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The Effects Embedding Science Standards Within the Mathematics Curriculum Has On Students' Perceptions of Mathematics and Mathematics Achievement

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Concordia University–Portland

College of Education

Doctorate of Education Program

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The Effects Embedding Science Standards Within the Mathematics Curriculum Has on
Students' Perceptions of Mathematics
and Mathematics Achievement

Christina Marie Giles

Concordia University-Portland

College of Education

Dissertation submitted to the Faculty of the College of Education

in partial fulfillment of the requirements for the degree of

Doctor of Education in Transformational Leadership

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Concordia University-Portland

2018

Abstract

This study was based on a quasi-experimental design and consisted of a comparative group (students taught using traditional math instruction) and an experiential group (students taught using math instruction embedded with science standards). The study focused on whether embedding science standards into the instruction of mathematics would improve standardized test scores in mathematics of students in the sixth grade. The embedded lessons were designed by the researcher. Data collection was conducted using an online platform called ALEKS (a screener), a survey that measured student perceptions of efficacy toward math, and students' math pre and posttests using test scores as measured by the State of Texas Assessments of Academic Readiness (STAAR). The results revealed that there was no difference in achievement gains regarding STAAR standardized test scores in mathematics between students who were taught using traditional math instruction and students taught using math instruction embedded with science standards. However, students' perceptions of self-efficacy, as it relates to math, increased in those receiving instruction embedded with science standards, in comparison to the students in the traditional math class.

Keywords: correlated instruction, integrated lessons, online learning, standardized testing

Dedication

This dissertation is dedicated to my supportive husband, Jason, and our two rambunctious and intelligent boys, Aidan and Owen. Without your endless support, continual encouragement, and unwavering love for me, this process would have been even more challenging. Thank you for believing in me.

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Chapter 1: Introduction to the Study

This study focused on whether the manner in which mathematics lessons are presented to students increases achievement on standardized tests. Specifically, if science standards are embedded within the mathematics curriculum the study aimed to show that achievement in mathematics would improve. “When mathematics and science learning is segregated, the context of the investigated phenomenon is lost and students are less able to solve real-life problems” (Bosse, Lee, Swinson, & Faulconer, 2008, p. 262; Frykholm & Glasson, 2005). If students are left to learn mathematics via traditional methods, through simple paper-pencil activities, achievement gains should be less significant according to the study. Annie Murphy Paul (2012) sites a study which “followed 273 students over the course of their first year of middle school...” which concluded that “...by spring, the pupils described mathematics as less valuable than they had the previous fall, and reported that they were investing less effort and persistence in the subject than they had before” (para. 1). This is evident, specifically, in Everyone Can Achieve Independent School District.

Background

Students in grades 5–8 in Everyone Can Achieve Independent School District have traditionally struggled to perform at or above the state’s designated level of Approaches Grade Level on the State of Texas Assessments of Academic Readiness, or STAAR, test in the area of mathematics. Looking at the potential sixth grade participants, approximately 50% of those students met expectations on the STAAR test for the 2015–2016 academic year, meaning that they scored at the designated level of Approaches Grade Level which was answering 35% of the questions correctly (see Appendix A). When compared to same age peers in other districts,

students in Everyone Can Achieve Independent School District typically underperform in the areas of measurement and geometry. According to the data obtained for the 2015–2016 STAAR test, only 47% of sixth graders at the selected campus performed at grade level in the area of geometry. Students are lacking prerequisite skills necessary for converting measurements, as well as skills needed to solve for perimeter, area, and volume. These same students enter middle school, from experience teaching at this level, with the mindset that mathematics is only boring, paper-pencil work which has no purpose in the real world. Research conducted by Frykholm and Glasson (2005) and Jacobs (1989) suggest that students are unable to form deeper understandings of content and recognize the relevance subjects have to their lives unless instruction is integrated. Approximately 55% of the students participating in a local study reported that mathematics had become boring and less important than in elementary school (Giles, 2014).

In an effort to assist students in preparing for the STAAR test, as well as in becoming ready for the future, Everyone Can Achieve Independent School District recently adopted a 1:1 technology initiative. With this new initiative, every student enrolled in grades 5–12 has been given a chrome book as a means of incorporating technology into the classroom. A chrome book is a personal laptop computer, or as Google refers to it “a laptop of a different breed,” (Casey, 2016) that the students can transport between home and school. Having access to the chrome book allows teachers and students to communicate after hours about assignments, and also gives the students flexibility in completing assignments online and quickly submitting them to their teacher.

Having access to chrome books was greatly beneficial for the current study. All students participating in the study accessed much of the activities via Google Classroom. Participants normally complete all assessments and other assignments on-line, showing their work and thought process on separate sheets of paper. This on-line testing is conducted, in part, because state testing is moving to an on-line platform for grades 3–12; all students currently receiving accommodations can elect to have their test on-line, or paper and pencil.

Along with testing on-line, student participants completed their surveys and reflection sheets via Google Classroom. Students also utilized Google Sheets and Google Drawing to create graphs, document their observations during activities, and interact with group members by means of an on-line, collaborative form.

Conceptual Framework

The conceptual framework for this study was based on three different learning theories: behaviorism, cognitivism, and constructivism. Behaviorism is a theoretical approach to learning coined by theorists such as B. F. Skinner, Ivan Pavlov, and Edward Thorndike. With behaviorism, learners are basically passive and go about their routines simply responding to the stimuli presented to them. Cognitivism, on the other hand, is a result of the works of Jean Piaget, Robert Gagne, and Lev Vygotsky. This learning theory is based on the construct that learners process, store, and retrieve information for later use which creates associations and knowledge sets which are useful for living. Constructivism, a theory coined by individuals like John Dewey and Lev Vygotsky, says that learning is an active process in which learners construct new ideas or concepts based upon their current and past knowledge, social interactions, and motivation.

While many of the sources uncovered during the search for literature demonstrate the idea that behaviorism is most commonly used within classrooms, this research study aimed to prove that modeling lessons based on cognitivism and constructivism are the most beneficial for student achievement. Providing rewards to students, such as stickers or candy or pencils, when they arrive at a correct response is not always beneficial to retention of information and achievement on standardized tests. Stipek (1996), as referenced by Roderick and Engel (2016), says that “extrinsic motivation tends to be short lived, dissipating when the threat or reward is removed” (p. 200). Roderick and Engel (2016) examined schools within the Chicago Public School system to determine whether the threat of retention, or promotion based on achievement, affected how students worked in class. It was discovered that students worked harder if they felt intrinsically motivated (Roderick & Engel, 2016, p. 213). Students who were praised infrequently tended to lack in motivation. In another study, conducted by Cameron, Pierce, Banko, and Gear (2005), the effects of offering a monetary reward based on solving puzzles was examined. Cameron et al (2005) utilized a control group and an experimental group. The participants in the experimental group were offered varying monetary rewards based upon puzzle completion and correct responses on a three-minute test (Cameron et. al., 2005, p. 644). The researcher found that rewarded participants found the puzzles to be “more interesting, exciting, enjoyable, and entertaining than did non-rewarded participants” (p. 646). Rewarded participants also evaluated their efforts as “better and reported greater competence than did non-rewarded participants” (p. 647).

Just as B. F. Skinner and Ivan Pavlov led studies in which animals were rewarded for their progress in mazes or their ability to refrain from a negative behavior, previous researchers

believed that students behave in much the same way. If students are given tangible rewards, consistently over a period of time, for arriving at a correct answer on a mathematics assignment, then they will continue to strive for those correct answers. This way of thinking would cause detriments later, as rote memorization using positive or negative reinforcements could be teaching students that they will be rewarded for correct responses and punished or reprimanded for negative ones. Such negative, or incorrect responses, according to Roderick and Engel (2016), could lead to the idea of the end goal as being unattainable. “Motivational theory suggests that students will be motivated to accomplish a goal if (1) they value the goal and (2) they believe that the goal is attainable” (Roderick & Engel, 2016, p. 200). If a student does not receive regular, positive rewards, a sense of unattainable goals may begin to affect performance in class.

Throughout the search for literature to examine for this study, it was discovered that some researchers believe students learn best when they can observe others in action, otherwise known as social cognitive theory. By observing others as they problem solve, and witnessing the verbal praise, satisfaction of achieving a correct answer, or reward of a pleasing grade on an assignment, students begin to learn how to problem solve. This way of thinking fits more in line with cognitivism. If students are able to observe another student being successful on an assignment, or working through one particular problem, the student doing the observing is more likely to learn how to problem solve. Such a theory also ties into the concept of brain science and brain growth, which the proposed study aims to delve into deeper. Looking at Piaget’s work dealing with stages of development, brain science is a critical factor in determining the answer to the proposed research questions. “Piaget believed that the development of a child occurs through a continuous transformation of thought processes” (Ojose, 2008, p. 26). Because of this,

students enter the classroom at varying cognitive levels and progress through each stage at different rates. In order to design effective lessons that meet the developmental stages of students, educators face a number of challenges. “One of the important challenges in mathematics teaching is to help students make connections between the mathematics concepts and the activity” (Ojose, 2008, p. 28). Understanding how brain growth occurs, and each of Piaget’s stages, can better assist in teaching problem solving.

Still other researchers have said that learners learn best when their teachers provide them with ways in which to connect new ideas to past learning, social interactions with peers, and motivation to do well. Constructivist theories describe the need for learners to be able to make connections between what is currently being taught and what they already know, often using real-world examples. “Constructivist theories . . . suggest a major shift from learning science and mathematics as an accumulation of rote facts and procedures to learning science and mathematics in authentic contexts-as socially negotiated constructions and explanations used to make sense of the world” (Frykholm & Glasson, 2005, p. 128). It also emphasizes the importance of social interaction, such as cooperative groups and think-pair-share activities, to assist in the development of knowledge sets.

With differing ideas on how mathematics should be taught to students, considering that previous researchers all fall into three different theories of learning, it has become necessary to identify which of the learning theories is best represented by the current research topic. The question being examined within the current scope of research is whether or not the correlation of mathematics and science instruction will lead to a better understanding of mathematical concepts, acquisition, and cognition, and, as a result, lead to higher scores on standardized tests. That being said, it has been determined that the learning theory to be considered here is that of

cognitivism; specifically focusing on social cognitive theory. It was the aim of the researcher to show that, when students are given the opportunity to communicate about mathematics and participate in hands-on, real-world lessons in which both mathematics and science are correlated, learning and retention of mathematics increases. “An additional benefit for students is that, through learning in an integrative fashion, they become better prepared for life through examining social issues of personal significance” (Fraser, 2000, p. 28-29). Along with being better prepared for life, “reflective and critical thinking skills are developed as students make connections between school activities and their own life experiences” (Fraser, 2000, p. 29).

Two cognitive theories of motivation include the Expectancy Theory and the Goal-Setting Theory (Sincero, 2012, para. 1). The Expectancy Theory explains the reasons that an individual chooses a specific behavior over another, while the Goal-Setting Theory describes the importance of establishing goals in order to motivate someone. The reasons in which a student chooses to solve a mathematical problem in a particular way, versus the method which was taught, goes back to their reasoning and cognitive ability. If a student has always worked out a problem in a specific way, and received positive feedback, the student attempts to use that same method repeatedly; tying back to Expectancy Theory. The student may find it easier to work a problem out using a longer method of computation, or he may find it less confusing to show as little work as possible. Some students retrieve information from previous years, or even prior lessons in science class, to assist them in completing a mathematics assignment. Students need to be taught that multiple methods exist for solving mathematical problems; there is no “one size fits all approach.” Students need to have strategies and goals for solving problems, from the very easy to the more complex. Being able to understand a student’s logic in working through a mathematical problem will assist in creating goals for that student.

Because a child's brain is at a different developmental stage than most adults, it is important for educators to understand cognitive theories and brain science when developing lessons that will be engaging and motivating, while also being at the students' readiness levels. Defending this idea that a child's brain is different developmentally, Cherry (2016) says "Piaget suggested that there is a qualitative change in how children think as they gradually progress through these four stages. A child at age 7 doesn't just have more information about the world than he did at age 2; there is a fundamental change in how he thinks about the world" (p. 3). Most students prefer to learn, or learn best, through hands-on, kinesthetic methods. "A study done by Specific Diagnostic Studies concludes that 29% of elementary and high school students learn best through the visual mode, 34% through the auditory mode, and 37% through the tactile/kinesthetic mode" (Miller, 2001, p. 5). This involves students manipulating materials, creating mathematical equations with their bodies, moving around the classroom, and even discussing concepts in cooperative groups.

"In the words of President Barack Obama, 'Whether it's improving our health or harnessing clean energy, protecting our security or succeeding in the global economy, our future depends on reaffirming America's role as the world's engine of scientific discovery and technological innovation. And that leadership tomorrow depends on how we educate our students today, especially in math, science, technology, and engineering'" (Hanushek, Peterson, & Woessmann., 2010, p. 6).

Given that the goal of this study was to learn whether or not the correlation of mathematics and science instruction can lead to an increase in mathematics achievement on standardized tests, a quasi-experimental design was used. Specifically, a pretest and posttest were administered to both the comparative group and the experiential group. These tests focused

on mathematical understanding and readiness level of the students. Each group of students was also administered an initial survey so that the researcher could gauge the students' perceptions regarding mathematics and science going into the study. Discussion groups were held with teachers of all of the students in order to identify teacher perceptions of correlated lessons and student achievement within the two content areas. Parental consent was requested, with the researcher ensuring confidentiality on the part of the student names and other identifiable data. Permission was also requested from the researcher's administrative team prior to conducting the study.

Statement of the Problem

For educators who have worked within Everyone Can Achieve Independent School District and seen the changes in standardized tests over the years, the concern regarding the steady decline in academic performance has become a battle that is fought on a daily basis. Classroom teachers have access to various technological tools-chrome books, Mimio boards (interactive white boards), iPads, Mimio Pads (hand-held devices similar to iPads which allow the teacher to write on the white board while walking around the room)-as well as online tools such as textbooks, ALEKS, Star Renaissance, iStation, Prodigy, Edmodo, and Khan Academy.

Even with access to the large variety of tools, student scores are still declining. Therefore, there is a need to change the way students are given the opportunity to learn the state standards. As a result of the research discovered, there is a need to reignite the love of mathematics and the sciences within the students. Students in all grade levels need to not only recognize that mathematics is necessary for success in the real world, but that it is also enjoyable. This study aimed to demonstrate that there is a need for embedding science within mathematics.

Purpose of the Study

The purpose of this study was to determine whether a positive relationship exists between the manner in which mathematics lessons are presented to students and achievement on standardized tests. The study specifically examined whether teaching mathematics and science concepts together improves mathematical understanding. A quasi-experimental design was utilized in which a comparative group and an experiential group were created. The comparative group received mathematics lessons in the traditional manner, through lecture, solving problems on the board, and worksheets. The experiential group received lessons which were embedded with science concepts. In the experiential group, participants worked through activities using cooperative learning techniques in order to gain a more thorough understanding of mathematical concepts at their assigned grade levels.

Research Questions

Throughout the course of the research study, the following five questions were considered:

1. Entering middle school, how do students perceive mathematics?
2. What is the difference between how female students and male students perceive mathematics?
3. Will the embedding of science standards within the mathematics curriculum have more of an impact on one gender than the other as it relates to standardized test scores in the area of mathematics?
4. Will the embedding of science standards within the mathematics curriculum increase standardized test scores in the area of mathematics?

5. How does embedding science standards within the mathematics curriculum affect students' perception of self-efficacy in the area of mathematics?

Hypotheses

There were several hypotheses which were developed based on the research questions for this study. Research question one, examining how students perceive mathematics upon entering middle school, did not warrant a hypothesis due to having no statistical way to analyze the data; none was developed.

Research question two, examining the difference between how female students and male students perceive mathematics, resulted in two null hypotheses. The null hypothesis for this research questions was that there would be no difference between how female students and male students perceived mathematics. The alternate hypothesis was that there would be a difference between how female students and male students perceived mathematics.

Research question three, looking at whether the embedding of science standards within the mathematics curriculum has more of an impact on one gender than the other as it relates to standardized test scores in the area of mathematics, also warranted two hypotheses. The null hypothesis was that there would be no difference in standardized math test scores between genders, when science standards were embedded in the mathematics curriculum. The alternate hypothesis was that there would be a difference in standardized mathematics test scores between genders, when science standards were embedded in the mathematics curriculum.

Research question four, examining whether the embedding of science standards within the mathematics curriculum increases standardized test scores in the area of mathematics, warranted two hypotheses. The null hypothesis was that there would be no difference in students' standardized mathematics test scores based on typical mathematics instruction and

mathematics instruction based on science standards being embedded into the mathematics curriculum. The alternate hypothesis was that there would be a difference in students' standardized mathematics test scores based on typical mathematics instruction and mathematics instruction based on science standards being embedded into the mathematics curriculum.

Research question five, examining whether embedding science standards into the mathematics curriculum affects students' self-efficacy in the area of mathematics, warranted two hypotheses. The null hypothesis being tested was that embedding science standards within the mathematics curriculum does not affect students' perception of self-efficacy in the area of mathematics. The alternate hypothesis was that embedding science standards within the mathematics curriculum affects students' perception of self-efficacy in the area of mathematics.

Significance of the Study

The study aimed to determine whether correlated instruction in mathematics and science, or embedding science standards within the mathematics curriculum, improved student performance in mathematics in relation to standardized tests. The study also aimed to examine whether there is a correlation between how students perceive mathematics and their mathematical abilities and how they perform when presented mathematical tasks or administered mathematical exams. Understanding the impact that correlated mathematics and science instruction may have on student performance and achievement could influence how educators prepare the lessons which get presented to students. Examining the relationship, should one exist, between mathematical perceptions and mathematical performance, will also help educators to understand the mindset which students enter the math classroom with; giving educators examples of correlated lessons for use in similar settings.

Definition of Terms

Brain Science

Brain science, as it pertains to the purpose of this research study, is the interdisciplinary study of the mind, intelligence, and learning.

Cognitivism

Cognitivism is how learners process, store, and retrieve information for later use, creating associations and a knowledge set useful for living. The learner uses information processing to transfer and assimilate new information.

Constructivism

Constructivism says that learning is an active process in which learners construct new ideas or concepts based upon their current or past knowledge, social interactions, and motivation.

Correlated Lessons

Correlated lessons are those lessons which have standards from two or more content areas embedded within the same lesson. Standards from multiple content areas are taught simultaneously and as one in order to gain the most from the learning experience.

STAAR

State of Texas Assessments of Academic Readiness, or end of year exams for students in grades 3-8 and high school.

TEKS

Texas Essential Knowledge and Skills, or the standards associated with each content area.

Study Teams

Study teams, as they relate to this study, are mixed ability groupings in which students collaborate to solve mathematical problems (Toumasis, 2004, p. 671).

A plan, under the umbrella of special education, that may include any disability, long-term illness, or various disorder that substantially reduces or lessens a student's ability to access learning in the educational setting due to a learning, behavioral or health related condition.

