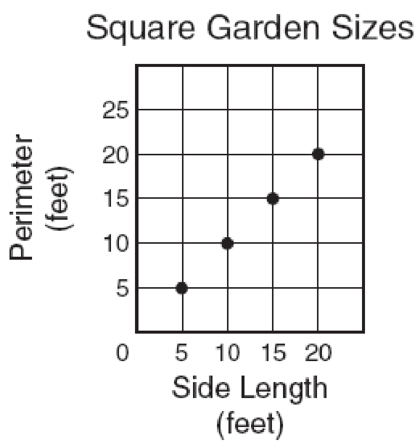
12 The table below shows the different sizes of square gardens Charlie can build.

Square Garden Sizes

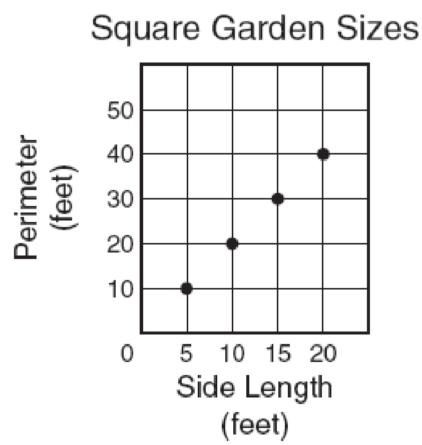
Garden	Side Length (feet)
W	5
X	10
Y	15
Z	20

Which graph shows the correct relationship between the side length and perimeter of each square garden Charlie can build?

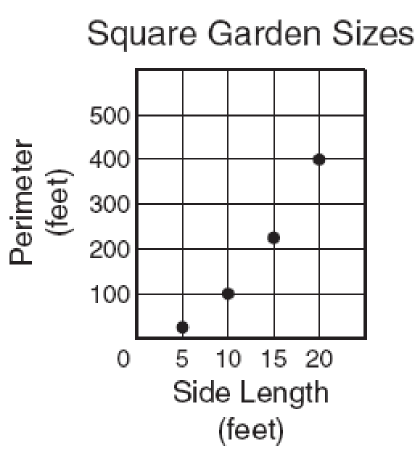
A



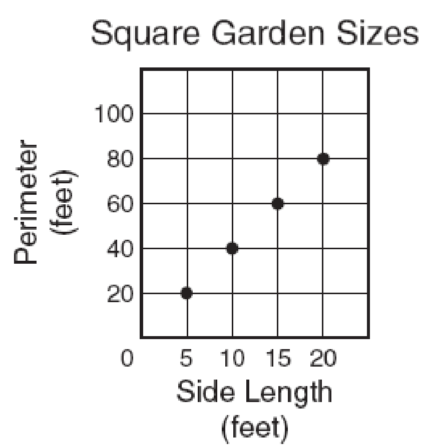
C



B



D



13 Which table below shows the sequence that follows the rule $8n - 2$, where n represents the position of a term in the sequence?

A

Position	1	2	3	4	5	n
Value of Term	7	8	9	10	11	

B

Position	1	2	3	4	5	n
Value of Term	6	14	22	30	38	

C

Position	1	2	3	4	5	n
Value of Term	6	4	2	0	–2	

D

Position	1	2	3	4	5	n
Value of Term	7	15	23	31	39	

14 What is the value of the expression below?

$$10 + 7 \cdot 8^2 \div 2$$

A 61

B 544

C 234

D 66

APPENDIX H: PERMISSION FOR USE OF TEACHING STYLE INVENTORY

From: "Sara Huisking" <shuisking@thoughtfulclassroom.com>
To: "Kimberly Williams" <Kimberly.Williams@clint.net>
Date: Thursday - January 20, 2011 9:20 AM
Subject: RE: Request to Use Teaching Style Inventory in Doctoral Research

Dear Ms. Williams,

Attached is the permission. As a stipulation for granting permission, we ask that you send us a copy of the research paper when it is finished.

Thanks again and good luck in your research.