Limitations

Limitations to the research approach and methodology will be the accuracy of the findings based upon the validity and reliability of the instruments used. While the concept of correlated instruction is not new, there is limited research to show whether or not correlated instruction improves scores in mathematics. Only two studies have been conducted which have demonstrated a positive relationship between correlating lessons and increases in standardized test scores.

The student survey will act as a self-assessment. This data will be subjective to each student. Student participants will all have varying responses, based upon their personal perceptions of self and their mathematical abilities. This variance within the responses could cause significant differences in regards to how participants ranked each statement on the Likert scale.

Initially, the researcher planned to only use sixth grade student participants. After reflecting upon multiple factors, it was concluded that more participants should be included. Having spent an entire academic year with the current seventh grade students, and developing a rapport with them, the researcher has decided to seek permission from their parents for participation in the study. Opening up the study to both sixth and seventh grade students may demonstrate that correlated instruction improves scores in mathematics.

Delimitations

The following delimitations are identified. First, the study is delimited to students enrolled in the sixth grade and a few students enrolled in seventh grade. Due to multiple administrations of the state test at the fifth and eighth grades, the researcher does not have access to students within those grade levels. Secondly, the study is delimited to only three teacher participants: one sixth grade math teacher, one special education co-teacher, and one instructional technology coach. Again, due to the demand of state testing, the researcher could not obtain more teacher participants.

Summary

The study aimed to examine the correlation between students' perceptions of mathematics and their mathematical performance. The study also aimed to examine whether correlated instruction, embedding science standards within the mathematics curriculum, would improve student performance and achievement in mathematics. Chapter 2 will provide an insight into the literature which paved the way for the study. Chapter 3 will discuss the research design, chosen site, as well as the instruments which were utilized during the data collection process. Chapters 4 and 5 will delve into the data analysis process and discussion of the overall results uncovered as a result of the study.

Chapter 2: Literature Review

While the concept of an integrated curriculum is not new, there are many problems that educators face when integrating content (Czerniak, Weber, Sandmann, & Ahern, 1999, p. 427). Lehman (1994), as cited by Czerniak et al., (1999), “found that, although teachers have positive perceptions about integrated curriculum, these perceptions do not carry over into practice” (p. 426). From time and how the school day is structured, to teacher preparation and the pressure of standardized testing, educators have a number of reasons for not integrating content areas. “Because most of these tests [standardized tests] still examine content separately, one can question whether the understanding, skills, and knowledge learned in an integrated unit would transfer to these tests” (Czerniak et al., 1999, p. 427). Looking at curriculum integration, specifically integration of science and mathematics, a review of the literature will examine teacher preparation and Texas Legislature and the history of standardized testing in Texas. The review of the literature will also examine subject integration and its relationship to cooperative learning, correlated lessons in science and mathematics, learning theories, and gender differences in mathematics.

American students have been under scrutiny for a number of years regarding their performance on standardized tests, particularly in the area of mathematics. American students ranked 28th when compared to same age peers from other countries, according to a TIMSS report from both 1995 and 1999 (Shen & Talvera, 2003). So why do American students lag behind their same age peers from other countries in mathematics?

While the concept of correlated mathematics and science instruction is not new, there have been limited studies on the topic. Much of the controversy within the literature focuses on

the differences in standards from state to state, as well as the recent implementation of Common Core Standards. As of August 2015, the Common Core Standard have been adopted by 42 states (Marshall, 2016, para. 1). Texas, where the present study took place, has chosen to follow their own set of state standards because they “account for all core subjects and classes, such as foreign language, technology applications, fine arts and other electives” (Marshall, 2016, para. 8). In fact, Texas has made it illegal to teach the Common Core Standards in schools (McGee, 2014, para. 8).

In 1979, Texas Legislature implemented the use of standardized testing. The goal was “to ensure students were learning the curriculum and prepared for the workplace” (Texas State University, p. 3). The first standardized test designed by the legislature was the Texas Assessment of Basic Skills (TABS). It was the very first state-wide, mandatory exam and was administered to students in grades 3, 5, and 9 only. TABS measured performance in reading, writing, and mathematics, and it “marked the start of the era of accountability in Texas Education” (Texas State University, p. 3).

Three years following the implementation of TABS, House Bill 246 mandated a need for the development of a state curriculum. In 1984, TABS became Texas Essential Assessment of Minimum Skills (TEAMS) and the test was given at grades 1, 3, 5, 7, 9, and 11. It became mandatory to pass this exam in order to graduate. Again, in 1990, the state exam was revised. TEAMS became Texas Assessment of Academic Skills (TAAS), and students in grades 3, 5, 7, 9, and 11 had to complete the exam. “Passing the more rigorous grade 11 test was required to graduate from high school” (Texas State University, p. 4). It was not until 1997, 16 years after House Bill 246, that “the Texas Essential Knowledge and Skills (TEKS) became the new curriculum standards” (Texas State University, p. 4).

The standardized test for Texas students underwent two more changes before becoming the State of Texas Assessments of Academic Readiness, or STAAR, test that exists today. This mandatory exam was introduced in 2011 and encompasses math, writing, reading, and social studies, as well as science at 5th and 8th grades. The STAAR test is administered at grades 3–11 but is “more rigorous and required a 12-course exit assessment” (Texas State University, p. 4).

In a study conducted by Browning (2011), it was discovered that teachers consistently do not receive adequate training in their content areas. More importantly, they do not receive guidance in correlating instruction or teaching cross-curricular lessons. Browning (2011), following aspects of the Mix-It-Up program developed by Vasquez-Mireles and West at Texas State University, used a new model of teacher training called Correlated Science and Mathematics. This new model of teacher preparation was shared with a group of teachers in grades 5–8 in Houston, Texas in 2011 (Browning, 2011, p. 1). Teachers were taught how to think differently about the ways in which they taught mathematics and science. “Teachers’ content knowledge was assessed with pre- and posttests in physics and mathematical reasoning at the beginning and end of the two-week summer institute” (Browning, 2011, p. 3). A total of twenty teachers, ten from each discipline, participated in Browning’s study. Teachers “worked in teams to create lessons that included science and mathematics concepts” (Browning, 2011, p. 4). Classroom observations, as well as interviews with both teachers and campus principals were conducted. The data, conducted and gathered by Browning at the University of Houston-Clear Lake, showed that teachers’ habits and instructional strategies changed after having been through the training. “Results indicate (pre- and posttests) that participant teachers did significantly improve their knowledge of both physics and mathematical reasoning” (Browning, 2011, p. 5). Classroom observations showed an increased ability to not only create lessons which correlated

science and mathematics, but to teach the lessons while using proper language for each subject area.

Examination of the findings from Browning's study showed that student achievement in mathematics improved with the implementation of correlated lessons. What could not be determined, however, was whether or not science scores would improve after students received correlated instruction.

Children learn differently. "Although students are usually grouped by chronological age, their development levels may differ significantly" (Ojose, 2008, p. 26). No child's brain is wired in the same way, meaning that a one-size-fits-all approach to learning does not work.

"According to Berk (1997), Piaget believed that children develop steadily and gradually throughout the varying stages and that the experiences in one stage form the foundations for movement to the next" (Ojose, 2008, p. 26). Everyone passes through Piaget's stages of development, but at different rates. This idea of correlated mathematics and science relates, therefore, to the cognitive and constructive learning theories. Both theories agree that individuals learn best when content is tied to previous learning and when individuals are given opportunities to learn through doing. Frykholm and Glasson (2005) addressed the idea of learning by doing when they studied 65 prospective teachers. Twenty-three preservice science teachers and forty-two preservice math teachers were grouped together and asked to develop a "curriculum project that would connect science and mathematics concepts" (Frykholm & Glasson, 2005, p. 131). Participants were encouraged to collaborate with a teacher in the opposite discipline in order to create the curriculum projects. The participants, Frykholm and Glasson discovered, all believed there were natural linkages between science and mathematics. It was also discovered that participants were at first apprehensive about the concept of

correlation because their own experiences were lacking. “Perhaps due, in part, to this general lack of exposure to settings in which mathematics and science were connected, the participants expressed some hesitation as they approached the collaborative experience” (Frykholm & Glasson, 2005, p. 133). Eventually, despite hesitation, participants created curricular units which provided “. . . an authentic context for teaching science and mathematics” (p. 133). Along the same line is the idea that children learn through observations of others, or social cognitive theory; correlated lessons allow for just that. “Through learning in an integrated fashion, they [students] become better prepared for life through examining social issues of personal significance” (Fraser, 2000, p. 28–29). Students also make connections between school activities and personal experiences, which helps to develop reflective and critical thinking skills (Fraser, 2000 & Beane, 1991).

Along with learning theories, there is significant evidence that a student’s learning style plays an important role in what and how they learn. Learning style theories have been around since the 1970s. The most notable is Howard Gardner’s Theory of Multiple Intelligences. Gardner’s theory, which focuses on seven intelligences, “states that all seven intelligences are needed to productively function in society” so teachers should “think of all intelligences as equally important” (Brualdi, 1996, p. 3). Gardner claims that the seven intelligences do not occur independently of one another. “Everyone is born possessing the seven intelligences. Nevertheless, all students will come into the classroom with different sets of developed intelligences” (Brualdi, 1996, p. 4). Through Gardner’s work, it was discovered that children learn differently and should be assessed differently. Teachers who only assess by means of multiple choice tests are not reaching each of the intelligences. Children who are musically inclined, therefore, may not be able to adequately demonstrate knowledge on all classroom

assignments. This leads to Slavin's (2010) claim that "when many students think of math, they think of a lonely and frustrating struggle to understand material or solve a problem." In order to reduce this feeling of loneliness and frustration, teachers can create an "intelligence profile" for each student (Brualdi, 1996, p. 4), showing each student's preferred method of learning.

Teachers can also utilize cooperative learning. Cooperative learning enables students to work with their peers in order to solve proposed problems. This form of learning ties in with different learning styles in that it emphasizes hands-on learning, kinesthetic learning, auditory learning, and visual learning.

Researchers at John's Hopkins University conducted a review of the effectiveness of 22 elementary math programs and 24 middle and secondary math programs (Slavin, 2010). This review determined that the most effective programs had strong evidence of effectiveness in areas associated with cooperative learning. "Cooperative learning can significantly enhance mathematics learning in the classroom...in cooperative learning, students work in pairs or small groups to help each other" (Slavin, 2010, para. 5).

Although this research will study the effects of correlated lessons on students' mathematics achievement, other research has also attempted to determine the effects cooperative learning and hands-on investigations of real-world situations has on knowledge growth. Piaget's stages of development have played a role in much of the research. According to Burns and Silbey (2000), as cited by Ojose (2008), "hands-on experiences and multiple ways of representing a mathematical solution can be ways of fostering the development of..." the concrete operational stage (Ojose, 2008, p. 27). In the study of 65 preservice teachers conducted by Frykholm and Glasson (2005), the participants "not only learned about collaboration, they also grew in their knowledge of the connections between science and mathematics" (p. 139). In

yet another study, the famous Eight-Year Study of the Progressive Education Association in 1942, it was found that “programs using integration or an interdisciplinary curriculum almost always produced equivalent or even better scores on standardized achievement tests than those where students were taught through the traditional discipline-oriented format” (Morris, 2003, p. 165).

Recent Decline in Mathematics Performance

American students have been under scrutiny for a number of years when it comes to their performance on standardized tests. Compared to their same age peers in other countries, American students are low-performing in mathematics; ranked 28th among other countries on two different TIMSS reports (Hanushek, Peterson & Woessmann, 2010). So, what is happening in American schools that is different in schools of other countries?

According to “*Models of Effective Mathematics Instruction*” (ERN, 2003, para. 6–7), American teachers spend a great deal of time focusing on re-teaching old concepts. Students in American schools are not given enough exposure to new concepts; very different, for example, from Japanese students. Students in Japan are given, typically, one problem a day to analyze. Students examine the problem and work with one another to come up with solutions for said problem. Teachers in Japan do not spend large amounts of time focusing on material that has already been covered. Attention is given to new material and allowing students to become analytical thinkers that are capable of problem solving for the real world.

Green (2014, para. 3) corroborated this insight by giving the example of Takahashi, a Japanese math teacher who was considered to be one of the best Japan had. Takahashi modeled his teaching after concepts which he learned were created by Americans. He encouraged active participation in his classroom, gave students opportunities to talk math with one another, and

provided hands-on experiences for his students. He and his students critically reflected about mathematical concepts and, together, became analytical thinkers. When Takahashi was given an opportunity to move to America and teach at a school operated by the Japanese Education Ministry in Chicago, he was ecstatic. It was not until Takahashi moved himself and his wife to America that his excitement burnt out. When he began visiting schools in America, Takahashi observed that not one of the schools was utilizing the methods that were developed by Americans; those that he cherished and lived by (Green, 2014, paras. 7–8).

American students, based on the experience of researchers, are performing poorly on standardized tests, compared to same age peers around the globe, because they are not provided adequate opportunities to become analytical thinkers; opportunities to discuss, think about, and write about the specific content does not always exist. “When students think about, are able to write about, and express what they derived from the activity and response, then the activity can be considered to be one that promotes a developmental experience” (Ben-Avie, Haynes, White, Ensign, Steinfield, Sartin, and Squires, 2003, p. 14). In American classrooms, students spend time on “drill and kill”, or rote memorization. “To students, the typical curriculum presents an endless array of facts and skills that are unconnected, fragmented, and disjointed” (Beane, 1991, p. 9). Students are not granted opportunities to think about different solutions, to experiment with different representations of problems, or to discuss math with their peers. “They find it difficult to understand why they need math when most of their instruction is based on a textbook used in isolation from its applications” (Jacobs, 1989, p. 4).

Other researchers have observed that American students are under-performing in mathematics because, quite possibly, American teachers are not prepared to teach mathematics. Alexander and Fuller (2004) reference a study conducted by William Sanders in 1998. During

this study of the Tennessee Assessment System, Sanders noted that the “single largest factor affecting academic growth of populations of students is differences in effectiveness of individual classroom teachers” (p. 1). Curriculum in American schools does not seem to go anywhere; it covers the same topics repeatedly, covering many topics per grade level with no clear focus (Schmidt, Tatto, Bankov, Blomeke, Cedillo, Cogan,. . . Schwille, 2007, p. 3). Top performing countries, those scoring well on TIMSS and PISA, have a clear-cut focus at each grade level. Also, top performing countries take the time to adequately prepare their teachers. According to Schmidt et. al., (2007), Taiwanese and Korean teachers take multiple mathematics courses during their preparation to become teachers. Upon completion of their preparation programs, Taiwanese and Korean teachers are fully equipped to teach mathematics, in any form, to their students with ease. American teachers, on the other hand, spend very little time actually learning how to teach mathematics and only a modest amount of time on pedagogy (Schmidt et. al., p. 4).

State Standards in Mathematics

With the implementation of No Child Left Behind (NCLB), schools across American were challenged to make curriculum accessible to all students. According to Sloan (2010, paras. 2–3), in an interview with Secretary Arne Duncan, NCLB requires that students achieve a specific rating of “proficient.” This goal was set for attainment by the year 2014, but students are still lagging behind their same age peers. Since its implementation, states were given the option to adopt the Common Core standards, or keep their own established standards, in mathematics and reading. According to Marshall (2016), the Common Core standards have been adopted by 42 states as of August 2015 (para. 1). Marshall states that the Common Core standards only apply to reading and mathematics (para. 8), whereas standards for other states consider all content areas. Texas AFT (2013) lists Texas, Alaska, Nebraska, Virginia, and

Minnesota as being those who have not elected to use the Common Core standards (para. 1). It was believed that the Common Core standards would level the playing field and make comparisons at the national level easier.

As a country, the United States lags behind other countries in the areas of mathematics and science. According to Hanushek, Peterson, and Woessmann (2010), “maintaining our innovative edge in the world depends importantly on developing a highly qualified cadre of scientists and engineers” (p. 3). In order to assess just how the United States compares to fellow countries, Hanushek et al examined TIMSS and PISA data related to math achievement scores. They also examined the graduating class of 2009 to determine just how many graduates were highly accomplished in the areas of math and science. Unfortunately, “...the percentage of students in the US class of 2009 who were highly accomplished in math is well below that of most countries with which the US generally compares itself” (p. 3). Looking at individual states, to determine how they stack up in comparison to other countries, seemed like the next logical step.

Some states, as previously mentioned, have elected not to use the Common Core standards, Texas being one of them. In Texas, teachers are not allowed to teach the Common Core standards; the state has made it illegal (Garland, 2016, para. 6). Texas elected to continue using their Texas Essential Knowledge and Skills (TEKS) as a way of measuring student success. While Common Core supporters feel that the standards offer a more rigorous means of measuring student success, Texas educators and politicians have stood by their decision. “...the Texas legislature has put an exclamation point on the state’s determination not to take part in the Common Core project at all” (Texas AFT, 2013, para. 3). During a legislative session in 2013, Rep. Dan Huberty presented House Bill 462 which “forbids adoption by the State Board of

Education or use by Texas school districts of the Common Core curriculum guidelines to determine essential knowledge and skills to be taught in Texas schools” (Texas AFT, 2013, para. 3).

Texas is one of a few states that have elected to not implement Common Core within their schools, still creating difficulty when it comes to comparing students at a national level. With a number of different curriculum standards, and therefore a number of different “goal posts” to achieve, it leaves to question whether or not students are learning the same material. Proponents of the TEKS, as well as supporters of Common Core, argue that curriculum needs to be rigorous and provide students with opportunities to think analytically. Professors at the University of Texas at Austin are divided as to whether or not the TEKS are similar to the Common Core standards. “There’s a lot of overlap because they’re basing this on the same body of research and knowledge about what’s going to support our students in becoming mathematically powerful” (Garland, 2016, para. 19). According to Garland, R. James Milgram, a professor at Stanford University, said, “the standards [TEKS] were so similar to Common Core that Texas might as well have adopted those standards instead of creating its own” (para. 28).

While Texas students struggle with the new mathematical TEKS, those in special education have the most difficulties. As an example, 38% of the students coded special education, who were enrolled in fifth grade at the selected campus in 2015–2016, were successful on their mathematics STAAR test. Opponents of Common Core use this to their advantage, stating that the rigor of Common Core is too tough for students with special needs (Beals, 2014, para. 2). Common Core standards have “severely straightjacketed America’s special needs students” (Beals, 2014, para. 2). Although students with special needs in Texas struggle to meet the expectations of Texas state standards, there are clearly defined criteria that

those students are expected to reach. The mathematics standards in Texas, unlike those attached to Common Core, clearly define accommodations and modifications that can be given to students with special needs; Common Core standards only provide clarification related to students who are deaf or visually impaired (Beals, 2014, para. 5).

Decline in STAAR Scores

Over the past few years, Texas has seen a decline in mathematics scores on the State of Texas Assessments of Academic Readiness, or STAAR, test. In many districts, students are achieving well below the state passing standard (Weiss & Hacker, 2014). Due to low performance, as well as continual changing of the TEKS, designers of the STAAR test have continually lowered the passing rate for each grade level. For this current school year, in fact, the passing rate for sixth grade mathematics was set at 34%, which is considered Approaches Grade Level in the eyes of the Texas Education Agency (Texas Education Agency, 2017).

Lowering the passing rate on the state test does not ensure success in the classroom. Students realize that, other than receiving a “failing” grade in the mail on their STAAR test, there are no repercussions for those who are not successful. “Well, the teacher and principal always say we will be back in our grade, but I failed my STAAR last year and moved on” (Giles, 2014). The only students held accountable are those in 5th and 8th grades. These students receive three attempts at passing their STAAR test because they are at an SSI grade level and have to pass in order to proceed to the next grade (Texas Education Agency, 2017). Students in other grades only receive one attempt at passing their tests, in some cases four different standardized tests, and there are no repercussions if they fail.

Correlated or Integrated Instruction

There is limited research in the area of whether correlated lessons are beneficial for students. What research has been conducted was done so based on the idea that mathematics and science naturally go together. Training teachers on a new way of thinking and teaching mathematics and science has begun to pop up across states. This new professional development model, called Correlated Science and Mathematics (CSM), was introduced in Houston, Texas in 2011 to a group of teachers in grades 5–8 (Browning, 2011, p. 1). With the introduction of this new professional development model, teachers were taught how to think differently about the ways in which they teach mathematics and science. The data, conducted and gathered by Browning at the University of Houston-Clear Lake, showed that teachers' habits and instructional strategies changed after having been through the training.

Using concepts developed by Vasquez-Mireles and West of Texas State University in San Marcos, Texas, the CSM model deals with teaching teachers how to provide correlated instruction so that they “. . . reinforce students' interest in mathematics or to enable the students to recognize the broad utility of mathematics” (Browning, 2011, p. 2). This method of teaching, although not new, was different for the participants in the program. Due to the seven fundamental goals within the CSM model, “(a) teaching for conceptual understanding, (b) using each discipline's proper language, (c) using standards-based learning objectives, (d) identifying the natural links between the disciplines, (e) identifying language that is confusing to students, (f) identifying the parallel ideas between the disciplines when possible, and (g) using 5E inquiry format in science and mathematics when appropriate” (Browning, 2011, p. 2), participants had to re-learn the language of mathematics and how to prepare their classrooms for the exploration of correlated lessons.

Browning, as well as Morlier who was a participant and assistant of Browning's, noted that student achievement in mathematics improved with the implementation of correlated lessons (Morlier, 2012, p. 3). What could not be determined, however, was whether or not science scores would improve after students received correlated instruction.

The idea of correlated lessons in mathematics and science relates to the cognitive and constructive learning theories. Both theories agree that individuals learn best when content is tied to previous learning and when individuals are given opportunities to learn through doing. "Learning is understood as a constructive process of conceptual growth, often involving reorganization of concepts in the learner's understanding, and growth in general cognitive abilities such as problem-solving strategies and metacognitive processes" (Green and Collins, 1996, p. 16). Along the same lines is the idea that children learn through observation of others, or social cognitive theory. "Observational learning occurs when a person watches the actions of another person and the reinforcements that the person receives" (Glanz et. al., 2002, p. 169). Correlated lessons allow for just that. With correlated lessons, children are presented with opportunities to talk to one another about mathematics and science concepts, analyze problems as a group, discover new ways of coming up with solutions for problems, and explore hands-on activities that relate to the content areas.

Learning Strategies and Correlated Lessons

"When many students think of math, they think of a lonely and frustrating struggle to understand material or solve a problem" (Slavin, 2010). In order to reduce this feeling of loneliness, teachers should emphasize the idea of cooperative learning. Cooperative learning enables students to work through problems with their peers, whether in small groups or simply with partners. Cooperative grouping ties in to different learning styles in that it emphasizes

hands-on learning, kinesthetic learning, auditory learning, and visual learning. Within cooperative grouping, students can participate in activities such as four square, partner check, think-pair-share, and Socratic circles. Four square and partner check activities allow students to take ownership of mathematical problems by dividing up the work and modeling the different steps to solve a problem.

Think-pair-share and Socratic circles enable students to work with partners or sit in small or larger groups and actually engage in “math talk.” Whether the lesson is strictly math-based or science-based, or it is correlated, students can discuss their strategies and teach one another different ways of arriving at a solution. According to Goodman Le and DeFilippo (2008), Socratic circles involve “. . . high-level discussions that help focus thought, encourage questions, and develop critical and creative thinking skills” (p. 66). Mathematical language potentially increases, as well as the development of the understanding that there are multiple ways to solve a mathematical problem. “Research demonstrates that learning can be improved and that scores on standardized achievement tests can be raised if thinking skills are regularly integrated in the classroom” (Hoag & Andrews, 1998, p. 16).

Researchers at the Johns Hopkins University conducted a review of the effectiveness of 22 elementary math programs and 24 middle and secondary school math programs. The review found that the most effective elementary programs had strong evidence of effectiveness in the following: class-wide peer tutoring, Peer Assisted Learning Strategies (PALS), Missouri Mathematics Program, Power Teaching Mathematics, and TAI Math (Slavin, 2010, para. 5). According to the researchers, “cooperative learning can significantly enhance mathematics learning in the classroom...in cooperative learning, students work in pairs or small groups to help each other” (Slavin, 2010, para. 3).

Due to the nature of cooperative grouping, it aligns well with the concept of correlated instruction. Science lessons tend to be hands-on or based on experiments and, to an extent, mathematics lessons can be hands-on as well. Bosse, Lee, Swinson, and Faulconer (2010) referenced a quote by Rutherford and Ahlgren which explains this well: “Science provides mathematics with interesting problems to investigate, and mathematics provides science with powerful tools to use in analyzing them” (p. 262). Correlating the two content areas as a means of strengthening the lesson content and presentation lends itself to cooperative grouping.

Cooperative Learning & Mathematics

Just like a novel, mathematics tells a unique story. Through numbers and symbols, a complex story emerges. The problem which arises is that students do not know how to interpret the mathematical stories, much less read the symbols (Toumasis, 2004, p. 669). To understand math, each symbol or word or number, one must have familiarity with the language. With mathematics, there are so many thoughts condensed into just a few statements; traditionally, however, little reading occurs.

Toumasis (2004) says that, rather than teaching facts or rote memorization, teachers should be responsible for teaching students how to think mathematically so that students do not rely so heavily on the teacher (p. 670). Toumasis (2004), along with other researchers believe that cooperative learning in the mathematics classroom can assist students in becoming more mathematically independent (Ajaja & Eravwoke, 2010; Zakaria, Chin & David, 2010; Tarim & Akdeniz, 2008; Zakaria, Solfitri, Daud & Abidin, 2013).

Toumasis (2004) examined the use of study teams in four secondary mathematics classrooms (p. 673). Toumasis describes a study team as being mixed ability groupings in which students collaborate to solve mathematical problems (p. 671). In a study team, those students

identified as average or above average learners help to clarify concepts being learned for low level achievers. The students take on the responsibility of learners who are in control of the learning process. Based on the notion of a study team, they would then begin to see the teacher as a guide, rather than someone whose sole purpose is to provide answers.

With study teams, the teacher introduces the unit concept. Once an introduction has been given, students are divided into study teams. Students begin looking for solutions to provided problems independently, and then move into team collaboration (Toumasis, 2004, p. 671). The work is then discussed as an entire group; whole class discussion provides the teacher with a platform in which to clarify misunderstandings and correct misconceptions. Students then summarize their learning on index cards and proceed to complete an independent assessment.

In Toumasis' (2004) study, 100 students in grades 8–10 from Greece were identified (p. 673). The study was experimental in design and aimed to learn whether study teams (cooperative learning) had a positive effect on math achievement and attitude. The study occurred over three years and was conducted twice a week during four-week intervals (Toumasis, 2004, p. 673). A control group received traditional lessons, while a treatment group received lessons in the form of study teams. Weaker students (low achievers) were interviewed prior to the study and upon completion. Both groups of students completed reflection sheets. Toumasis (2004) discovered that study teams help to motivate students because everyone is involved in discussing and learning the material (p. 675). It was also learned that such a cooperative learning strategy helps to minimize anxiety, which creates a less threatening environment.

Tarim and Akdeniz (2008) mention that the way math is presented, as well as the overall content, can cause anxiety in people (p. 78). Cooperative learning, they say, can help to alleviate

this anxiety because students are encouraged to take risks in their thinking (p. 78). While there are many different types of cooperative learning, Tarim and Akdeniz (2008) examined Team Assisted Individualization (TAI) and Student Teams-Achievement Divisions (STAD) in order to determine which method caused a greater increase in students' math achievement. TAI, according to Tarim and Akdeniz, "combines cooperative learning with individualized instruction" (2008, p. 78). STAD, on the other hand, is a method in which "... after the teacher presents a lesson, students work in their teams to try to master the lesson themselves and make sure that the other members in their team also master the lesson" (p. 79). The final stage of STAD requires that each student complete an individualized assessment.

Tarim and Akdeniz (2008) conducted their 14-week study in Turkey, utilizing 248 fourth grade students (p. 79). One group, 73 students, received the TAI treatment while the other treatment group of 71 participants received STAD. The remaining 104 students were taught math lessons via lecture and worksheets (p. 80). The teachers within the control group used a common method of teaching, described by some as explain-practice-memorize (Tarim & Akdeniz, 2008, p. 82). The researchers found that students in the TAI group saw significantly greater gains in achievement than those in the control group (p. 85). It was also learned that those in the TAI group showed greater gains than even those in the STAD group; results favored TAI instruction. These results were similar to those of Slavin and other advocates of cooperative learning, showing that "... cooperative learning methods STAD and TAI were more effective in terms of academic achievement than the traditional methods" (Tarim & Akdeniz, 2008, p. 85).

Traditional learning methods, especially in mathematics, often resemble the teacher lecturing and providing facts to the entire class. "... during traditional mathematics teaching, the teacher gives explanations, writes problems on the board, asks someone from the class to

come to the board, and lets him/her solve the problem” (Tarim & Akdeniz, 2008, p. 86). In contrast, cooperative learning encourages collaboration and therefore improves motivation, attitude regarding mathematics, and academic achievement (Tarim & Akdeniz, 2008; Zakaria & Iksan, 2007; Zakaria et al., 2013; Shimazoe & Aldrich, 2011).

Movement Towards Integration

A major push has been made towards the integration of math, science, and other content areas (Lonning & DeFranco, 1997, p. 212). A question that needs to be considered, however, is: What does the integration of mathematics and science mean? Lonning and DeFranco (1997) describe integration as occurring “when individual activities are designed and implemented that include concepts from more than one discipline” (p. 212). With curriculum integration, there is a need to look not only at what is being taught, but the extent to which it is being taught. Lonning and DeFranco (1997) make the claim that lessons and activities must be meaningful for students. “. . . ‘meaningful’ is used to describe activities that are relevant, engaging, and follow the recommendations of the national standards” (p. 212).

To determine the extent of integration, Lonning and DeFranco (1997) designed the “*Continuum of integration of mathematics and science concepts/activities*” (p. 213). This continuum has independent math and independent science on either end, moving to balanced integration in the center. “When the mathematics and science content are both part of the curriculum for a particular grade level and the instruction is delivered in a meaningful way, the activities created are classified as ‘balanced’ on the continuum” (Lonning & DeFranco, 1997, p. 213). This model of integration can assist teachers in determining whether the activity being planned will meet the needs of the targeted group of students. One area of science which

Lonning and DeFranco say lends itself well to balanced integration is physical science. “The physical science domain provides abundant opportunities for balanced mathematics and science integration (e.g., density, buoyancy, force, and motion)” (1997, p. 213).

Davison et al. (1995), as cited by Lonning and DeFranco (1997), described an integrated lesson in which the math concept was measurement and the science concept was dinosaurs (p. 213). To determine whether this activity was balanced, it was necessary to determine the appropriateness of the content at the targeted grade level. If dinosaurs were taught at one grade level and measurement was taught at another grade level, but both concepts were being presented to the lower of the two grade levels, the activity would have had a science focus on the continuum; nearing balanced integration but closer to independent science. “If dinosaurs are part of the curriculum at the same grade level that the measurement objectives are taught, the activity is considered ‘balanced’ on the continuum” (Lonning & DeFranco, 1997, p. 213). The researchers contend that if both subject areas are equally important to the curricula at the targeted grade level, then the activity can be classified as being balanced.

To address the question posed previously, what does the integration of mathematics and science mean, key issues must be examined. First, “integration can be justified only when students’ understanding of the mathematics and science concepts is enhanced” (Lonning & DeFranco, 1997, p. 215). Just because some topics can be taught together does not guarantee they will be more meaningful than when taught separately. Meaningful activities should be relevant, engaging, and fit the standards being addressed. Secondly, “integration makes sense only when it grows out of the school districts’ science and mathematics curricula” (p. 215). The scope and sequence provided to teachers should be utilized to help drive the creation of

integrated lessons. Finally, “because not all mathematics or science concepts can or should be taught in an integrated fashion, a better method is to focus more on the question ‘How can the concepts best be taught?’ . . .” (p. 215). If it does not make sense to teach a topic, such as fractions, during a lesson involving force and motion, integration should not be forced.

Effects of Integrated Lessons on Achievement

The National Middle School Association, as described by Vars (1997), “calls for ‘curriculum that is challenging, integrative, and exploratory’” (p. 183). The association describes integrative curriculum as that which “helps students make sense out of their life experiences. . .” (Vars, 1997, p. 183). When any type of integrative approach to learning is considered, Vars says it is important to ask whether there will be a positive effect on student achievement.

“Studies conducted over more than 60 years point to the same general conclusion: almost without exception, students in any type of combined curriculum do as well as, and often better than, students in a conventional departmentalized program” (Vars, 1997, p. 185). Advocates of integrated curriculum assert that such a curriculum approach makes learning more meaningful for students (p. 185). Vars posits that research has shown that an integrated curriculum improves critical thinking, relationships with peers and teachers, and instills a positive attitude toward learning.

As an integrative approach, STEM education aims to improve student achievement and attitudes toward learning. Introduced in the 1990s, STEM education focuses on science, technology, engineering, and mathematics (Sanders, 2009, p. 20). At its inception, educators appeared to only focus on their content specialty; believing that they were incorporating all aspects of other content areas into their curriculum (Sanders, 2009, p. 20). In 2007, Sanders and

his team realized the need to make STEM education integrative. “Our notion of integrative STEM education includes approaches that explore teaching and learning between/among any two or more of the STEM subject areas, and/or between a STEM subject and one or more other school subjects” (Sanders, 2009, p. 21). This approach to learning was chosen because, Sanders says, “too many students lose interest in science and mathematics at an early age, and thus make an early exit from the so-called ‘STEM pipeline’” (2009, p. 22). Grounded in the belief that learning is constructive, STEM education provides evidence with regard to achievement. Exemplars within the integrative STEM education are learner-centered and knowledge-centered, thus adding to the evidence that integrative instruction enhances learning (p. 24).

Whether it is integrative STEM education, gaming programs, or virtual manipulatives such as those found within Gizmos or Geometer’s Sketchpad, there is evidence that integrating curriculum improves achievement and beliefs about learning. Computer use within classrooms has been expanding over the years, making such integration possible. “When integrated properly into the teaching and learning process, computers improve student proficiency in mathematics” which helps to explain the “positive correlation between computer use and student achievement” (Ozel, Yetkiner, & Capraro, 2010, p. 81).

Gender Differences in Mathematics

“It is a widespread belief among students, teachers, and parents alike that girls and mathematics are a ‘bad fit’” (Frenzel, Pekrun & Goetz, 2007, p. 497). Over the years, researchers have examined the potential causes for perceived gender differences in subject areas, specifically mathematics. Recent research, as described by Frenzel et al. (2007), has indicated that students experience a vast range of emotions related to achievement and learning.

Specifically, the subject of mathematics has been found to elicit anxiety in many students (Frenzel et al., 2007, p. 498).

Pekrun, Goetz, Titz, and Perry, as referenced by Frenzel et al. (2007), “reported that emotions typically experienced by students include task- or activity-related feeling states such as task enjoyment, and emotions which relate to learning outcomes, such as pride, shame, anxiety, and hopelessness” (p. 498). Such emotions impact student learning and achievement. Learning at an in-depth level can be time-consuming and require much effort. “Learners are more willing to invest such effort if learning activities are affectively rewarding—that is, enjoyable and interesting rather than anxiety-laden or boredom-inducing” (Frenzel et al., 2007, p. 498). According to Frenzel et al., emotions alter the learning process and knowledge retention by changing dopamine levels in the brain.

Various studies have demonstrated that girls tend to be more anxious than boys when faced with mathematical tasks. Stipek and Gralinsky’s (1991) data, discussed by Frenzel et al., found that girls reported less pride in their work after experiencing success and were more likely than boys to hide their papers after experiencing failure (p. 498). The data “. . . suggested that girls tend to experience a more negative emotional pattern in mathematics, beyond the well-researched emotion of anxiety” (Frenzel et al., 2007, p. 498). Could these differences in perception be traced back to parental influence?

Social-cognitive theory suggests that children learn through modeling, or by example. “A great deal of gender-linked information is exemplified by models in one’s immediate environment such as parents and peers, and significant persons in social, educational, and occupational contexts” (Bussey & Bandura, 1999, p. 685). Media also influences students’

perceptions of self and their ability, as well as how parents describe their children's abilities. Jacobs and Eccles (1985) conducted a study which examined how a media report describing mathematical abilities of boys and girls influenced parents' perceptions; the report discussed how girls underperform when compared to boys. Jacobs and Eccles (1985) found that mothers who had been exposed to the media report "appeared to think that their daughters had less math ability, were less likely to succeed in math in the future, found math more difficult, and had to work harder to succeed in math" (p. 22). After being exposed to the report, fathers of girls generally believed that their daughters had less mathematical ability than fathers did of their sons. This media report added to the views about men and women that children are already inundated with; men in advanced careers and women in clerical positions or as home-makers (Jacobs & Eccles, 1985).

Stereotype threat was examined by Spencer, Steele, and Quinn (1999) as being a reason for gender differences in mathematics. A number of stereotypes in society present a false notion that girls possess less ability in math and related fields. "Thus in situations where math skills are exposed to judgment—be it a formal test, classroom participation, or simply computing the waiter's tip—women bear the extra burden of having a stereotype that alleges a sex-biased inability" (Spencer, Steele, & Quinn, 1999, p. 6). This stereotype threat may cause girls to feel as though they do not belong in math classes. They may, according to Spender et al. (1999), begin to disidentify with math and avoid taking further mathematics classes (p. 6).

Spencer et al. (1999) conducted three separate studies to examine stereotype threat and its effect on achievement in mathematics. In one study, Spencer et al. (1999) selected 28 men and 28 women from a psychology course at the University of Michigan. Participants were

“required to have completed at least one semester of calculus and to have received a grade of ‘B’ or better” (p. 7). The participants also had to score above the 85th percentile on the math portion of the SAT or the ACT. They also had to strongly agree that they were good at math, and that being good at math was important. Participants were placed into two groups; difficult test and easy test. The results found that women performed just as well as men on the easier test, but worse on the more difficult test (p. 9).