Sincerely,

Sara Huisking
Director of Marketing
Silver Strong & Associates

-----Original Message-----
From: Kimberly Williams [mailto:Kimberly.Williams@clint.net]
Sent: Thursday, January 20, 2011 10:48 AM
To: Sara Huisking
Subject: Request to Use Teaching Style Inventory in Doctoral Research

Good morning Ms. Huisking,

I spoke to you on Tuesday in reference to use of the Teacher Style Inventory (TSI) as a survey instrument for my doctoral research. Attached is a signed letter requesting use of the instrument. If you will allow me permission to use the TSI for educational research purposes, please respond to this e-mail and sign the "Permission Granted" portion of the letter to return to me. The signed letter can either be scanned and returned or faxed to 915-926-4039. Thank you, in advance, and I assure you that the TSI will be used to further advance educational research.

Thank you again,

Kimberly G. Williams
Clint Independent School District
Math/Science Coordinator
915-926-4034

January 20, 2011

Kimberly G. Williams
3680 Tierra Calida
El Paso, TX 79938

Thoughtful Education Press, LLC
227 First Street
Ho-Ho-Kus, NJ 07423-1533

Dear Thoughtful Education Press:

My name is Kimberly Williams and I currently a doctoral student at Liberty University in Lynchburg, Virginia. I recently purchased the "Teaching Style Inventory" and I am writing to request permission to use the instrument in my doctoral research. The inventory will be used to determine the teaching modes currently being implemented in the classrooms of the teachers involved in the study. I would appreciate your permission to use the inventory and include the document as an appendix, with appropriate citations and copyright information. All citations will include the title, author, and copyright information.

Thank you, in advance, for your assistance. If you are willing to grant my request, please complete the section below and return this request. If you have any questions or would like additional information, please contact me at 915-342-8153 or via e-mail at kj_williams71@yahoo.com. Again, thank you for your support.

Sincerely,

Kimberly G. Williams

Kimberly G. Williams

Doctor of Education Student
Liberty University

Permission granted:

Sara Hosking	[signature]	Jan 20, 2011
Copyright owner or agent	Signature	Date

APPENDIX I: SECONDARY OBSERVERS CONFIDENTIALITY AGREEMENT

Confidentiality Agreement

It is understood and agreed upon that the below-named Secondary Observer will participate in confidential classroom observations for the sole purpose of doctoral research for Kimberly Williams, Liberty University Doctoral Candidate. Information obtained and recorded on the William and Mary Classroom Observation Form-Revised (COS-R) will become the sole property of the Primary Observer, Kimberly Williams, at the conclusion of each observation. All information collected from each documented observation is confidential and it is agreed that this information will not be shared with any outside entity, including campus administrators, members of the Instructional Services Department, or Cabinet Members.

No information will be disclosed to any party, unless required by law. Both parties acknowledge they have read and understand the confidential nature of the data being collected. This agreement is entered into voluntarily and without coercion.

Primary Observer:

Name (Print or Type):

Kimberly G. Williams

Signature:

____

Date:

____

Secondary Observer:

Name (Print or Type):

____

Signature:

____

Date:

____

APPENDIX J: PERMISSION FOR USE OF CLASSROOM OBSERVATION SCALES – REVISED

January 20, 2011

Kimberly G. Williams
3680 Tierra Calida
El Paso, TX 79938

The College of William and Mary
Center for Gifted Education
P.O. Box 8795
Williamsburg, VA 23187-8795

To The College of William and Mary:

My name is Kimberly Williams and I currently a doctoral student at Liberty University in Lynchburg, Virginia. I am conducting research focused on the effect of differentiated instruction on standardized testing in the middle school classroom. I am writing to request permission to use "The William and Mary Classroom Observation Scale Revised (COS-R)" in my study. The purpose is to analyze the instructional practices being used in the classroom, specifically those practices which are differentiated. My research will focus on student performance in classrooms where instruction is differentiated compared to classrooms where instruction is not differentiated.

I would appreciate your permission to use the classroom observation tool and include the document as an appendix, with appropriate citations and copyright information. All citations will include the title, author, and copyright information. I have enclosed an overview of the research design and a second copy of this request for your records.

Thank you, in advance, for your assistance. If you are willing to grant my request, please complete the section below and return in the self-addressed stamped envelope that is provided. If you have any questions or would like additional information, please contact me at 915-342-8153 or via e-mail at kwilliams13@liberty.edu. Again, thank you for your support.

Sincerely,

Kimberly G. Williams

Doctor of Education Student
Liberty University

Permission granted:

Kimberley L Chandler	KIMBERLEY L. CHANDLER	1-28-11
Copyright owner or agent	Signature	Date

APPENDIX K: INSTITUTIONAL REVIEW BOARD APPROVAL

IRB Approval 1159.092311: The Effect of Differentiated Instruction on Standardized Assessment Performance of Students in the Middle School Mathematics Classroom

Sent: Friday, September 23, 2011 2:51 PM
To: Williams, Kimberly
Cc: Woolard, Linda J; IRB, IRB; Garzon, Fernando

Attachments: Annual Rev)

Good Afternoon Kimberly,

We are pleased to inform you that your above study has been approved by the Liberty IRB. This approval is extended to you for one year. If data collection proceeds past one year, or if you make changes in the methodology as it pertains to human subjects, you must submit an appropriate update form to the IRB. Attached you'll find the forms for those cases.

Thank you for your cooperation with the IRB and we wish you well with your research project. We will be glad to send you a written memo from the Liberty IRB, as needed, upon request.

Sincerely,

Fernando Garzon, Psy.D.

IRB Chair, Associate Professor

Center for Counseling & Family Studies

(434) 592-5054

APPENDIX L: DISTRICT APPROVAL TO CONDUCT STUDY

August 20, 2011

To Whom It May Concern:

This letter will serve as formal approval for Kimberly Williams, doctoral student, to conduct interviews of [redacted] staff, review data, and conduct other research tied to her doctoral study. It is our understanding that Kim will be conducting research on seventh grade mathematics classrooms and staff. This research may involve looking at student data, reviewing student test scores, and reviewing teacher lesson plans. Furthermore, the research may involve classroom observations and interviews with [redacted] students and staff. Kim has completed all the required documentation from [redacted] and has permission to conduct all of the aforementioned activities. She has been made aware of the confidentiality of student data and has assured the District she will maintain that confidentiality at all times.

[redacted] is glad to approve this research project and visit with our staff. We look forward to the research and if you have any questions or comments please feel free to contact me.

Sincerely,

[redacted]

Assistant Superintendent of Instructional Services

APPENDIX M: INFORMED CONSENT FOR RESEARCH PARTICIPANTS

INFORMED CONSENT

The Effect of Differentiated Instruction on Standardized Assessment Performance in the Middle School Mathematics Classroom
Kimberly G. Williams
Liberty University
School of Education

You are invited to participate in a research study to determine if incorporating differentiated instruction practices in the classroom has a significant effect on student performance on standardized assessments. You were selected as a possible participant because the study is focused on seventh grade mathematical achievement levels and you are currently a seventh grade mathematics teacher.

Please read this form in its entirety and ask any questions you may have before agreeing to be a participant in the study.

Researcher

This study is being conducted by Kimberly G. Williams, Doctoral student at Liberty University School of Education.

Background Information

The purpose of this study is to determine if student scores increase on standardized assessments when differentiated strategies are maximized in the classroom. As the new testing system is implemented in Texas, results will provide a stronger indication of the types of teaching strategies that will maximize student performance on high-stakes testing.

Procedures

If you agree to be in this study, you will be asked to do the following:
Participants will complete the Silver, Hanson, and Strong (2005) Teaching Style Inventory (TSI). You will be asked to complete the TSI self-assessment survey which is comprised of 56 questions relating to your preferred style of classroom instruction. I will score the instrument to determine your preferred teaching style and characteristics of instruction. If you agree to participate in the research, you will be given the survey today and asked to return it within 7 days. You do not have to provide your name; the inventory is completely anonymous. The form will be returned in the self-addressed stamped envelope that is provided. The purpose of this survey is to determine the types of teaching styles present in the classroom prior to beginning research. Results will be used for dissertation, publication, and presentation purposes. No identifying information will be provided. Only the overall results will be published.

Participants will implement lesson plans provided by the researcher. I will provide lesson plans for 10 weeks of instruction. The lessons will be lecture-based or differentiated, depending on the treatment group you are assigned. All copies, worksheets, and materials will be provided at the beginning of the research period. The first set of lesson plans will begin October 3, 2011, and end November 4, 2011. The second set of lesson plans will begin November 7, 2011, and end December 16, 2011. Each set of lesson plans will include 22 days of instruction, 1 day for review, 1 day for re-teaching, and 1 day to administer the benchmark assessment. You will be expected to adhere to the lesson format provided.