In another study, Spencer et al. followed the same procedures as in the study previously discussed except the more difficult test was administered to both groups. With the experimental group, participants were initially told that the test had uncovered gender differences in previous studies (p. 12). “When participants were explicitly told that the test yielded gender differences, women greatly underperformed in relation to men” (Spencer et al., 1999, p. 12). The study provided compelling evidence that females experience stereotype threat in academic situations, especially when faced with a test which could be seen as competitive.

Along with stereotype threat, personal efficacy plays an important role in gender differences. “Female students judge themselves more efficacious for the types of occupations traditionally held by women but have a weaker sense of efficacy that they can master the educational requirements and job functions of traditionally male-gendered occupations . . .” (Bussey & Bandura, 1999, p. 692). These beliefs are shaped by social practices at home, school, by peers, through media, and through the culture overall (p. 692). While girls can perform equally well as boys, invoking the gender stereotype lowers girls’ beliefs in their abilities. “Women’s lowered sense of mathematical efficacy is, of course, changeable” (Bussey & Bandura, 1999, p. 693). The proposed study aims to examine this malleability through the use of

integrated instruction as a means of improving girls' perceptions of math while increasing test scores.

Review of Methodological Issues

Upon reviewing the literature associated with integrated instruction, including integration involving cooperative learning, successful cases have emerged. Focusing on cooperative learning techniques, integration of content areas, new models of correlating mathematics and science, and a continuum for integrated mathematics and science, a number of previously cited researchers have begun to demonstrate the necessity for integrating instruction as a means of raising mathematical achievement.

Browning (2011) and Morlier (2012) both had a hand in evaluating the Correlated Science and Mathematics model (CSM) of instruction and teacher preparation. During their studies and evaluations, teachers in grades 5–8 were utilized across the Houston area. Each participant was administered a pre- and posttest, assessing their knowledge of mathematics and science. Classroom observations were conducted on each teacher participant in the training program, and teacher and principal interviews were conducted.

Even though Browning (2011) and Morlier (2012) focused on teacher preparation, the studies were severely limited. Teacher participants were the only data collection point, along with one-time interviews of campus principals. Instead of interviewing participants, principals, mentor teachers, students, or content coaches, both Browning and Morlier looked only at participants; limited data was retrieved from principals (Browning, 2011 & Morlier, 2012). In order to obtain more valid information, it would have been more effective to include interviews of students in participating teachers' classrooms. Creating a set of interview questions, or a

survey to administer to the students, would have provided the researchers with more information pertaining to whether or not the new model of teacher preparation truly benefits the students it is meant to impact. A local study from Giles (2014) included student reflection sheets and student interviews. The study, a brief look at correlation of content areas, found that student input on the reflection sheets helped to revamp the lessons for future use (Giles, 2014). What better way to determine if a program works than to go to those who are impacted by it?

With Browning's (2011) and Morlier's (2012) evaluations, it is also difficult to determine just how many participants were involved and exactly where in the Houston area they came from. The studies do not specify whether all participants resided in Houston and taught at neighboring schools, or if participants came from across the state of Texas to attend this professional development session. Understanding the mobility of the participants and the location of their respective campuses should be a key factor in the study itself. If all of the participants who attended were from affluent areas in Houston, the effects of their experiences during the training might be different from those attending from poverty-stricken schools.

Zakaria, Chin, and Daud (2010) examined the effects of cooperative learning on student achievement and attitude towards mathematics. Their study was a "...quasi-experimental non-equivalent control group design" (p. 273). There were 44 participants in the experimental group and 38 in the control group. The average age of the participants was 13 years. The study was conducted over a period of two weeks and used Slavin's cooperative model of Student Teams-Achievement Divisions (STAD). Participants were administered both a pre- and posttests, as well as an attitude questionnaire.

At the beginning of their study, Zakaria et al (2010) learned that participants were all at the same level academically, by pretest results, and generally felt the same way about mathematics. By the end of the two weeks, the researchers noticed significant gains in achievement for the experimental group. Participants within the experimental group also developed more positive attitudes in relation to mathematics (Zakaria et al., 2010, p. 274).

While the study conducted by Zakaria et al. (2010) included pre- and posttests and an attitude questionnaire, the study was limited by a few factors. First, while the study was conducted in Sarawak (part of Malaysia), the demographics of the participants do not appear to be representative of the entire school population. According to Zakaria et al. (2010), nearly 60% of the participants were Iban, 21% Chinese, 13% Malay, and 9% other (p. 274). Secondly, the authors do not mention the total population of the school. The number of participants, which was 82, may not accurately represent the overall composition of the school selected. Finally, the study only lasted for two weeks. Even though the study demonstrated that cooperative learning can have positive effects on attitude, this is a very abstract characteristic. “. . . attitude is something very abstract and subjective in detecting changes in the short term” (Zakaria et al., 2010, p. 275). In order to better determine whether cooperative learning impacts student attitudes positively, it would have been more effective to run the study over a longer period of time.

Ajaja and Eravwoke (2010) also examined whether cooperative learning techniques positively impact academic achievement (p. 5). Their study utilized a total of 120 students, whom were randomly selected. The participants were divided into two experimental groups and

two control groups; control groups served as the traditional teaching group (p. 5). Participants were administered the Scholastic Ability Test in Integrated Science, a student attitude questionnaire, and the Integrated Science Achievement test (p. 6). All participants completed a pretest prior to the study.

In the control group, lessons were teacher-centered. “Instead of discussing the material, helping each other, or developing projects in groups, students read the assigned reading material silently, completed assignments independently at their seats, engaged in discussions with the teacher in response to the teacher’s questions” (Ajaja & Eravwoke, 2010, p. 7). This particular method of teaching was what the researchers believed to be most common in science classrooms. The experimental groups, on the other hand, were involved in face-to-face interaction, working together to master the lessons.

Ajaja and Eravwoke (2010) learned that cooperative learning, paired with aspects of integration, lead to higher posttest scores (p. 8). Those taught using cooperative learning also showed gains in attitude. Their study demonstrated that integration, along with cooperative learning, can yield significantly higher achievement and attitude scales than traditional teaching alone (Ajaja & Eravwoke, 2010, p. 10).

The biggest unknown of this study, which could be a limitation, is the length of the study. There is no mention throughout the study as to how long it was conducted for. Although the researchers had used a significant sample size and achieved desired results, we are left to wonder whether it was over a few weeks, months, or years.

Another limitation is that one of the research questions specifically dealt with gender differences (Ajaja & Eravwoke, 2010, p. 4). The data provided, however, does not address the

issue of gender differences. To expand on this idea that women deal with stereotype threat (Spencer, Stule, & Quinn, 1999), Ajaja and Eravwoke could have delved deeper into that portion of the research.

Critique of Previous Literature

While there is not an overwhelming amount of research that has been conducted on the concept of correlating mathematics and science as a means of improving academic achievement, some researchers have arrived at sound evidence that this concept does hold true. Whether it is utilizing video games to teach students mathematics and science concepts, incorporating cooperative learning into the classroom setting, or ensuring that teachers are properly trained in how to correlate lessons, the evidence that can be located favors correlated instruction.

Cooperative Learning Strategies

Slavin (1990) synthesized 60 studies related to the concept of cooperative learning. In order to be included within his synthesis, the studies had to have taken place for at least four weeks and the groups involved had to be administered the same materials under the same sets of conditions (Slavin, 1990, p. 52). Slavin, through his examination of the studies included, found that cooperative learning techniques can and usually do have a positive effect on student achievement. Achievement, however, depends upon two essential features: group goals and individual accountability.

While cooperative learning can improve student achievement, under the right conditions, it requires students to work together. Groups must work together to earn recognition, grades, rewards, and other indicators of group success (Slavin, 1990, p. 52). Cooperative learning was once thought to hinder the achievement of those students who are already “high achievers,” but Slavin found that even they can excel further through this concept.

Correlated Science and Math Model

Even though the concept of correlated instruction is not new, the research is somewhat limited. Two individuals in Texas, a professor in Houston and a graduate student who worked under the professor, have shown that correlated instruction in mathematics and science can improve mathematical achievement on tests (Browning, 2011 & Morlier, 2012).

Browning (2011) and Morlier (2012) have evaluated the Correlated Science and Mathematics model (CSM) of instruction and teacher preparation. Browning examined the CSM model as a new way of preparing teachers to teach mathematics and science in a correlated manner. Browning used teachers in grades 5–8 for her study; all of whom taught math and science.

During the study of the professional development model, teacher participants were administered a pre- and posttest. Browning conducted classroom observations of the teachers in action, after having attended the professional development, and teacher interviews were conducted as well. It was found that, with this new model of teacher professional development, teachers increased their ability to develop integrated science and mathematics lessons. Teachers were better able to identify language that was confusing to students, and improve student understanding of content (2011, p. 3).

Morlier (2012) also evaluated the same model of teacher professional development using archived CSM data. Morlier also spoke with Sandra West and Vasquez-Mireles who were responsible for implementing the Mix-It-Up program, another teacher professional development program involving correlated instructional practices. Morlier examined the effectiveness of the new CSM model and found that teacher participants enjoyed the new model of professional development. Participants had gained new insights regarding how to develop integrated lessons

for their students. Morlier discovered that, upon having received this new model of professional development, teachers were able to improve their students' attitudes regarding math and science, as well as increase mathematics scores (2012, p. 4).

Browning's (2011) and Morlier's (2012) studies were highly limited. Neither study explains where the teacher participants were exactly located. The study took place in Houston, Texas, yet there is not mention as to whether the teachers were from the immediate area or from across the state of Texas. It is unclear whether the participants were employed in different districts or high poverty districts, which is necessary in order to determine if such a training model could benefit all schools in all areas. If the teachers were all from affluent schools in the Houston area, and they all noticed significant changes in their teaching and the learning taking place with their students, high poverty area teachers may not experience the same rate of change or success. The program could potentially need to be tweaked for it to work for other schools.

Another limitation of these two studies is the way in which the interviews were conducted. It appears that only teacher participants, and a few campus principals, were interviewed throughout Morlier's evaluation. Questions related to how differently the participants felt when it came to teaching, both prior to the training and after. There were no questions pertaining to whether student achievement could be seen as improving as a direct result of the training in correlated instruction. In this sense, the questions asked do not assist in determining whether the research question could be answered.

During interviews, students were not spoken to. Teachers attended the programs mentioned in order to improve upon their teaching so that student achievement would increase. Those types of questions were not asked, and students were never interviewed. For a more informed research, the researcher could include students in the interview process. Teachers

attend training sessions in order to directly improve their students' thinking and learning. How do we know whether a teacher is successful unless we ask those directly affected by the training program? The researchers could regenerate interview questions so that they included all affected groups-teachers, principals, students, content coaches. The questions could be higher level questions associated with the content being covered in class that day. Those types of questions could help the researcher to understand if the training was directly affecting student achievement because, according to Piaget's levels of development, "one of the important challenges in mathematics teaching is to help students make connections between the mathematics concepts and the activity" (Ojose, 2008, p. 28).

Claim of the AoA

Based on this review of the literature and the previous research findings, which develops a unique conceptual framework using web-based learning, cooperative learning, and correlated instruction to understand what can assist the improvement of mathematical achievement on standardized tests, there is sufficient reason for thinking that an investigation examining the impact of correlated instruction on mathematical achievement may yield significant (or important) findings. A claim can be made that the literature review has provided strong support for pursuing a research project to answer the following research question: Does the correlation of mathematics and science instruction improve students' scores on standardized math tests?

Summary

While American students are continually being scrutinized for their poor performance on standardized tests, it seems to be unclear as to the main culprit behind the low performance of students. There are many assumptions as to why American students lag behind their peers in other countries, ranging from lack of teacher preparation to differing curriculum standards to

motivation and desire of students.

Global reports, such as TIMSS and PISA, have made it quite clear that countries such as Taiwan, Korea, and Japan greatly out-perform the US in the area of mathematics. While math teachers in Taiwan, Korea, and Japan are well-prepared to step in to a mathematics classroom at any level and teach, American teachers seem to be ill-prepared to do the same. Spending more time on learning a little bit about every content area, as well as pedagogy, hinders the teachers in US schools (Schmidt, 2007, p. 4).

Researchers have begun to realize that there is an urgent need to reclaim our status as mathematical and technological engineers. A look at web-based learning tools, video games to teach mathematics concepts, cooperative grouping, learning styles, and correlated instruction is on the rise. More and more individuals are beginning to determine that technology, along with hands-on and correlated experiences, can vastly improve the achievement level of students in the area of mathematics.

Chapter 3: Methodology

Everyone Can Achieve Independent School District, at one point in time, was easily comparable to other districts across Texas in regards to STAAR testing. Over the past few years, something shifted within the district and student performance on the STAAR test has declined. The decline is evident across all tested areas, but more so when it comes to mathematics.

In the last two years alone, students in the sixth grade have underperformed in comparison with their same age peers across the state. On the 2015–2016 STAAR test in mathematics, sixth graders in Everyone Can Achieve Independent School District have collectively scored a passing percentage of 55%, meaning that only 55% of the district's sixth graders are approaching a sixth-grade level of mathematics according to state standards. When looking at the school chosen for the study, sixth graders scored 49.91% passing. While the percent passing is alarming, the weakest areas across the district and within the campus are measurement and geometry; 54% passing for the district and only 47% passing for the campus.

These low passing rates have caused concern among teachers, specifically this researcher. It has become evident that something needs to change in the way in which the Texas Essential Knowledge and Skills, TEKS, are taught. A change needs to occur, somewhere, in order to increase student performance and student enjoyment of mathematics.

The present study aimed to prove that correlated instruction in mathematics and science will improve student performance on standardized tests, particularly in the area of mathematics. The study focused on sixth and seventh grade students in Everyone Can Achieve Independent School District. A comparative group was utilized in which students received instruction in mathematics, with little deviation from the standard curriculum. An experiential group was

utilized in which students received correlated instruction in mathematics and science via hands-on labs, interactive lessons, journaling, and small group exercises. Data was gathered in order to determine to what extent performance in mathematics is increased with the implementation of correlated lessons. Data was also gathered to determine whether or not embedding science standards within the mathematics curriculum has an overall impact on one gender over another in relation to standardized test scores in mathematics.

Research Design

To address the hypotheses, a quasi-experimental research design was implemented. This type of design was chosen due to observing and following both a comparative group and an experiential group. Students in each group were administered pre- and post-surveys, pre- and posttests, and observations were conducted. This type of design allowed for the collection and analysis of different data points for multiple variables using the same participants (Johnson, 2004, p. 14). Due to the proposed examination of whether or not embedding science standards within the mathematics curriculum will affect student achievement on standardized tests, it was determined that a quasi-experimental design would be the best option. Such a design allowed two groups to be compared in relation to instruments administered, including previous and current state tests, while controlling the way in which lessons are delivered to the participants. Delivery of the lessons was controlled by embedding science standards within the curriculum for the experiential group, while only presenting mathematics TEKS to the comparative group.

The study focused specifically on whether correlated instruction- that is, embedding science standards within the mathematics curriculum-will improve standardized test scores in the area of mathematics. In order to accomplish this examination, and answer the research questions, the following steps were taken.

Obtaining site permission. Prior to conducting the study and after receiving IRB approval, the researcher met with campus administrators, the District Math Coordinator, and the campus interventionist. These meetings were used to share the purpose and plan for the study, and to obtain written permission to conduct the study on the researcher's assigned campus. Permission forms were signed by all respective parties and retained by the researcher in a secure area.

Instruments. Once permission has been obtained to conduct the study, the researcher worked with the District Math Coordinator and campus interventionist to make sure that the pre- and posttests, as well as the student and teacher surveys, are valid instruments. After further checking into the experience and backgrounds of the District Math Coordinator and the campus interventionist, it was discovered that both hold at least a Master's degree in either mathematics or Curriculum and Instruction. Both parties have multiple years of experience in designing district or campus assessments, as well as some experience working with the state education board to revamp test questions. Working alongside the District Math Coordinator and campus interventionist helped to ensure that the instruments were unbiased and valid.

Prior to beginning the study, a pretest and initial survey were administered to both the comparative group and the experiential group. The pretest consisted of fifteen questions, taken from released STAAR tests. The questions focused only on measurement and geometry, the areas which are traditionally the weakest.

Student participants were given an initial survey to respond to as well. Their survey consisted of ten statements related to how they perceive their mathematical abilities, emotions related to mathematics, and whether or not they enjoy mathematics and science. All statements were based on a Likert Scale of 1 to 5. The survey was created using Google Forms and

distributed to participants electronically. Being able to answer anonymously allowed for a greater return of responses. To help ensure that surveys were returned promptly, and that adequate data was collected, reminders were sent out periodically to student participants. Assistance was sought from the classroom teachers to help in getting a 100% response rate with the student surveys. A spreadsheet was created and updated with each response submitted so that an accurate account of student responses is noted. The spreadsheet was created using the options within Google Forms for collecting data and ID information associated with respondents.

Upon receipt of pretests and surveys, the results were analyzed and input into the previously created spreadsheet. Having pretest data, STAAR results from years 4-6, and initial survey responses, the researcher could begin the actual implementation of lessons.

Participant consent. Consent for participation was sought regarding all student participants (see Appendix E). Since the potential student participants were all under 18 years of age, Consent to Participate forms were sent out to the guardians of the students. The consent forms clearly outlined the intent of the study, ensure confidentiality of all participants, inform guardians that the study and participation decisions will not impact students' grades, as well as state that guardians have the right to revoke participation at any time.

All consent forms, once collected, were housed in a secure area. A record of participants was compiled, assigning unique numbers to each participant so as to remove names. The only information to be placed in a spreadsheet was: the unique number assigned to each participant, the genders of each student participant, as well as the ethnicity and grade level of student participants.

Upon obtaining Consent to Participate forms, students were divided into a comparative group and an experiential group. The comparative group, as well as the experiential group, were

comprised of those participants who traditionally scored at the “Meets Grade Level” mark, or in the 60% range on STAAR and at “Approaches Grade Level,” or 37%, on STAAR. Since “Approaches Grade Level” is considered passing the exam, but not working at grade level, it is critical to include participants at this level as well. The difference in achievement levels between the student participants will hopefully help to prove the hypothesis that there is a positive relationship between how mathematics lessons are presented to students and achievement on standardized tests.

Teacher Data. Similar to the Consent to Participate forms for students, all teachers involved in the study were given a Consent to Participate form (see Appendix F). This particular form stated that participation is voluntary. Teachers were also made aware that all information will be kept confidential, to the best ability of the researcher, and that no information collected will influence teacher evaluations.

Three teachers provided input for the study, such as information regarding mathematical ability of students enrolled and participating in the study and ideas related to correlated instruction. One of the teachers providing information for the study was the special education co-teacher, who spends 49 minutes daily in one of the classes which will be receiving correlated instruction. The second teacher was a sixth-grade math teacher, who has the remaining group of sixth grade students. The third teacher was the campus technology specialist, whose main position within the campus is to work side-by-side with teachers to integrate technology into the classrooms.