Participants will be observed a minimum of four times during the research period. Two observations will be scheduled and two observations will be unscheduled. Observations are a necessary component of the research in order to validate that appropriate lesson plans are being implemented. Observations will conducted by a two-person team. The researcher will serve as the Primary Observer and the Elementary Math/Science Coordinator or Bilingual Coordinator will serve as the Secondary Observer. A confidentiality agreement will be signed by the secondary observers before any classroom observations occur. The William and Mary Classroom Observation Scale Revised (COS-R) (2003) will be used to determine general teaching behaviors, differentiated teaching behaviors, and overall student responsiveness. A follow-up conference of approximately 15 minutes will take place after each observation. You will determine a pseudonym that will be used as a reporting tool on the dissertation publication to protect your identity. All observations are confidential and will not have any impact on your Professional Development Appraisal System (PDAS). The Secondary Observers will not keep a copy of the observations; they will be relinquished to the researcher.

Participants will administer an authentic standardized assessments at the end of each five-week period. Exams were created based on Texas Assessment of Knowledge and Skills (TAKS) formatted-items and are multiple-choice. Each benchmark contains 20 questions with each Texas Essential Knowledge and Skills (TEK) assessed with the same number of questions. Student exams and scoring sheets will be provided. I will scan all answer documents and provide you with your students' results.

You will be asked to provide a brief summary of the research experience at the conclusion of the study.

Risks

This research study has minimal risks, those you encounter every day in the classroom or when being observed by an outside party. However, because of the small number of seventh grade teachers, some individuals could make inferences about your identity from the results of the TSI or classroom observations.

Benefits

Participating in this study may provide deeper insight into current teaching methods. You may find alternative approaches to teaching that will benefit student learning, and in turn, increase standardized assessment scores. District wide, this study will assist in determining the most successful teaching practices in the classroom as they relate to high-stakes testing.

Confidentiality

All records of this study will be confidential. The TSI results will not be shared with any outside party. Classroom observations will be kept confidential between the team of observers and will not be shared with any administrator or district personnel. Participants will receive copies of the TSI, all classroom observations, and assessment results. Some short-answer quotes will be taken from the classroom observations and anonymous research summaries at the conclusion of the research. All research records will be stored securely in a locked file cabinet and I will be the only researcher with access to the records. At the conclusion of the research and mandatory period for retaining all records, the self-assessments, classroom observations, and assessment results will be shredded and destroyed.

Voluntary Participation

Participation in this study is voluntary and you may withdraw at any time. If you choose not to participate, your decision will not affect your current relationship with the school district or with the District Coordinator for Math and Science.

Contacts

The researcher conducting this study is Kimberly Williams. You may ask any questions you have now. If you have questions in the future, please contact me at 915-342-8153 or via e-mail at kj_williams71@yahoo.com or kwilliams13@liberty.edu. If you have concerns that you would like to address with my research advisor, please contact Dr. Linda Woolard at ljwoolard2@liberty.edu.

If you have ethical concerns or need additional information, please contact the Institutional Review Board, Dr. Fernando Garzon, Chair, 1971 University Blvd, Suite 1582, Lynchburg, VA 24502 or email at fgarzon@liberty.edu.

You will be given a copy of this information to keep for your records.

Statement of Consent:

I have read and understand the above information. I have asked questions and have received answers. I understand that participation is voluntary and I may withdraw from the research study at any time. I consent to participate in the study.

Signature:_______________________________________ Date: _______________

Signature of Investigator:___________________________ Date: _______________

APPENDIX N: HISTORY OF TEKS ASSESSED

Frequency of TEKS on TAKS – 1st Five Week Research Period

TEK		2011	2010	2009	2008	2006	2004
7.1B	The student is expected to convert between fractions, decimals, whole numbers, and percents mentally, on paper, [or with a calculator].	#1	Obj 1 #1	#2		#18	#14; #31
7.2D	The student is expected to use division to find unit rates and ratios in proportional relationships such as speed, density, price, recipes, and student-teacher ratio.	#3		#19		#3	#1
7.3A	The student is expected to estimate and find solutions to application problems involving percent.		Obj 2 #1	#33; #45	Obj 2 #1	#26; #34	#16; #25
7.3B	The student is expected to estimate and find solutions to application problems involving proportional relationships such as similarity, scaling, unit costs, and related measurement units.	#4	Obj 2 #2	#21 #36	Obj 2 #3	#43	#47
7.6D	The student is expected to use critical attributes to define similarity.	#7		#32	Obj 2 #2	#9	#9
7.7A	The student is expected to locate and name points on a coordinate plane using ordered pairs of integers.			#24	Obj 3 #3	#1	#2
7.7B	The student is expected to graph reflections across the horizontal or vertical axis and graph translations on a coordinate plane.	#8	Obj 3 #2	#18	#48	#13	#43