The campus technology specialist, once the Consent to Participate form had been returned, was responsible for assisting in correlating the lessons which the experiential group received. The technology specialist’s role was to introduce the students to the technology, such

as Sphero robots and stop-motion animation, that tie together the science and mathematics pieces of the lessons. Through the combined efforts of the technology specialist and the researcher, the correlated lessons involved a multitude of modalities to meet every learning style.

Daily Lessons. The comparative group received traditional, paper-pencil lessons. Every lesson was tied to the mathematics standards for measurement and geometry. Teachers presented the lessons through the use of worksheets, weekly homework, and lecture. Student participants used their chrome books to access their online textbook, Google Classrooms, tests, and ALEKS only.

The experiential group received lessons in which science standards are embedded within the mathematics curriculum. The researcher provided correlated lessons to the teacher participants in which the students participated in daily labs. Labs will consist of activities such as designing a paper airplane, predicting flight distance according to applying varying weights to the airplane, flying the planes, and calculating and recording distance flown. Students used their chrome books to access tests, post reflection lesson assignments, and ALEKS. All of the lessons incorporated hands-on, student-centered activities. Teachers assigned the same homework assignments that the comparative group receives.

Teachers administered unit tests, campus tests, and district tests as outlined in their scope and sequence. The researcher only supplied the pre- and posttests, as tests are concerned. The researcher conducted classroom observations, unannounced, to make note of lesson presentation and student engagement. Information gathered was used to help determine whether or not embedding science TEKS into the mathematics curriculum affects standardized test scores.

The researcher also conducted interviews with the teachers who agreed to assist with the study. Interviews focused on the teachers' perceptions of lessons taught, as well as whether or not growth is evident from lesson to lesson or test to test. Interviews were recorded, with permission of the teachers, and later transcribed for continual reflection and comparisons.

End of Study. Upon completion of the study, a posttest and post-survey was administered to each student participant. Both instruments were identical to the pretest and the initial survey. The collected data was entered into the spreadsheet and compared to the initial data gathered.

Student results from the STAAR test for years 4–6, as well as Mock STAAR data, was gathered, entered into the spreadsheet, and analyzed. The data was utilized to look for student academic growth in mathematics. A t-test was used in order to determine whether enough evidence exists to say that lesson presentation has a positive effect on achievement.

The researcher compared all findings to student progress in ALEKS, looking carefully at each student's progress pie chart, as well as beginning and ending grade equivalency level in ALEKS. ALEKS progress was examined every week to ensure that participants are logging into the program, as well as completing their pathways which have been established for them.

Target Population, Sampling Method, Procedures

Schools across Texas have seen a decline in student achievement, specifically on the STAAR test. One district in particular, Everyone Can Achieve Independent School District, has struggled to get all students at a satisfactory level. Many factors contribute to this low performance; however, the factor discussed the most is lesson presentation-specifically being able to keep all students engaged while addressing the Texas Essential Knowledge and Skills (TEKS).

Subjects

The target population, or sampling frame, in this study was sixth and seventh grade students from an identified campus within Everyone Can Achieve Independent School District. These selected students have traditionally underperformed on the STAAR test in the area of mathematics. The state standard for passing the STAAR test has always been set low for sixth grade math, approximately 35% each administration. At fifth grade and seventh grade, however, the passing rate is significantly higher. The standards taught from grade level to grade level rarely spiral, introducing many new concepts each year. Each of these factors, coupled with a student sense that math has become boring, have caused significant decreases in standardized test scores.

The population of the study was sixth grade students (currently enrolled in fifth grade), approximately 94 in number; and seventh grade students (currently enrolled in sixth grade), roughly 150 in number. Both student groups came from one identified campus in Everyone Can Achieve Independent School District. The identified campus being watched by the state due to low scores on STAAR.

Participants who have been enrolled at the selected campus for a minimum of 80% of the school year, from the time the study begins until the time the study ends, were counted as eligible participants. If a student enrolled at the campus at the beginning of the study, and consent was given to participate within the study, and attended at least 80% of the school days associated with the study, that student's data was calculated as a part of the overall data for the study. Any participant who was granted permission to participate, but then transferred to another campus during the first or second correlated unit, had their data removed from the overall calculations. In order to attempt to obtain data that clearly demonstrated whether correlated

instruction impacts students' perceptions of mathematics and mathematics performance, data that could skew the final results was eliminated.

Although this study will use a quasi-experimental design, it is important to have a larger number of participants in order to ensure validity and reliability of the data. While relying on the quasi-experimental design, the study will incorporate correlational and t-test data analysis in order to examine the effects of correlated instruction on mathematics achievement. The sample size of 244 students is based on the recommendation of Creswell (2015) for conducting research on the relationship between two variables, lesson presentation and improved performance in mathematics. Permission to conduct the study was obtained through verbal conversations and will be obtained in writing from campus administration and the District Math Coordinator within two months prior to the start of the study.

The identified campus is one of three intermediate schools within the district, all having a 1:1 chrome book initiative. The identified campus is a Title I school, with roughly 75% of the student population receiving free and reduced lunch (percentage of student participants; campus is about 92%). Approximately 69% of the potential participants are Hispanic, 15% are African American, 19% are White, and 3% are coded "other." Roughly 37% of the student participants are considered English Language Learners, while 25% are serviced under special education. Each of the four teacher participants are considered highly qualified, with full credentials.

The principal of the campus is responsible for ensuring that all students understand mathematical concepts, and that all learners are being reached through various means of instructional practices. These instructional practices should positively impact achievement on STAAR, helping to move the campus off of the watch list.

According to the 2015 STAAR results for the current sixth grade students enrolled at the campus in question, only 31% of the students met expectations on the mathematics STAAR. This is compared to the nearly 65% of sixth graders district wide who were successful on the same STAAR test in 2015 (see Appendix A). The researcher, at this time, does not have accurate data to represent the students currently enrolled in fifth grade.

Instrumentation

The instruments that will be utilized throughout this study include: teacher surveys, pre- and posttests, classroom observations, interviews of teachers, post lesson reflections, student surveys, ALEKS data, and analysis of STAAR tests for the study year as well as previous years.

Student Surveys. The student survey was designed by the researcher and then evaluated by administrators and the District Math Coordinator for content related evidence of validity regarding questions pertaining to students' perceptions of ability and mathematics understanding. The survey was created using Google Forms and shared with participants electronically. Sharing the survey electronically enabled the participants to respond anonymously and provided a quick return of responses to the researcher. Since the student survey was not be piloted prior to being given to student participants, there is a threat to validity and reliability.

A five-point response scale was utilized to measure the statements within the survey. Response points for the survey were as follows: 5 = "Definitely Agree," 4 = "Somewhat Agree," 3 = "Neutral," 2 = "Somewhat Disagree," and 1 = "Definitely Disagree." Therefore, a higher score on the survey indicated a positive relationship between students' perceptions of ability and mathematics learning (See Appendix B).

Pre- and Posttests. A pretest was administered to both the comparative group and the experiential group at the beginning of the study. The pretest was analyzed in order to determine students' mathematical understanding related to measurement and geometry. A posttest was administered upon completion of the study and analyzed in order to determine if a change exists in students' mathematical understanding from beginning of the study to the end.

Both the pretest and posttest consisted of the same set of questions. All questions were taken from released STAAR tests. Due to the district using previously released STAAR tests as district benchmark exams, it was difficult for the researcher to utilize entire released tests in place of the pre- and posttests. Utilizing pieces of each test, from two and three years ago, ensured that the researcher did not expose student participants to questions that could potentially be included within district exams. Keeping the two tests identical helped to ensure validity and reliability of the instruments (see Appendix C). Neither the researcher, nor the teacher who acted as co-researchers, reviewed the pretest with the student participants upon completion. The different questions used within the pretest were tied into the various lessons and activities that each group of students completes.

Classroom Observations. Observations were conducted of both the comparative group and the experiential group. The researcher observed and documented behaviors exhibited by both the teachers and the student participants in each of the two groups. The researcher looked for patterns in student behavior, as well as teaching style differences and similarities between the comparative group and the experiential group.

Interviews. Interviews of teachers were conducted mid-study and upon completion of the study. Interviews were utilized as a means of determining mathematical readiness, perceptions of students' ability as observed by teachers, as well as thoughts pertaining to

cooperative learning and correlated lessons. The researcher recorded all interviews, with permission from the teachers, and transcribed later so as to be able to refer back for comparison purposes.

Question one on the interview focused on engagement of the typical student in a mathematics classroom. Asking such a question assisted the researcher in determining whether issues with engagement during lessons may arise. While not all students are engaged 100% of the time in every lesson, creating activities in which student engagement is strong will be important. This is especially true in the case of the lessons which have embedded science TEKS.

Questions two, three and four had to do with mathematical ability. Having teachers look at the ability levels of their students, during and upon completion of the study, helped to understand if the designed lessons are at the correct ability level. If a student in sixth grade is mathematically functioning at a first or second grade level, completing tasks written at a sixth-grade level will prove daunting. Even though standardized tests are written at the expected grade level, it is necessary to have students comfortable in solving problems. Understanding a student's ability level in regards to mathematics can help the teachers and the researcher to tweak lessons as needed.

Cooperative learning can reach students at a variety of modalities. Auditory learners, kinesthetic learners, and visual learners can all perform well in cooperative groupings. Question number five in Appendix G focused on cooperative learning and how teachers feel it benefits their students. Being able to understand whether students can function in a cooperative group is critical, especially in the setting of the experiential group. Many of the activities for the experiential group focused on working in small groups, cooperatively, so it was important to

know if students have exposure to such grouping and how it has worked for them in the regular classroom.

The final two questions of the interview, six and seven, focused on correlated instruction. Definitions of correlated instruction, or integrated instruction, can be different for different individuals. Contardi, Fall, Flora, Gandee, and Treadway (2000), say that “integrated curriculum adopts a student-centered approach, by nature of its definition, it moves further away from the modernist viewpoint” (para. 9). By correlating, or integrating, curriculum, there is no right way to complete a task. “Students are free to reach conclusions on their own and they are provided with many different perspectives...” (Contardi et al., 2000). It was necessary and important for the researcher to gain an understanding as to what correlated instruction means to the teachers, and where they believe it is necessary to begin implementing such a concept so as to improve mathematical understanding in students.

Post Lesson Reflections. Students in both the comparative group and the experiential group were asked to complete a reflection upon completion of each lesson activity. Reflections were based on a Likert Scale, with 1 being “disliked the lesson; did not learn anything” and a 5 being “enjoyed the lesson; learned something new.” The researcher created a data table to illustrate and compare responses for each post lesson reflection. Data was also used as a way of indicating how lessons can be restructured to better meet the needs of all learners (see Appendix D).

STAAR Scores. STAAR scores for the year of the study, as well as previous years, were examined for all student participants. Analyses were used to determine whether or not participants who received correlated instruction improved their mathematical knowledge enough to show gains on the STAAR test. STAAR scores are a valid instrument in part because Texas

follows national standards for best practice when building its standardized assessments.

ALEKS. ALEKS is an online platform which the campus has purchased for students in grades 5–8. Currently, the mathematics program is only being utilized consistently by those students identified as “at-risk.” The program starts each user with a benchmark test to establish a grade level equivalency for math. Users work through a program specifically geared towards their mathematical ability to improve comprehension.

Participants within both groups used ALEKS, with the experiential group coupling the program with researcher-developed, correlated lessons. Students’ benchmark data, mid-study data, and end of study data was documented. The researcher analyzed the data in order to determine if coupling the program with correlated lessons impacts progress within the program.

Data Collection

Permission to conduct the study was first obtained from the principal assigned to the specific campus, as well as from the District Math Coordinator. Both parties were provided with information in order to grant permission for the study at both the campus and district level.

Consent to participate in the study was obtained from the caregivers of each student participant. Consent forms, along with confidentiality notices, were sent to participants’ guardians. Consent to Participate forms were given to each participant, in English and Spanish, and signed forms were collected and locked in a secure cabinet for safeguarding.

Each participant was assigned a unique number in order to protect their identification. This coding was used to identify specific participants during the data collection process only.

Power Analysis

According to Creswell (2015), a power analysis is “...a means of identifying appropriate sample size for group comparison by taking into consideration the level of statistical significance

(alpha), the amount of power desired in a study, and the effect size” (p. 611). The sample size for an Independent t test was determined using priori power analysis. The power analysis was conducted in G-Power using an alpha of 0.05, a power of 0.8, and a medium effect size ($p=0.3$) for a two-tailed test. Because “Spearman’s rank correlation coefficient is computationally identical to Pearson product-moment coefficient...” (Statistics Solutions, 2017), the priori power analysis was conducted to estimate power of a Pearson’s correlation. Based on the previously mentioned assumptions, the required sample size has been determined to be 102. That being said, the target of 150 participants should be more than sufficient to test the stated hypotheses.

Operationalization of Variables

Information regarding the operationalization of variables will be included once the data collection has been finalized.

Independent and Dependent Variables

Within the study, the dependent variable was the student results on the State of Texas Assessments of Academic Readiness, or STAAR, test. The independent variable was how the mathematics instruction was delivered to students.

In regards to the comparative group, the independent variable consisted of delivering mathematical concepts in a more traditional manner. This meant that students accessed their on-line textbook, ALEKS, and had concepts presented via worksheets, lecture, and videos. Students in the comparative group had opportunities to work through problems presented in worksheet format with a partner, yet they were not exposed to lessons in the same way as their counterparts.

Students placed into the experiential group had access to their on-line textbook and ALEKS. They were taught mathematical concepts with embedded science standards. This meant that each of the lessons that students were exposed to within the experiential group were

correlated; lessons involved both science standards and mathematics standards so that it was nearly impossible to determine which subject was being learned. Students in the experiential group worked through all lessons in small groups, making much of their learning cooperative in nature. Students examined measurement and geometric concepts by calculating flight times and paths of paper airplanes, analyzing landforms and their features, as well as designing blueprints and three-dimensional models for parks and homes.

Altering the independent variable, how instruction is delivered, helped the researcher to understand whether embedding the standards of one content area into those of another will cause a change in standardized test scores.

Data Analysis Procedures

Once the data was completed, a data spreadsheet was finalized which included the unique number assigned to each participant. This numbering system helped to address any concerns related to anonymity.

Student data pertaining to pre- and posttests, ALEKS benchmark data, and STAAR results was entered into the spreadsheet. Also to be included were any unit tests given as well as Mock STAAR data. A t-test was used to analyze STAAR data. Data was examined fully upon completion of the study. Furthermore, all interview transcriptions (qualitative) were presented in a descriptive format.

Survey results and evidence retrieved during classroom observations were included. These pieces were examined as a means of determining the extent to which the research questions were answered.

Limitations

Limitations to the research approach and methodology were the accuracy of the findings based upon the validity and reliability of the instruments used. While the concept of correlated instruction is not new, there is limited research to show whether or not correlated instruction improves scores in mathematics. Only two studies have been conducted which have demonstrated a positive relationship between correlating lessons and increases in standardized test scores.

The student survey acted as a self-assessment. This data was subjective to each student. Student participants may have tended to rank themselves higher or lower based upon their perceptions of self and expectations. The student survey also presents a risk of false validity due to being created solely by the researcher and having no pilot run prior to being administered.

Initially, the researcher planned to only use sixth grade student participants. After reflecting upon multiple factors, it was concluded that more participants should be included. Having spent an entire academic year with the current seventh grade students, and developing a rapport with them, the researcher has decided to seek permission from their parents for participation in the study. Opening up the study to both sixth and seventh grade students may demonstrate that correlated instruction improves scores in mathematics.

Delimitations

The following delimitations are identified. First, the study is delimited to students enrolled in the sixth grade and a few students enrolled in seventh grade. Due to multiple administrations of the state test at the fifth and eighth grades, the researcher does not have access to students within those grade levels. Secondly, the study is delimited to only three teacher

participants: one sixth grade math teacher, one special education co-teacher, and one instructional technology coach. Again, due to the demand of state testing, the researcher could not obtain the assistance of more teachers.

Internal and External Validity

Since this study was seeking to determine if a positive relationship exists between the manner in which lessons are presented to students (independent variable) and achievement on standardized tests in mathematics (dependent variable), internal validity is crucial. While one would like to believe that no other variables will influence the outcome of the study, it could occur. Variables that could affect the study would be: a teacher refusing to follow the correlated lessons, a teacher not having enough experience to present the TEKS adequately, student participants not wanting to complete a portion of or even the entire lesson, and not being able to collect sufficient data on a student due to absences or lack of completion of the work.

In order to assist with validity of the study, particularly external validity, a diverse group of sixth and seventh grade students was used; a small sample of the total population of sixth and seventh grade students at the campus and district level. Conclusions should be representative of the larger population. To ensure validity, the researcher enlisted the help of the campus administrators and the District Math Coordinator to ensure validity is maintained at each step. Since both parties have years of experience in designing tests and assisting in revamping questions for state assessments, their assistance in ensuring validity will be a key factor.

In order to maintain reliability of the instruments used, the researcher created pre- and posttests which had identical questions. The surveys asked participants to respond to the same statements, and post lesson reflections utilized the same Likert Scale and statements.

Keeping the statements and questions the same throughout each tool will ensure assessment validity and reliability.

Expected Findings

There is not much research in the way of correlated instruction and improvement on standardized tests. What has been studied is the need for reform in how mathematics and science are taught.

Furner and Kumar (2007) have examined some of the reasons as to why students in k–12 across American struggle with mathematics and science, and have discovered a need to reform education in these areas. “Efforts should be taken now to direct the presentation of science and mathematics lessons away from the traditional methods to a more student-centered approach” (Furner & Kumar, 2007, p. 1). It is essential that mathematics and science are taught in every classroom, however it is critical that teachers learn how to make the content meaningful and engaging for students. “In a test-driven curriculum where students and teachers are evaluated on student performance based on reading and mathematics standardized test scores, teaching meaningful science remains a challenge” (Furner & Kumar, 2007, p. 1).

That being said, it was expected that the results would show that a positive relationship does exist between lesson presentation and student achievement on standardized tests. The researcher expected all data pieces to demonstrate that, when mathematics and science concepts are connected within a correlated lesson, student achievement on mathematics standardized tests would increase.

Ethical Issues in the Study

This section will discuss possible ethical issues tied to the research and how human participants, along with the data collected, will be protected. All research participants will be

protected to the best of the researcher's ability. Participants, including the caregivers of those student participants, will be informed in writing of the limitations of protection, the risks associated with the research, as well as the fact that-despite all precautionary measures taken-there still exists the possibility of breeches of confidentiality and anonymity. This will minimize the risks and harm to participants agreeing to participate in the study.

The study complied with each of the following: the design chosen for the study, sampling procedures and target population, theoretical framework, and all research questions that drive the study. The data was collected and housed by the researcher in a secure area that ensures safeguarding. All results of the study were first shared with members of the dissertation committee.