Frequency of TEKS on TAKS – 2nd Five Week Research Period

TEK		2011	2010	2009	2008	2006	2004
7.2E	The student is expected to simplify numerical expressions involving order of operations and exponents.			#26	Obj 1 #4	#44	#30
7.2F	The student is expected to select and use appropriate operations to solve problems and justify the selections.		Obj 1 #3	#46	Obj 1 #5	#12	
7.4A	The student is expected to generate formulas involving unit conversions within the same system (customary and metric), perimeter, area, circumference, volume, and scaling.			#25		#30 #41	#4
7.4B	The student is expected to graph data to demonstrate relationships in familiar concepts such as conversions, perimeter, area, circumference, volume, and scaling.		Obj 2 #3	#14		#31	#19
7.4C	The student is expected to use words and symbols to describe the relationship between the terms in an arithmetic sequence (with a constant rate of change) and their positions in the sequence.			#17 #41		#5 #37	
7.5A	The student is expected to use [concrete and] pictorial models to solve equations and use symbols to record the actions.			#28	Obj 2 #3	#11	#44
7.5B	The student is expected to formulate problem situations when given a simple equation and formulate an equation when given a problem situation.	#5		#8	Obj 2 #4	#7	#37

APPENDIX O: BENCHMARK BLUEPRINTS

1st Five Week Research Period – Benchmark Blueprint

TEK		Q1	Q2	# of BM Items
7.1B	The student is expected to convert between fractions, decimals, whole numbers, and percents mentally, on paper, [or with a calculator].	2009 #2	2011 #1	2
7.2D	The student is expected to use division to find unit rates and ratios in proportional relationships such as speed, density, price, recipes, and student-teacher ratio.	2008 Obj 6 #1	2011 #3	2
7.3A	The student is expected to estimate and find solutions to application problems involving percent.	2008 Obj 2 #1	2010 Obj 2 #1	2
7.3B	The student is expected to estimate and find solutions to application problems involving proportional relationships such as similarity, scaling, unit costs, and related measurement units.	2010 Obj 2 #2	2011 #4	2
7.6D	The student is expected to use critical attributes to define similarity.	2006 #9	2009 #32	2
7.7A	The student is expected to locate and name points on a coordinate plane using ordered pairs of integers.	2004 #34	2008 Obj 3 #3	2
7.7B	The student is expected to graph reflections across the horizontal or vertical axis and graph translations on a coordinate plane.	2010 Obj 3 #2	2011 #8	2

2nd Five Week Research Period – Benchmark Blueprint

TEK		Q1	Q2	# of BM Items
7.2E	The student is expected to simplify numerical expressions involving order of operations and exponents.	2006 # 44	2009 # 26	2
7.2F	The student is expected to select and use appropriate operations to solve problems and justify the selections.	2008 Obj 1 # 5	2010 Obj 1 # 3	2
7.4A	The student is expected to generate formulas involving unit conversions within the same system (customary and metric), perimeter, area, circumference, volume, and scaling.	2004 # 4	2006 #41	2
7.4B	The student is expected to graph data to demonstrate relationships in familiar concepts such as conversions, perimeter, area, circumference, volume, and scaling.	2006 #31	2010 Obj 2 # 3	2
7.4C	The student is expected to use words and symbols to describe the relationship between the terms in an arithmetic sequence (with a constant rate of change) and their positions in the sequence.	2009 # 17	2009 #41	2
7.5A	The student is expected to use [concrete and] pictorial models to solve equations and use symbols to record the actions.	2008 Obj 2 # 3	2009 #28	2
7.5B	The student is expected to formulate problem situations when given a simple equation and formulate an equation when given a problem situation.	2008 # 4	2011 #5	2

APPENDIX P: PEARSON PUBLISHING PERMISSION FOR USE OF RELEASED TAKS QUESTIONS

From: "Monroe Porter, Karen" <karen.monroe-porter@pearson.com>
To: "Copyrights" <Copyrights@tea.state.tx.us>
CC: <Kimberly.Williams@clint.net>
Date: Wednesday - February 16, 2011 1:44 PM
Subject: FW: Use of Texas released assessment materials
Hi Jack,