As required, IRB approval was granted prior to any research being conducted. The researcher ensured that all processes of the study had received IRB approval. The researcher conducted the study professionally and ethically, without coercion. Measures were taken to ensure security, such as assigning unique numbers to all participants and securing data and documents in locked areas.

Since a group of student participants were the current students enrolled in the researcher's classroom, it was critical to ensure that favoritism was not shown. To alleviate any chance of the researcher's personal opinions or feelings influencing data, the researcher enlisted the help of the campus interventionist to score students' pre- and posttests.

Summary

This chapter described and explained the methods that will be used for this study. It states the type of research being conducted and describes the context for the research. An outline of the participants for the study is provided, along with a description of each measurement tool to

be implemented. The validity and reliability of the research design has been explained, which correlates to the trustworthiness of the study. The data collection and analysis procedures are described, as well as ethical considerations and potential limitations. The researcher's expected findings are noted, based on limited, prior research.

Chapter 4: Data Analysis and Results

Across Everyone Can Achieve Independent School District, as with other areas, students have been struggling to perform at an academic level equivalent to that of their same age peers. This is especially true in the area of mathematics.

Through this study, data was collected and analyzed to determine whether teaching mathematical concepts via a correlated approach could improve mathematical understanding; to assess whether taking a correlated approach to teaching mathematics impacted the mathematical performance of students.

Description of the Sample

An intermediate school, consisting of 920 students in grades 5–8, was chosen for the study. Student participants, 180 of them, were selected from sixth grade; 150 seventh graders were selected from seventh grade initially. The sample of sixth graders was chosen because they are students of the researcher. The sample of seventh graders was selected because they are former students of the researcher, and there was a strong desire to determine whether the seventh graders have continued to experience academic growth.

Both the group of seventh graders and the group of sixth graders, having had the researcher as a mathematics teacher, received similar instruction as it pertains to mathematics. The daily routine throughout both academic years was the same, consisting of a warm-up at the beginning of each class period, a guided lesson followed by a partner or small group activity, and then an independent activity to assess individual understanding. During both academic years, the current sixth graders and the seventh graders were given various project-based lessons in which

mathematics and science were correlated. Both groups were exposed to ways in which mathematics and science are intertwined in the real world and how necessary each content area is to different career paths that students are leaning towards. While worksheets were a necessary component of the classroom experience to an extent, projects and correlated activities were equally important.

Consent to Participate letters were distributed to all potential participants. Of the letters handed out to sixth graders, 97 were returned and the remaining parents or guardians were sent follow-up emails. Out of the follow-up emails sent, 27 returned responses which granted consent to participate in the study. Of the letters given out to seventh grade students, only four parents granted consent to participate. The majority of these parents cited time as a reason, describing not wanting to take away from the curriculum needing to be covered or from the current teacher's plans.

The 124 sixth grade participants consisted of students enrolled in a Gifted and Talented (G/T) class, regular education classes, students in special education classes, and students identified as English Language Learners. Approximately 25 participants, or 20%, were identified G/T; 15, or 12%, were identified special education or 504; 9, or 7%, were identified as ELL; and the remaining 75, or 61%, were not given a label.

Along with the student participants, four teachers were identified: two mathematics teachers, one special education co-teacher, and one technology instructional coach. Consent to Participate letters were given to each teacher, with 100% return rate and agreement to participate. All teachers were trained in correlated instruction and what was expected throughout the course of the research study, using the training presentation created by the researcher.

The researcher met with the selected teachers after work for an hour, prior to the start of the study. The selected teachers were trained in what correlated instruction looks like, using examples from a lesson involving algebra and speed and motion. Teachers were first asked to participate in a brief, ten-minute activity in which the researcher demonstrated how to properly solve algebraic equations and then calculate speed of vehicles using scientific formulas. Teachers were given five questions to answer as the researcher went through the presentation.

Upon completing the ten-minute activity, teachers were then told to discuss with one another how the lesson made them feel. The researcher then had the group come back together and presented the same lesson, but with a different approach. Teachers were given ramps, matchbox cars, calculators, and stop watches. Teachers were told that they needed to determine, as a group, which ramp would cause their cars to travel at the fastest speed. The teachers were also told to use their understanding of algebraic equations to figure out how to come up with a way to express their findings mathematically. After approximately fifteen minutes, the group discussed how the activity made them feel and how their feelings differed from the first activity. This led the researcher into the discussion of the importance of correlated lessons and how the study aims to prove that, through the concept of correlated instruction, mathematical performance of students will improve.

Research Methodology and Analysis

The methodological component of this study consisted of examining student data as it pertains to standardized test results for mathematics and a student survey which examined perceptions of mathematics. The standardized test used for this study was the State of Texas Assessments of Academic Readiness, or STAAR, test. Results for each participant were

gathered for grades four through six, for both the comparative group and the experiential group. Results are disseminated to educators each Spring via an online portal operated by the Texas Education Agency; districts, such as Everyone Can Achieve, typically upload student scores for each designated teacher as well. The researcher also utilized a perception survey, created by the researcher, to determine self-efficacy as it pertains to mathematics. T-tests were run upon completion of the study in order to determine statistical significance, if any, regarding the effects that embedding science TEKS into the mathematics curriculum has on mathematics achievement as well as self-efficacy as it relates to mathematics.

From 2005–2009, Everyone Can Achieve Independent School District was performing just as well as other districts of comparable size across Texas in regards to STAAR testing. Over the past few years, there was a shift within the district and student performance on the STAAR test has declined. The shift within student performance began happening when the district began to notice a significant staff turn-over, especially at administrative levels. From 2005–2009, when the district was performing as well as other districts across the state, the superintendent strived to create a culture of caring and life-long learning. When the position of superintendent changed over in 2012, the culture of life-long learning and caring changed as well. It is now, with yet another new superintendent, that the culture is again one of caring and continual learning; which will move the district towards a positive trend in student performance. This decline is evident in all tested areas, but more so when it comes to mathematics.

In the last two years alone, students in sixth grade have underperformed in comparison to their same age peers across the state. On the 2015–2016 STAAR test in mathematics, sixth graders in Everyone Can Achieve Independent School District collectively scored a passing

percentage of 55%, meaning that only 55% of the sixth graders within the district met the state's designated level of Approaches Grade Level. When looking at the school specifically chosen for the study, sixth graders scored 49.19% passing. While the passing percentages achieved are alarming, the weakest areas across the district and within the campus are measurement and geometry; 54% passing for the district and only 47% passing for the campus.

Such low passing rates have become cause for concern among teachers, specifically for the researcher. It has become evident that changes need to be made in the way in which the Texas Essential Knowledge and Skills, TEKS, are taught. A change must occur in order to increase student performance and student enjoyment of mathematics.

The present study sought to prove that correlated instruction in mathematics and science would improve student performance on standardized tests, particularly in the area of mathematics. The study focused on sixth grade students in Everyone Can Achieve Independent School District.

The primary hypothesis of the study was: There will be a positive gain in mathematics achievement on standardized tests when science standards are embedded within the mathematics curriculum. To address this hypothesis, a quasi-experimental research design was implemented. Of the 124 participants, 56 were placed into the comparative group and 68 were placed into the experiential group. The comparative group wound up being slightly smaller due to fewer students being enrolled in specific classes; the comparative group was comprised of periods 4, 5, and 8.

The comparative group received instruction solely in mathematics, with little deviation from the standards. The experiential group received correlated instruction in mathematics and science via hands-on labs, interactive lessons, journaling, and small group exercises.

Prior to beginning any instruction in either the comparative group or the experiential group, a pretest was administered. The pretest (see Appendix C) consisted of eight mathematics questions and seven science questions. Participants in both groups were provided with a formula chart to assist them with measurement problems, as well as 49 minutes to complete the test. Upon completion of the pretest, data was analyzed in order to determine how girls performed in relation to the boys academically. Looking over the pretest data and comparing the overall passing percentages of boys and girls in both the comparative group and the experiential group, results were quite similar between the two groups overall. As a group, the comparative group had 51.5% of its participants pass the pretest; in comparison, the state's passing rate for the mathematics STAAR test is 35% meaning that a student must answer 35% of the questions correctly to pass the exam and reach the level of Approaches Grade Level designated by the state. The experiential group had 43% of its participants pass the pretest.

When comparing female participants to male participants, females in the comparative group scored 11% lower than the males with only 46% of the girls reaching the Approaches Grade Level designation. Within the experiential group, 45% of the girls reached Approaches Grade Level as opposed to 41% of the boys (see Table 1).

Table 1

Pretest: At Beginning of Study

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	45	41	43
Comparative	46	57	51.5
Total	45.5	49	47.25

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the pretest.

Once participants had completed the pretest, each participant was given a survey. The purpose of the survey was to determine student attitude regarding mathematics. Specifically, the researcher was looking to discover two things: entering middle school, how do students perceive mathematics; and is there a difference between how female students and male students perceive mathematics.

As the surveys came in, it took some time to go through each piece of data. Participants responded to ten statements based on a Likert scale, from 1 being “definitely disagree” to 5 being “definitely agree.” Each specific statement had to be tabulated for each of the 124 respondents. As the responses were examined, it was noted that 30% of the participants in the comparative group, and 20% in the experiential group, said that “Math lessons give me anxiety.” Within the comparative group, 65% of the participants felt that “Math and Science are fun, interesting subjects;” similar to the 62% of the participants within the experiential group who agreed to the same statement. Examining the responses further, it was noted that 74% of the males in the experiential group, and 68% of the males in the comparative group, find math and science

interesting. Within the comparative group, 67% of the females responded on the pre-survey that math and science were interesting; 56% of the females in the experiential group felt as though math and science were interesting. It was also noted that 29% of females in the comparative group, and 14% of females in the experiential group, believed that boys performed better than they did in math (responses were higher than males) (see Table 2 and 3).

Table 2

Pre-Survey Results: Experiential Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	16	47	38
2.Equations, expressions, & numbers in general seem confusing.	20	58	20
3.Topics like weathering, erosion, force, & motion are difficult to understand.	20	58	22
4.Math & science are fun, interesting subjects.	62	20	16
5.Math lessons give me anxiety.	20	55	24
6.Science lessons give me anxiety.	18	62	16

Table 2 (Continued)

Pre-Survey Results: Experiential Group Continued

7.I enjoy learning about geometry & measurement.	36	24	40
8.I believe that other students always perform better than me when it comes to math.	31	42	24
9.I believe that members of the opposite sex are better at math & science than I am.	13	60	22
10.If I could go to school and not take math or science, I would be happy.	16	60	20

Note. Pre-survey given prior to the start of the correlated units.

Table 3

Pre-Survey Results: Comparative Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	28	30	42
2.Equations, expressions, & numbers in general seem confusing.	21	58	19
3.Topics like weathering, erosion, force, & motion are difficult to understand.	9	74	16
4.Math & science are fun, interesting subjects.	65	16	19
5.Math lessons give me anxiety.	30	47	23
6.Science lessons give me anxiety.	23	65	14

Table 3 (Continued)

Pre-Survey Results: Comparative Group Continued

7.I enjoy learning about geometry & measurement.	35	28	37
8.I believe that other students always perform better than me when it comes to math.	35	35	30
9.I believe that members of the opposite sex are better at math & science than I am.	26	49	23
10.If I could go to school and not take math or science, I would be happy.	21	60	19

Note. Pre-survey given prior to the start of the correlated units.

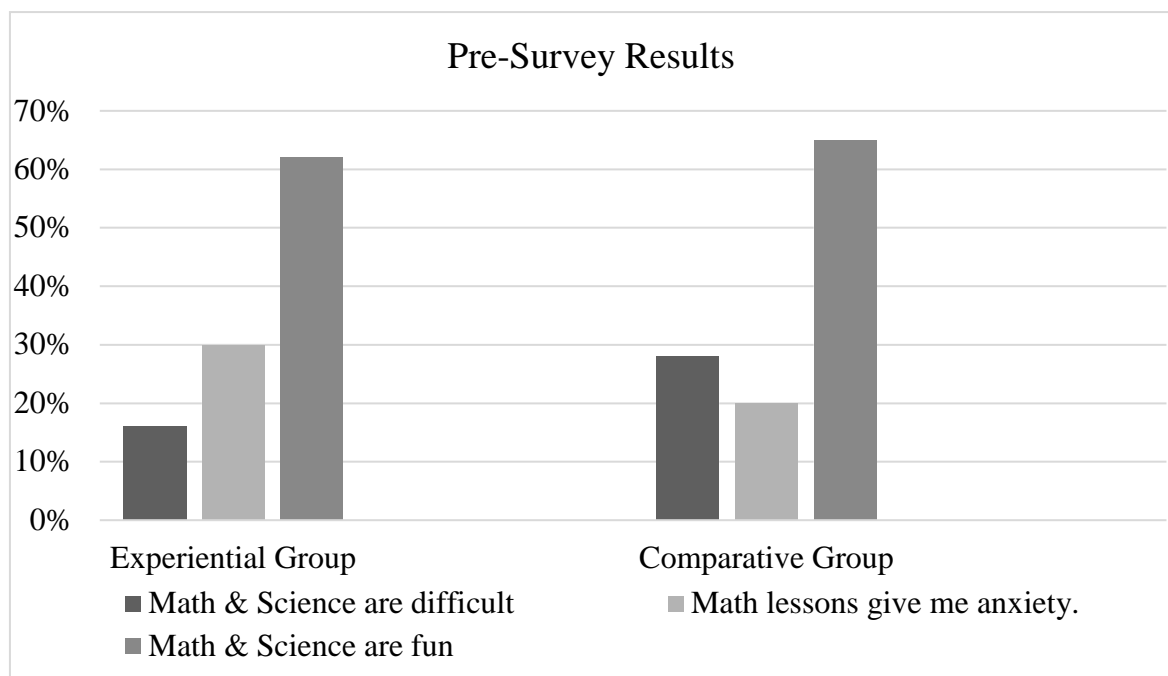


Figure 1. Pre-survey results: comparison of comparative group and experiential group.

Upon completion of the pretest and survey, instruction began in both groups. The first lesson was over area, perimeter, integers, and the coordinate plane. Within the comparative group, participants received traditional instruction. Their daily lessons consisted of a five-minute warm-up, a guided lesson in which the teacher was at the board teaching, and then either partner work or independent practice. Participants were assigned homework every Monday and it was collected every Thursday. Within the experiential group, lesson delivery looked differently.

On day one of the unit, participants completed a pretest covering only the topics for the unit; 10 questions. Participants in the experiential group completed the same five-minute warm-up as the comparative group and were assigned the same weekly homework as the comparative group. Participants in the experiential group were then directed to sit with their newly assigned teams and examine the large coordinate grid displayed on the floor. A discussion was held about integers and where specific integers would be located within the coordinate grid. The researcher

and the technology instructional coach then introduced Sphero, a spherical robot that can be programmed using coding, to the participants. Sphero introduced the lesson and told participants that they would be using Legos to construct a building of their choice. During construction, participants were instructed to use Stop-Motion animation to record the building process. Participants were also given a form on which to record the dimensions of their building so that they could calculate the area, perimeter, and volume. Participants were using math, science, and technology to examine the construction of a city from the ground up.

Participants spent two days learning how to use Stop-Motion animation, one day planning their design for their building, one day reviewing coordinate grids and integers, three days building and recording, and two days learning how to code and drive Sphero around their newly constructed cities while they practiced naming ordered pairs. Participants spent a total of nine days on this lesson, from the pretest for the unit to the final test. Collectively, 51.5% of the comparative group participants passed the pretest covering area, perimeter, integers, and coordinate graphing; 59.5% of the experiential group passed. When comparing girls and boys on the pretest, 48% of the girls in the comparative group and 55% of the boys passed the pretest; compared to 61% of the girls and 58% of the boys in the experiential group (see Table 4).

Table 4

Correlated Unit 1: Pretest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	61	58	59.5
Comparative	48	55	51.5
Total	54.5	56.5	55.5

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the pretest which was administered prior to the start of the first unit.

After completing the nine days of lessons within this first correlated unit, the experiential group saw a 50% growth in academic performance. Within this group, 88% of the participants passed the posttest, which was identical to the pretest at the start of the unit. This unit, on average, resulted in a gain of anywhere from two percentage points to seventy-five percentage points per student. The comparative group participants, who received traditional lessons, grew slightly more at 70% growth; 90.5% of participants passing (see Table 5).

Table 5

Correlated Unit 1: Posttest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	92	84	88
Comparative	96	85	90.5
Total	94	84.5	89.25

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the posttest upon completion of the first correlated unit.

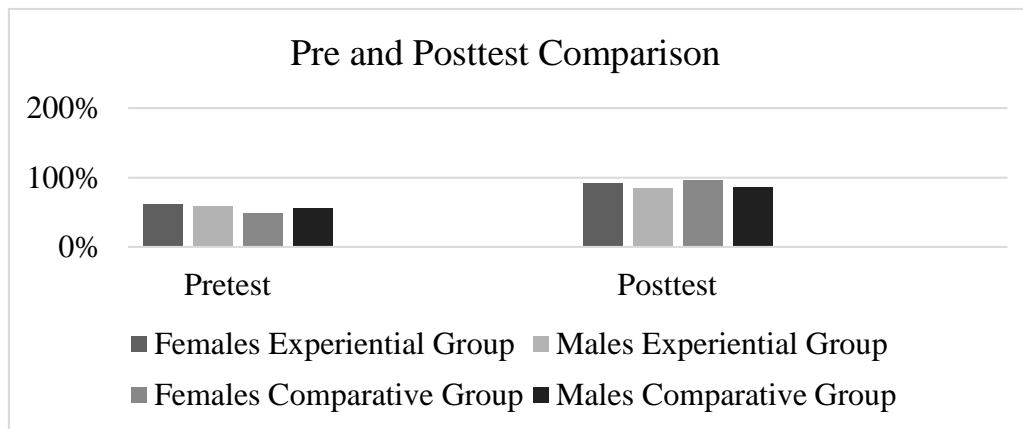


Figure 2. Correlated Unit 1: Pre and Posttest Comparisons

The second correlated lesson involved measurement conversions, distance, time, aerodynamics, and mass. All participants were first administered a pretest to assess where they were with their comprehension of measurement and geometry. In regards to the comparative group, 65% passed the pretest; 70% of the females passed and 60% of the males passed. With respect to the experiential group, 64.5% of the participants passed; 66% of the females passed and 63% of the males passed (see Table 6).

Table 6

Correlated Unit 2: Pretest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	66	63	64.5
Comparative	70	60	65
Total	68	61.5	64.75

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the pretest prior to the start of the second correlated unit.

After completing the pretest, each group went through ten days of lessons. The comparative group received instruction via daily warm-ups, guided lessons, homework, and independent practice. The experiential group was taught using a correlated approach similar to that of the first lesson.