I'm recommending a restricted no-fee agreement for Kimberly. She has confirmed she is graduate student and the released materials will only be seen by Texas students. Please let me know if you have any questions or concerns. Thanks, Karen

Karen Monroe-Porter
Sr. Test Development Manager
Assessment Planning Services
Pearson
512-989-5136 office
512-269-6178 cell
512-989-5178 fax

-----Original Message-----
From: Kimberly Williams [mailto:Kimberly.Williams@clint.net]
Sent: Wednesday, February 16, 2011 2:40 PM
To: Monroe Porter, Karen
Subject: Re: Use of Texas released assessment materials

Good morning Ms. Porter,

(1) I would like to use some released TAKS items to create two benchmark assessments.

(2) Seventh grade students in Clint Independent School District in El Paso, Texas will be administered the assessment.

(3) I am requesting use of the following items to create two benchmark assessments:

Released 2010 TAKS Items: Obj 1: #1, 2, 3; Obj 2: #1, 3 (5 items total)

Released 2009 TAKS Items: #2, 3, 6, 12, 13, 24, 30, 33, 38, 42, 45, and 48 (12 items total)

Released 2008 TAKS Items: Obj 1: #1, 2, 3, 4; Obj 2: #1, 3; Obj 3: #3; Obj 6: #1, 2, 3 (10 items total)

Released 2006 TAKS Items: #1, 10, 11, 12, 18, 19, 21, 23, 26, 27, 29, 31, 32, 34, 39, 33, 34, and 47 (18 items total)
Released 2004 TAKS Items: #2, 3, 14, 16, 18, 19, 23, 24, 25, 27, 30, 31, 38, 41, 42, 44, 45, and 48 (18 items total)

I am requesting copyright release for the aforementioned questions (63 items total). Although only 40 items will be used, the final benchmark assessment will not be created until June 2011 because of modifications to the district scope and sequence.

I am currently working on my dissertation to determine if differentiated instruction has a significant impact on standardized assessment results. Data analysis would provide information as to how the students who receive differentiated instruction compare to the students who receive lecture-based instruction.

(4) Approximately 800 7th grade students would take the assessment.

(5) There are no fees associated with the assessment. Students will take the benchmark as their six-week exam in their mathematics classes. Student score sheets will be used and will be scanned using our district software program.

Thank you for your assistance and I will look forward to your reply,

Kimberly G. Williams
Clint Independent School District
Math/Science Coordinator
915-926-4034

>>> "Monroe Porter, Karen" <karen.monroe-porter@pearson.com> 02/07/11 8:58 AM >>>

Hello,

Pearson has been hired as the contracting agent for the marketing of TEA released assessment materials. I was given your contact information by TEA. First of all, I want to thank you for taking the time to read the copyright information given on the TEA website and contacting TEA before using their information. I have a few questions for you in order to determine if a fee needs to be accessed for the use of the requested materials.

What information from TEA's website would you like to use?

Will the materials be used in Texas or another state/region?

How will you utilize the information (benchmarking, item banking, individual review and study, etc)?

How many students/customers will use TEA's information?

Will you be charging a fee associated with the product that utilizes TEA's information?

Please feel free to give me a call or email me back with any questions you may have.

Thank you for your time and interest, Karen

Karen Monroe-Porter
Sr. Test Development Manager
Assessment Planning Services
Pearson
512-989-5136 office
512-269-6178 cell
512-989-5178 fax

APPENDIX Q: TEA PERMISSION FOR USE OF RELEASED TAKS ITEMS

TEA™
TEXAS EDUCATION AGENCY

1701 North Congress Ave. • Austin, Texas 78701-1494 • 512 463-9734 • 512 463-9838 FAX • www.tea.state.tx.us

Robert Sco
Commission

May 20, 2011

Kimberly G Williams
Clint ISD
Math/Science Coordinator
Email: Kimberly.Williams@clint.net

Re: License for Reproduction/Modification/Use of Specified TEA Copyrighted Materials (Works)

Ownership: The Texas Education Agency ("TEA") is the owner of the copyright interests in various materials (hereafter called the "Works" and described below) and for which is granted to the above identified Licensees ~~a~~ limited license to reproduce/modify/use. You (Licensee) agree that you do not have any ownership in the Works and that you will not seek to register the Works or any derivatives (called "Derivative Work") of the Works, or take any action that would harm TEA's interests in the Works or Derivative Work.

License Terms: TEA licenses to Licensee on a revocable, nontransferable, nonassignable, and nonexclusive basis the right to reproduce/modify/use the Works or Derivative Work in your Adult Education program in Texas only for the Limited Use described below. Licensee agrees to reproduce/modify/use the Works or Derivative Work only for the reasons or purposes stated in Limited Use Section below. Any modifications to the Works or Derivative Works not consistent with the purposes or the intent of the Works is prohibited. Any use of the Works or Derivative Work inures to the benefit of TEA. This license may not be modified or transferred other than in writing and by agreement of Licensee and TEA.

Derivative Work: Licensee agrees that all Works or Derivative Work, developed from the Works or from other TEA owned Derivative Work, or developed using TEA funds or using TEA funds in conjunction with "other" funds (including products produced by subcontractors) are, upon creation, "works made for hire" and as between Licensee (or its subcontractors) and TEA, the property of TEA. If the Works or Derivative Work developed from the Works are developed using TEA funds or using TEA funds in conjunction with "other" funds are, under applicable law, not considered works made for hire, Licensee hereby assigns to TEA or its designee all of Licensee's worldwide ownership of all rights, if any, including all intellectual property rights, in the Works or Derivative Work without the necessity of any further consideration, and TEA or its designee can obtain and hold in its own name all such rights. Licensee agrees to maintain written agreements with all officers, directors, employees, agents, representatives, and subcontractors engaged by Licensee regarding this Agreement, granting Licensee rights sufficient to support the performance and grant of rights to TEA by Licensee. Copies of such agreements shall be provided to TEA promptly upon request.

Limited Use: All reproductions/modifications/use of the Works or Derivative Work must include at minimum the following copyright notice: *"Copyright © 2011 Texas Education Agency. The materials are © copyrighted as the property of the Texas Education Agency and may not be reproduced without the express written permission of the Texas Education Agency".* This Copyright Notice must be place in the content and on all media containing the Works or Derivative Work.

License Period: Beginning date: May 20, 2011. Ending date: August 31, 2012. Amendments for extension of the License Period or any other terms and conditions are due (30) days prior to the end of the License Period.

Student Data Requirements: Licensee understands that any unauthorized disclosure of confidential student information is illegal as provided in the federal Family Educational Rights and Privacy Act of 1974 (FERPA), 20 USC, Section 1232g, and implementing federal regulations found in 34 CFR, Part 99. FERPA is specifically incorporated into the Texas Public Information Act as an exception to information that is subject to disclosure to the public (Texas Government Code, Section 552.026). Licensee understands that any personal characteristics of a student that could make the student's identity traceable, including membership in a group as ethnicity or program area, are protected.

Sincerely,
Norma Barrera
Director, Purchasing and Contracts
Texas Education Agency

APPENDIX R: CLASSROOM OBSERVATION SCALES REVISED RESULTS

				General Teaching Strategies	Differentiated Teaching				
Research Period	Teacher	Treatment or Control	Scheduled (Yes or No)		Accommodations	Problem Solving	Critical Thinking	Creative Thinking	Research Strategies
1	A	T	Y	1	1	1	1	1	1
1	A	T	N	3	3	2.7	2.8	2.8	3
2	A	C	Y	Not present for Observation					
2	A	C	N	2	2	N/0	N/0	3	N/0
1	B	T	Y	1.6	2	2.3	1.5	1.5	1.7
1	B	T	N	2.2	2.7	2.3	2.3	2.3	2.7
2	B	C	Y	1.6	2	1	1.5	1.5	N/0
2	B	C	N	2.5	1.8	2	2.7	2	1.7
1	C	T	Y	1.6	2.2	1	1	1	N/0
1	C	T	N	2.5	2.8	2.7	3	2.5	3
2	C	C	Y	1.4	1.5	1.3	1.3	1.3	N/0
2	C	C	N	1.5	1.5	2	1	1.3	1.7
1	D	T	Y	1.2	1	1	1	1	N/0
1	D	T	N	2.5	2.3	2.7	2.7	2.3	2.7
2	D	C	Y	Not present for Observation					
2	D	C	N	1	1.3	N/0	1	N/O	N/O
2	E	T	Y	3	2	2.3	2	2	2
2	E	T	N	2.5	2.5	3	2.7	2.7	1.3