The participants within the experiential group were kept with their same teams as before. For this lesson, participants were first given a brief lesson related to sequential tasks and coding (i.e., steps for creating a paper airplane). Participants identified the correct steps for constructing a paper airplane. Next, participants were told that they were going to work with their team to build a paper airplane that could fly a great distance while having a different amount of weight added to it at different times. Their objective was to design a plane that, when paper clips were added to the body of the plane, could fly farther than anyone else's. Participants were all given the same materials to choose from: copy paper, construction paper, and card stock. Participants were given 49 minutes to design and another 49-minute class period to construct their plane.

The third day, after all planes were constructed, the technology instructional coach and the researcher gave a lesson related to Google sheets. Participants were taught how to make a copy of a file, how to calculate a formula for a column in a spreadsheet, and how to calculate columns and rows quickly and accurately.

On day four, participants were asked to choose a flier, a time keeper, a recorder, and a measurer for their groups. The researcher took the teams into the hallway, having marked off approximately six feet of space beforehand, to run eight separate trials with the paper airplanes. Participants had their team member who was the flier stand behind the designated line, the time keeper let everyone know when it was time to fly the planes, and the fliers let the planes fly down the hallway. Once the planes landed, those responsible for measuring did so quickly and reported back to the recorder who took note of the time and distance and documented the information within the Google sheet. A paper clip was added and another trial run until all eight trials were completed.

As participants were completing their eight trials, the researcher specifically looked for cooperative learning and team building; which team members were able to step into the role of leader and assist those who were struggling with their roles. As the day went on and larger class periods came and went, it was clear that some of the larger groups could not handle this particular activity due to not having enough roles to assign to each team member. The researcher noted that behavioral issues began to arise with several students. The researcher had to remove two boys from the activity, since physical violence took place, and other participants were moved into new teams in order to alleviate future problems. Other than those instances, the activity went well with the participants. Those participants who had a role, some team members even graciously took turns with others, were very active throughout the entire activity. This

lesson provided for a lot of movement, a lot of communication, and had the participants thinking about formulas and calculations. Participants said that this was their favorite activity because they were allowed to fly paper airplanes in school.

Upon completion of the eight trials, teams had to calculate speed, create ratios and rates to express the comparison of time to distance, and express the relationship between weight and how far the planes flew each time. Since this unit fell around the holidays, and it tied in with aerodynamics and calculating measurements, participants were challenged to use Tinkercad.com to create a three-dimensional model of either an airplane or Santa's sleigh-newly redesigned. The top three models were chosen out of the 124 and printed using a 3D printer.

To end the unit, all participants completed a posttest. Once all participants were finished, data was analyzed. The comparative group had 93% of its participants achieve a passing score; 96% were females and 90% were males. The experiential group had 92% of its participants earn a passing score; 95% were females and 89% were males. The participants within the experiential group saw a 27.5-point increase from pre to posttest, with the average participant growing anywhere from three percentage points to seventy-five percentage points (see Table 7).

Table 7

Correlated Unit 2: Posttest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	95	89	92
Comparative	96	90	93
Total	95.5	89.5	92.5

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the post-test upon completion of the second correlated unit.

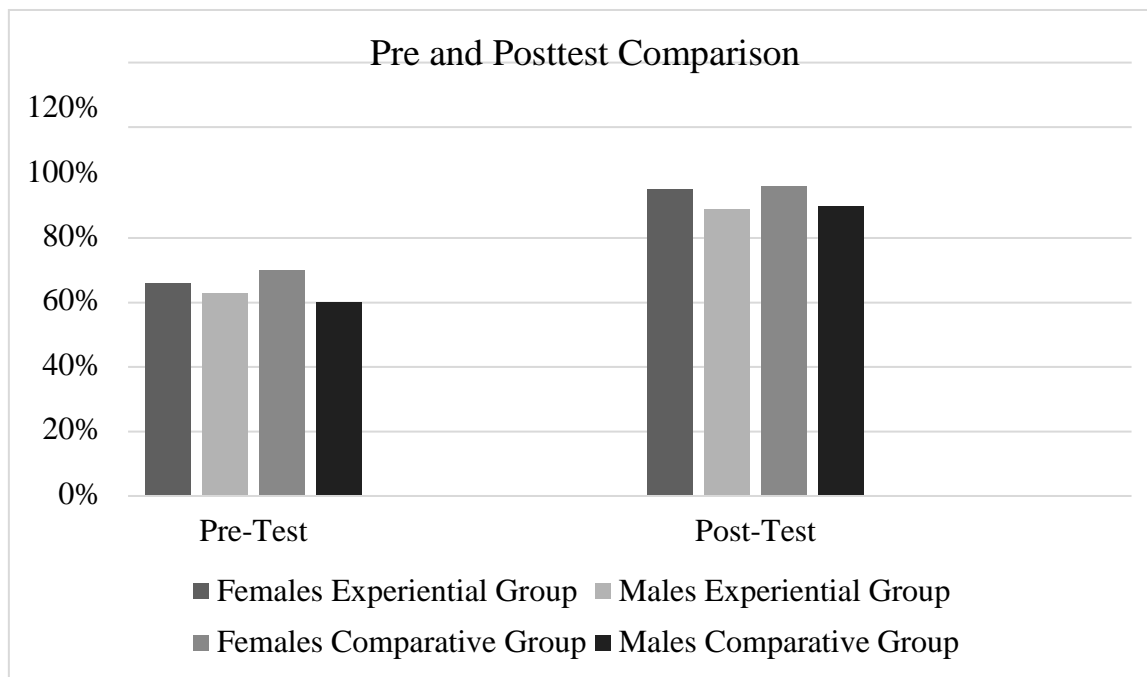


Figure 3. Correlated Unit 2: Pre and Post-Test Comparison

The third and final correlated unit involved algebra, measurement, and coding. Participants in both the comparative group and the experiential group were administered a pre-test prior to beginning the unit. Within the comparative group, 86.5% of the participants

demonstrated a strong working knowledge of algebraic concepts; 83% were females and 90% were males. In the experiential group, only 71% of the participants were successful on the pretest; 79% were females and 63% were males (see Table 8).

Table 8

Correlated Unit 3: Pretest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	79	63	71
Comparative	83	90	86.5
Total	81	76.5	78.75

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the pretest prior to the start of the third correlated unit.

As with the other units, the comparative group received instruction via daily warm-ups, guided lessons, homework, and independent practice. The experiential group received instruction through a correlated approach. With this particular lesson, the correlated instruction came in two pieces: implementation of code.org and a hands-on activity in which teams used the concepts of algebra and geometry to build a structure that would support the weight of three books of equal size. Teams were given the same materials to build their structure with: 15 drinking straws, 20 marshmallows, and 5 pieces of tape. Each structure had to be self-standing and it had to be able to hold three books-small chapter books from the classroom library. As they worked to build their structure, teams had to record their findings and their measurements. Participants also had to record the weight of each book, as well as the combined weight of all three books. The entire unit took ten days from pretest to posttest.

With this last correlated unit, the researcher made observations based on how well the teams worked together and conversations that were taking place amongst the teams. It was important to note the mathematics vocabulary that was being used between team members because measurement and algebraic reasoning were weaker areas for the participants, and algebraic reasoning was a newer unit; algebra is not taught in 5th grade. As the researcher observed each team, it was noted that team members were frustrated with the activity. While they usually give up once frustration hits, participants were not quitting this time. When an equation that they wrote down did not appear to give them the value that they were looking for, they expressed their frustration by shoving their papers to the side and putting their heads down on their desks after verbalizing that they saw themselves as “stupid.” Even though they displayed these reactions, they still found a way to provide words of encouragement to one another and help each other to work through the problems towards a solution; this had never happened before.

As team members built their structure, they would rely on the other members to give them the information pertaining to the mass of the books. When a team member could not perform their task in such a way that gave an accurate answer, team members did not get angry but instead assisted that member in finding the correct answer. It became an activity in which the participants were helping each other and the researcher was facilitating the learning process, rather than the researcher being the giver of the knowledge. When participants completed the reflection sheets at the end of the unit, many cited this unit as a favorite because it challenged their thinking.

Upon completion of the third unit, participants were administered a posttest. While analyzing the results of the posttest, it was noted that 91.5% of the participants in the comparative group passed the posttest; only up 5.5% from the pretest. Within the experiential group, it was noted that 88% of the participants passed the posttest; 97% of the females and 79% of the males. This was a growth of 17% from the pretest to posttest. (see Table 9). Although the difference in achievement between the comparative group and the experiential group was not statistically significant, there was an increase in achievement noted within the experiential group after having received lessons embedded with science standards. These results could mean that, potentially, there would be significant gains in achievement upon completion of a prolonged study focusing on instruction embedded with science standards.

Table 9

Correlated Unit 3: Posttest Data

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	97	79	88
Comparative	83	100	91.5
Total	90	89.5	89.75

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the posttest upon completion of the third correlated unit.

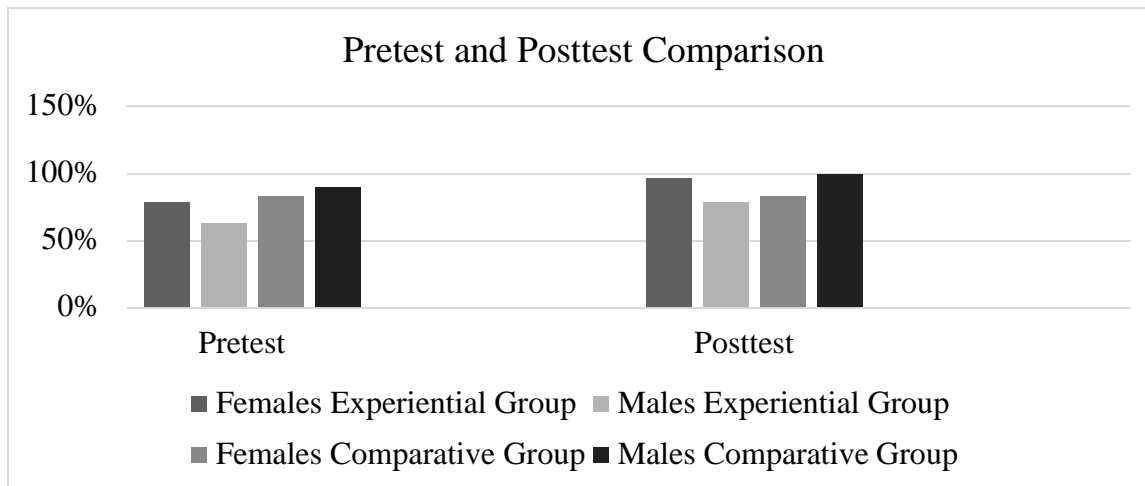


Figure 4. Correlated unit 3: pretest and posttest comparison.

Around the same time that the third correlated unit ended, the school district was scheduled to administer its Mock STAAR test in mathematics. The district administers a practice state assessment every year in order to try to gauge where the students are in relation to the same time the previous year, as well as where they are in regards to their curriculum. As the participants completed their Mock STAAR tests and the tests were turned in to the testing coordinator, data was scanned into the computer. Individual teachers were then able to pull their results and examine how well their students performed when compared to the campus and the district.

On the 2016–2017 Mock STAAR test, the researcher’s group of sixth graders (now seventh graders) scored a 42% passing rate as a group. This year on the Mock STAAR, the researcher’s group of sixth graders scored 58% passing; 16% higher than the previous year. The researcher’s group was, on average, 25% higher than the other two sixth grade math teachers on campus; 27 of the researcher’s students just missing the passing rate by one or two questions (see Table 10). When compared to the overall district, the researcher’s group was 4% behind the passing rate.

Table 10

Mock STAAR Data

Teacher Name	Total Students	Percent at Approaches Grade Level (passing)	Percent at Meets Grade Level (on grade level)	Percent at Masters Grade Level (commended)
Researcher	143	58.04	11.89	1.4
Teacher A	48	33.33	4.17	0
Campus	210	50	9.05	0.95
District	889	62.09	18.45	3.71

Note. There are 19 bilingual/ESL students not figured into these numbers because the teacher was not a part of the study.

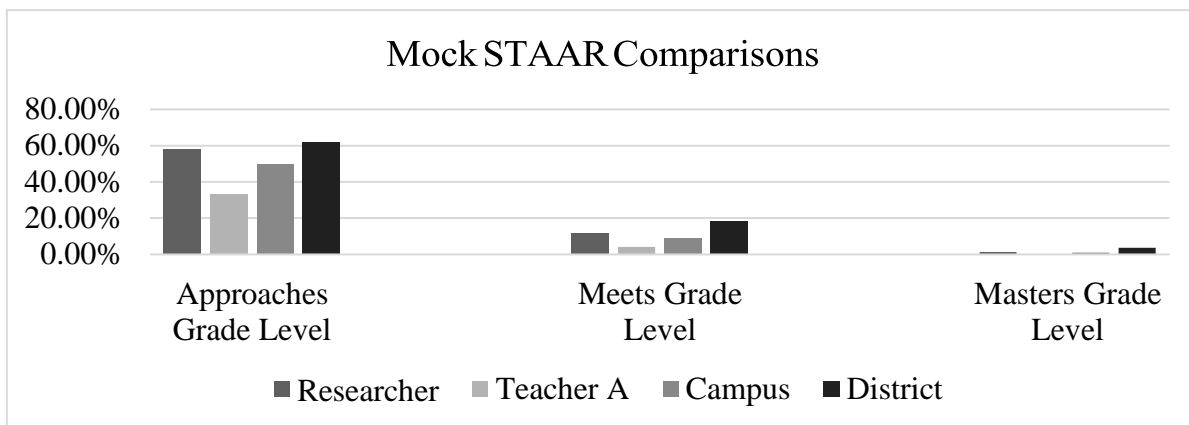


Figure 5. Comparison of Mock STAAR results.

All of the participants in the study were also administered a posttest, identical to the pre-test with eight mathematics questions and seven science questions (Appendix C). This test was administered a second time to determine whether embedding science standards within the mathematics curriculum helped to improve students' performance in mathematics.

Posttests were collected and participants' responses were compared to those from their pretests to check for knowledge growth and comprehension. Tests were scored based on a scale system in which the readiness TEKS, those given more weight on the real STAAR test, were scored heavier (pretests were scored the same). After scoring all posttests and issuing a passing score of 35% to those who met state requirements, comparisons were made between the comparative group and the experiential group. The comparative group saw a decline from the initial pretest to the posttest, dropping from 58% passing to only 48% passing on the posttest. In regards to the experiential group, however, participants improved their academic performance by 7%, rising from 45% passing on the pretest to 52% on the posttest (see Table 11).

Table 11

Posttest Data: Upon Completion of Study

Group	Percent of Females Passing	Percent of Males Passing	Total Percent Passing
Experiential	54	43	48.5
Comparative	29	57	43
Total	41.5	50	45.75

Note. Table illustrates the percentage of females and males within both the experiential group and the comparative group who passed the posttest.

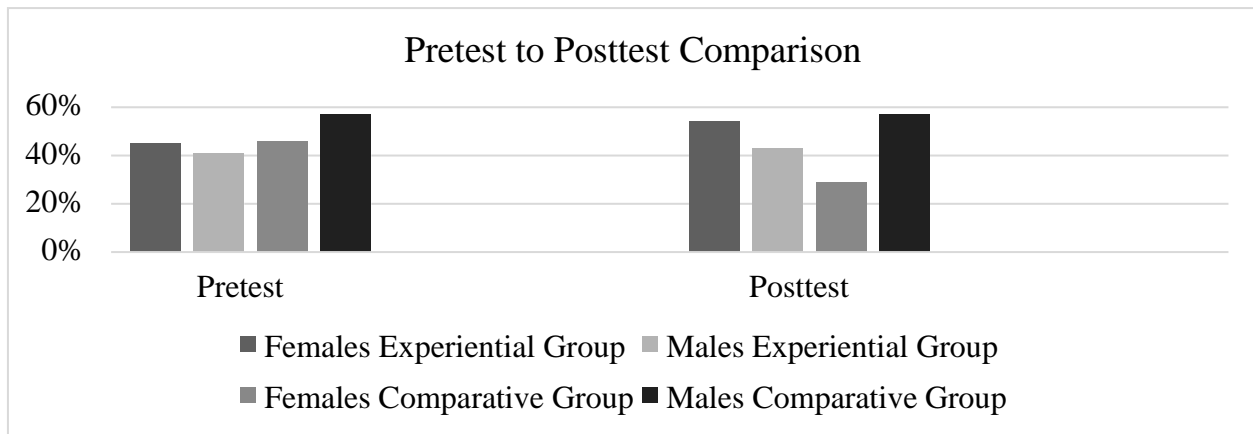


Figure 6. Comparison of the pretest at the start of study to the posttest upon completion of study.

Teachers were also asked to respond to seven interview questions (see Appendix G). Teachers who responded include Teacher A-a sixth grade math teacher, Teacher H-a special education co-teacher, and Teacher W-a technology instructional coach. The fourth teacher was the researcher and therefore interview questions were not completed by the fourth teacher.

Summary of the Findings

Throughout the course of the study, five research questions were considered:

1. Entering middle school, how do students perceive mathematics?
2. What is the difference between how female students and male students perceive mathematics?
3. Will the embedding of science within the mathematics curriculum have more of an impact on one gender than the other as it relates to standardized test scores in the area of mathematics?
4. Will the embedding of science standards within the mathematics curriculum increase standardized test scores in the area of mathematics?
5. How does embedding science standards within the mathematics curriculum affect students' perceptions of self-efficacy in the area of mathematics?

In order to determine whether or not each of these four questions had been answered within the scope of the study, or the hypotheses addressed, t tests were run utilizing pre and posttest data as well as pre and post-survey data.

RQ1: Entering middle school, how do students perceive mathematics?

While this research question is not a testable question, the researcher was able to utilize the perception survey and observational data to gain a working knowledge as to how students perceive mathematics upon entering middle school. At the beginning of the study, 62% of those students in the experiential group believed that math and science were fun, interesting subjects. Upon completion of the study, 80% of the student participants within the experiential group responded (on the same survey) that math and science were fun and interesting subjects.

Also within the experiential group, participants at the beginning of the study were more likely to be happy if they never had to take a math or science class in school again (16% of respondents agreed). Upon completion of the study, only 10% of the participants said that they would be happy to never have to take another math or science class.

Throughout the learning process, participants developed an enjoyment of mathematics and science and began to visualize themselves completing mathematical tasks. By creating lessons that were engaging, allowed for cooperative learning, provided hands-on investigations, and opened the channels of communication regarding mathematics, the researcher ignited a flame in the participants that they did not know existed.

RQ2: What is the difference between how female students and male students perceive mathematics?

An independent-samples t-test was conducted to test the null hypothesis that there would be no difference in perceptions of math efficacy between female and male students. The analysis

revealed no statistically significant difference in the perceptions of math efficacy with respect to gender, $t(83) = 1.98, p = .053$. The average growth in perceptions of females ($M = .15, SD = .66$) was less than the average growth in perceptions of math efficacy of students taught with science standards embedded methods ($M = -.21, SD = .89$). The 95 % confidence interval for the difference in means ranges from $-.72$ to $.004$. The results indicated that male and female students do not differ in the average growth in their perceptions of math efficacy. Details of the differences in male and female students taught using the traditional methods of instruction and students taught using science (standards) embedded within mathematics are also presented in Table 12. The null hypothesis that there would be no difference in average growth in perceptions of math efficacy of students based on gender failed to be rejected.