				General Teaching Strategies	Differentiated Teaching				
Research Period	Teacher	Treatment or Control	Scheduled (Yes or No)		Accommodations	Problem Solving	Critical Thinking	Creative Thinking	Research Strategies
1	E	C	Y	2	2.5	2	2.5	3	N/0
1	E	C	N	3	3	3	3	3	3
2	F	T	Y	1	1	1	2	N/O	N/O
2	F	T	N	2.8	1.8	2.5	1.3	2	1
1	F	C	Y	1.6	1	1.3	1.3	1	N/0
1	F	C	N	2.6	2.5	2.3	3	2.8	3
2	G	T	Y	2.4	2.3	2.7	1.5	2.5	1.5
2	G	T	N	Not present for Observation					
1	G	C	Y	1.8	1.3	2	1.5	1	N/O
1	G	C	N	3	3	3	3	3	3
2	H	T	Y	2	1.3	1.3	1	1.3	N/O
2	H	T	N	2.7	2.3	2.5	2	2	N/O
1	H	C	Y	1.6	1.5	1	1.5	1.5	N/O
1	H	C	N	2.5	2.3	3	3	3	2.3
2	I	T	Y	1.6	1	1	1.3	1	N/O
2	I	T	N	1.5	1	1.5	2.3	1.5	1.6
1	I	C	Y	1.8	1.5	1	1	1	N/O
1	I	C	N	2.8	2.5	2	2	2.3	2

APPENDIX S: STUDENT OBSERVATION SCALE RESULTS FROM COS-R

				General Teaching Strategies	Differentiated Teaching				
Research Period	Teacher	Treatment or Control	Scheduled (Yes or No)		Accommodations	Problem Solving	Critical Thinking	Creative Thinking	Research Strategies
1	A	T	Y	0.4	0	0.3	0.25	0	1
1	A	T	N	4	4	2.7	3.8	4	4
2	A	C	Y	Not present for Observation					
2	A	C	N	N/A	N/A	N/A	N/A	N/A	N/A
1	B	T	Y	1.4	1.5	1	1.5	1.3	1.7
1	B	T	N	3.5	3.7	3.3	3.3	3.3	3.3
2	B	C	Y	1.4	1.8	1.7	1.5	1.3	N/A
2	B	C	N	1.7	2	2	2	1	2.7
1	C	T	Y	2	2.7	0.3	2	2.7	N/A
1	C	T	N	4	4	4	4	3.8	4
2	C	C	Y	1.8	1.3	2	1.5	0.5	N/A
2	C	C	N	1.8	2.7	2	0.5	1.7	2
1	D	T	Y	1.2	0.5	0.7	0.3	0.3	N/A
1	D	T	N	2.6	2.8	3.3	2.8	3.3	2.7
2	D	C	Y	Not present for Observation					
2	D	C	N	0.5	1.7	0	0	0	N/A
2	E	T	Y	3.2	1.3	2.3	2.3	2.3	1
2	E	T	N	3	3.3	3	3.3	2.7	3

Research Period	Teacher	Treatment or Control	Scheduled (Yes or No)	General Teaching Strategies	Differentiated Teaching: Accommodations	Problem Solving	Critical Thinking	Creative Thinking	Research Strategies
1	E	C	Y	2.3	2	N/A	2.5	3	N/A
1	E	C	N	4	4	4	3.8	3.8	4
2	F	T	Y	0.3	0	1	0	1	N/A
2	F	T	N	2	2	2	2	2	2
1	F	C	Y	0.8	1.5	0.3	0.5	0	N/A
1	F	C	N	2.8	2.8	2.7	3.8	2,8	4
2	G	T	Y	1.4	2.5	2	1.5	2	1
2	G	T	N	Not present for Observation					
1	G	C	Y	0.2	0.3	1	0.5	0.3	N/A
1	G	C	N	4	4	4	4	3.8	4
2	H	T	Y	1.6	1	2	0.3	0.5	N/A
2	H	T	N	3.3	2	3.3	4	2.3	4
1	H	C	Y	1.4	1	1.7	0.3	0.5	N/A
1	H	C	N	3	2.8	3	3.3	1.8	3.7
2	I	T	Y	0.6	0.3	0.7	0.3	0.5	N/A
2	I	T	N	1.2	1.3	1	1	0.8	1
1	I	C	Y	1.4	1	1	0	1	N/A
1	I	C	N	1.4	2.7	1.7	1.5	1.5	2