RQ3: Will the embedding of science within the mathematics curriculum have more of an impact on one gender than the other as it relates to standardized test scores in the area of mathematics?

An independent-samples t-test was conducted to test the null hypothesis that there would be no difference in math test score gains between male and female students taught math using the traditional methods and those taught math with science standards embedded in the mathematics curriculum. The analysis revealed no statistically significant difference in the test score gains, $t(83) = .068, p = .95$. The average math test score gains of male students, ($M = 3.38, SD = 2.33$) was not significantly different statistically, from female students, ($M = 3.34, SD = 2.37$). The 95 % confidence interval for the difference in means ranges from $-.99$ to 1.07 . The results indicated that on the average, female students did not differ in test score gains from the male students. The null hypothesis that there would be no difference in average test score gains in math for male and female students failed to be rejected. The statistical means of average test score gains in math

and the standard deviations of the participants are presented in Table 12.

Table 12

Means and Standard Deviations of Average Growth in Test Score Gains of Math

Gender	<i>M</i>	<i>SD</i>	<i>n</i>
Female	3.34	2.37	32
Male	3.38	2.33	53

RQ4: Will the embedding of science standards within the mathematics curriculum increase standardized test scores in the area of mathematics?

An independent-samples t-test was conducted to test the null hypothesis that there would be no difference in math test score gains of students taught math using the traditional methods and those taught mathematics with science standards embedded in the mathematics curriculum. The analysis revealed no statistically significant difference in the test score gains, $t(83) = .54$, $p = .59$. The average math test score gains of students taught with traditional methods, ($M = 3.19$, $SD = 2.241$) was not significantly different statistically from students taught with science standards embedded methods, ($M = 3.47$, $SD = 2.38$). The 95 % confidence interval for the difference in means ranges from .51 to -1.16. The results indicated that on the average, students taught in the traditional manner did not differ in test score gains from the students taught math using science (standards) embedded within the mathematics curriculum. The null hypothesis that there would be no difference in average test score gains in math failed to be rejected. The statistical means of average test score gains in math and the standard deviations of the participants are presented in Table 13. Also see figure 7 and additional representation in Table 14.

Table 13

Perception and Test Score Differences Between Students Who Learned Math Traditionally (Comparative) or Learned with Science Embedded in the Curriculum (Experiential)

Comparisons	Comparative		Experiential		$t(83)$	p	Eta^2
	M	SD	M	SD			
Student Test Scores	3.19	2.21	3.47	2.38	.54	.59	n/a
Student Perceptions	-.75	.41	.58	.38	15.49	<.001	.74

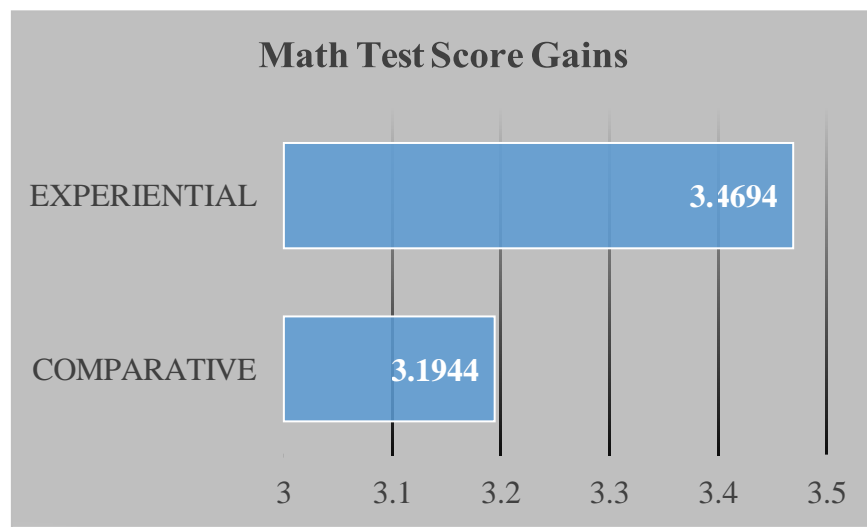


Figure 7. Comparison of math test score gains between the experiential and comparative groups.

Table 14

Multiple Comparisons of Perception and Test Score Differences Between Students Who Learned Math Traditionally (Comparative) or Learned with Science Embedded in the Curriculum (Experiential)

Comparisons	Comparative		Experiential		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Male Test Scores	3.63	2.41	3.00	1.96	.215
Female Test Scores	2.71	1.93	3.64	2.52	.413
Male Perceptions	-.85	.40	.73	.44	.133
Female Perceptions	-.64	.41	.53	.34	.053

RQ5: How does embedding science standards within the mathematics curriculum affect students' perceptions of self-efficacy in the area of mathematics?

An independent-samples t-test was conducted to test the null hypothesis that there would be no difference in perceptions of math efficacy of students who were taught math using the traditional methods and those who were taught math with science standards embedded in the mathematics curriculum. The analysis revealed a statistically significant difference in the perceptions of math efficacy, $t(83) = 15.49$, $p < .001$, $\text{Eta}^2 = .74$. The average growth in perceptions of math efficacy of students taught using traditional methods, ($M = -.75$, $SD = .41$) was less than the average growth in perceptions of math efficacy of students taught with the science standards embedded method ($M = .58$, $SD = .38$). The 95 % confidence interval for the difference in means ranges from 1.50 to 1.16. The use of Eta^2 revealed a large effect size. The Eta square index indicated

that 74% of the variance of the average growth in perceptions of math efficacy of students was accounted for by type of math instruction, i.e., whether it was traditional math instruction or not. The results indicated that on the average, students taught in the traditional method had less average growth in perceptions of math efficacy than students taught using science (standards) embedded math. The null hypothesis that there would be no difference in average growth in perceptions of math efficacy of students based on type of math instruction was rejected. The statistical means of average growth in perceptions of math efficacy and the standard deviations of the participants are presented in Table 15.

Table 15

Means and Standard Deviations of Average Growth in Perceptions of Math Efficacy

Math Instruction Type	<i>M</i>	<i>SD</i>	<i>n</i>
Science Embedded	.58	.38	49
Traditional	-.75	.41	36

Perception of mathematics. Initial survey results showed that approximately 64% of the 124 participants disliked math and science; 65% from the comparative group and 62% from the experiential group. The data also illustrated that more females than males felt less prepared to be in a math or science classroom.

Upon completion of the correlated units, students in the experiential group increased to 90% liking math and science, with 80% of them being females compared to the initial 56%. It was also noted that participants within the comparative group tended to respond differently from pre-survey to post-survey, many lowering their ratings on multiple statements,

and moving from enjoying math and science to an attitude of disliking both content areas. When the researcher spoke with some of the participants in the comparative group, participants mentioned disliking worksheets and wanting to be able to work on more of the activities that their peers were doing in class; referencing students from the experiential group. This caused a decline in a few of the statements between pre and post-survey. The biggest shifts occurred between “math and science lessons are difficult for me” -statement 1, “math and science are fun, interesting subjects” -statement 4, and “math lessons give me anxiety” -statement 5. On the pre-survey, 28% of the comparative group agreed with statement 1, 65% agreed with statement 4, and 30% agreed with statement 5. On the post-survey, 60% of the comparative group agreed with statement 1, 25% with statement 4, and 70% with statement 5.

Statement ten on the survey asked participants whether they would be happy if they could go to school and not take a math or science class. On the pre-survey, only 40% of the comparative group and 34% of the experiential group said that they would be happy or indifferent if they did not have to take math or science. On the post-survey, however, 65% of the comparative group noted that they would be happy not to take a math or science class, whereas only 20% of the experiential group agreed.

Academic performance: Pre and posttest. The purpose of this study was to determine whether embedding science standards within the mathematics curriculum would lead to an increase in mathematics achievement on standardized tests. To begin examining this hypothesis, a pre and posttest were created which were identical to one another. The pretest was administered prior to beginning any lessons with the two groups of participants.

The pretest was analyzed and scored as if it were a real state test, with 35% being the state's designation of Approaches Grade Level. Looking at the data for the two groups, it was noted that 51.5% of the comparative group was successful and 43% of the experiential group was successful on the pretest. Within the comparative group, 46% of those passing were females, compared to the 45% of females in the experiential group who passed. Within the experiential group, many of the male participants skipped questions that they did not know, whereas the female participants attempted to respond. On average, male participants within the experiential group skipped at least five questions, with seven of the 19 males skipping more than half of the questions on the pretest. The female participants, on the other hand, attempted to answer every question on the pretest whether they knew what the question was asking or not. Only five of the 38 female participants in the experiential group skipped any questions at all, averaging only three skipped questions. This led to several male participants achieving a 0% on the pretest and their female counterparts earning more, positive points.

When participants were asked to complete the posttest, fewer participants skipped questions, which resulted in more positive scores. The posttest data showed that, upon completing the correlated lessons, 48% of the participants in the comparative group passed the posttest; 29% of the females and 57% of the males. This was a decline from the pretest. In the experiential group, 52% of the participants passed the posttest; 54% of the females and 43% of the males. Again, the results were not statistically significant to show that mathematics instruction embedded with science standards increases achievement on mathematics standardized tests. However, the results do indicate that, upon exposure to a prolonged study of similar characteristics, achievement gains on standardized mathematics tests could be tied to correlated instruction.

Portions of the data for the posttest, in regards to the comparative group, are a little skewed. Throughout the course of the study, the researcher had five participants move schools from the experimental group, three participants move schools from the control group, five participants from the control group not complete the posttest, and 14 new students transfer in but not get added to the study. The five participants who did not complete a posttest began the test but never finished; it was graded “as is.” Due to the large number of students that transferred in to the classroom later in the study, participant data was not included in the overall tabulations for the study. When a potential participant newly enrolled, and a unit was underway, consent letters were not sent home to include the student data within the study. Those students who transferred to other classrooms, or left and then later returned, resulted in unused data as well.

Lessons. Each of the three correlated lessons was designed with cooperative, hands-on learning as a focus. The researcher used data from the 2016–2017 STAAR mathematics test to determine which TEKS to highlight, and then embedded science standards into the lessons which would build upon those mathematics TEKS.

Of the three lessons which were completed, the Lego City unit (lesson 1) and the algebra and coding unit (lesson 3) were the two with the best data overall. The airplane lab unit (lesson 2) did not provide data that was as supportive to correlated lessons as the researcher had hoped. Those participants who did not have an established role within their assigned groups for the airplane lab unit performed lower from pretest to posttest than did those who had a more active role within the group. Participants who were involved in calculating measurements, flying the airplanes, determining speed and velocity, and writing ratios and rates were exploring deeper aspects of the mathematics and science standards than those who were simply copying the

information from their partners. The Lego City lesson provided participants with an opportunity to build a city using Legos, record the construction process using stop-motion animation, program and drive a robot, and learn about area, perimeter, volume and spreadsheets. All members of the teams were actively engaged at all times; therefore, everyone was involved in the learning process. Within the experiential group, the researcher noted a 35% growth rate from pre to posttest; females had an 8% gain over their male counterparts.

With the algebra and coding unit, all team members were actively engaged, from constructing a structure which would support three books to completing independent coding lessons. Participants had to work together to formulate algebraic equations to represent supplies used in their construction process, complete charts and tables, and record mass. Since everyone had a part to play at all times, learning was always taking place. Within the experiential group, the researcher saw 37% growth from pre to posttest, with females improving nearly 40% and males improving roughly 34%.

Mock STAAR data. Going into the Mock STAAR test, the researcher knew that sixth graders the year previously collectively scored 42% passing. The researcher also knew that the current group of sixth graders averaged two to fifteen missed questions on their Mock STAAR as fifth graders. This provided a rough baseline to go by when examining the data for this year, 2017–2018.

As a group, 58% of the researcher's students passed the mathematics Mock STAAR; up 16% from the year prior. This was roughly 25% higher than the other two teachers at the campus level and only 4% behind the district.

Looking at how the participants performed based upon their designated research groups, 61% of those assigned to the control group improved from 5th grade and 72% of those in the

experiential group improved. Of those participants in the comparative group, 59% of the females experienced growth and 67% of the males experienced growth. In regards to those in the experiential group, 70% of the females improved from 5th grade to 6th grade and 85% of the males improved.

Summary

Through the implementation of correlated instruction, teaching mathematics enriched with science, mathematical understanding and student performance improve. Along with improvements noted in mathematical understanding and student performance as related to mathematical assessments, student perception of mathematics and their mathematical abilities tends to be altered as well. Data collected and analyzed has demonstrated that, although some growth is less significant than that experienced by others, the majority of students who are exposed to lessons in a correlated manner experience growth academically. What is more statistically significant, however, is that students' self-efficacy as it relates to mathematics positively improves upon receiving lessons embedded with science standards.

Chapter 5: Discussion and Conclusion

Everyone Can Achieve Independent School District, specifically the campus in question, was chosen because of the decline in STAAR scores over the past couple of years in mathematics. Since 2014, scores on standardized tests have been dropping across the district, specifically in sixth grade math at the selected campus. With the decrease in scores, it was evident that a change in how the mathematics TEKS are presented was needed. This research study set out to determine whether embedding science standards within the mathematics curriculum, or correlated instruction, would lead to the improved test scores the district would like to once again see.

Summary of the Results

Perception of Mathematics Prior to the Study

Prior to the start of the study, 64% of the participants disliked math and science; 65% of the control group and 62% of the experiential group. By the end of the study, 90% of the participants in the experiential group said that they liked math and science, with 80% of them being females compared to the initial 56%. The participants within the comparative group tended to respond differently from pre to post-survey, often lowering their responses significantly.

Looking solely at the experimental group, and the nearly 30% shift in the number of females who said they enjoyed math and science upon the completion of the study, it would appear that correlated lessons assisted in shifting those mindsets. Students who were placed into the experiential group were more actively engaged in small group activities in which hands-on learning was a daily expectation. Students were given multiple opportunities to manipulate both

mathematical and scientific instruments in order to build their understanding of the concepts being learned. Through their explorations and discussions with one another, they were able to strengthen their knowledge of measurement and geometry as well as those science standards which were being implemented.

Students within the comparative group, on the other hand, tended to change their feelings regarding their enjoyment of mathematics and science simply because they regarded much of the class time as boring. On the pre-survey, 65% of the participants within the comparative group agreed that “math and science are fun, interesting subjects,” whereas on the posttest that percentage decreased. Through daily observations conducted by the researcher of the student participants, it was often noted that a student participant would complain that another class was able to work on a “fun activity” and the other student had to finish a “boring worksheet.” Typically, it was the same student or two who would complain about not being able to participate in the paper airplane lab; the same one or two students that would elect to not complete parts of surveys and tests because they “just did not want to” that day. The pre-survey data demonstrated that females entered middle school with lower self-images related to mathematics and science capability.

Pre and Posttest Comparisons

Participants were also given a pretest at the start of the study and the same test as a post-test upon completion of the study. When the data was analyzed, it was observed that 51.5% of the comparative group and 43% of the experiential group was successful on the pretest. The experiential group and the comparative group scored similarly on the pretest in regards to the percentage of the population that achieved the passing rate of 35% (Approaches Grade Level), with the comparative group being slightly higher at an 8.5% difference.

Upon completing the posttest, only 43% of the comparative group passed; 29% were female and 57% were male. In the experiential group, 48.5% of the participants passed; 54% were females and 43% were males. This was the second time that the participants had been given these questions, with the first time being the pretest. Between the administration of the pretest and this posttest, correlated lessons had been taught but these questions had not been presented to either group in any way. To be able to examine the posttest results and see that the experiential group participants went from 43% passing on the pretest to 48.5% passing on the posttest helped to confirm that correlating mathematics and science, teaching math and science together in such a way that an outside observer cannot conclude which content area is supposed to be being taught, really does improve mathematical understanding and achievement. Not only does correlated instruction improve overall mathematical achievement, based on this study's results, it also has an impact on the learning and attitude of female students.

Lessons

As participants initially got ready for the very first unit, there was some hesitation among the participants. As the researcher made observations and listened to the students make comments regarding the pretest and what they were going to be learning about, it was clear that many of the participants disliked mathematics and really did not want to do anything related to math. Prior to beginning the lesson, participants discussed how measurement was difficult for them and how they did not understand the concept of a coordinate grid. The researcher noted that, through conversations with their peers, participants expressed their confusion when it came to distinguishing between the x-axis and y-axis and which one came first when plotting points on the coordinate grid. As the lesson progressed, and participants were introduced to more of the pieces of the activity, their attitudes began to change. Participants, through the visual of the

floor-sized coordinate grid, began to comprehend the differences between the two axes. Participants, being able to walk about on the floor-size grid, were able to visualize the movement along the x and the y-axis. The researcher started to notice that participants were enjoying building with the Legos, being able to make a short movie using stop-motion animation, and they were excited to talk about what they were doing. More participants volunteered to step in front of the classroom to demonstrate a problem or to find a solution, or drive Sphero, than on a normal day. This first correlated unit provided a much-needed shift in student attitudes across the board.

The difference noted between the growth rates of the two groups, for the Lego City unit, can be attributed to the fact that some participants were absent when the pretest was administered or they were assigned to another placement within the district (i.e., alternative school). When students were absent on the day the pretest was administered, oftentimes the pretest was not given upon their return to school. In many instances, absences for students stretched out over multiple days and pausing the lesson for the student to complete the pretest did not seem feasible at the time. It made more sense to have the participant complete the lesson, as much of it as possible given the absences, and then complete the posttest with the rest of the group when it was administered. When this was the case, data for absent students was removed.

Lesson two, the airplane lab, was not deemed as successful by the researcher in part because not much learning happened on the part of each participant. Within the teams, there were instances in which participants did not all have roles assigned to them; larger classes, for example, meant larger teams which made assigning roles difficult. When not every participant had a role, such as time keeper or measurer, there were more opportunities for off-task behaviors to occur. In some situations, participants had to be removed from the activity for the day. In

other cases, team members lost digital files or neglected to complete data from the previous day, which led to teams having to extend their lab time so as to collect the necessary data. Although 92% of the participants within the experiential group were successful on the posttest, an increase of 27.5% from the pretest, participants in the comparative group performed better with 93% passing. This data showed that not only was measurement a weakness, but algebraic understanding was as well.

Post-Survey: Perceptions of Mathematics at the End of the Study

Participants in both groups also completed a post-survey, responding to the same ten statements given at the beginning of the study. The biggest changes noted within the post-survey results were that more female students began to think of math and science as “fun and interesting subjects;” approximately 80% of girls in the experiential group agreed whereas only 56% of the same girls agreed on the initial survey. The other noticeable change was that, in both groups, the number of participants who felt members of the opposite sex are better at math and science than they are declined.

The sixth-grade participants, particularly the females, entered into the study with the mindset that mathematics caused anxiety and was not necessarily a fun or enjoyable subject area. According to the pre-survey responses, approximately 45% of the participants within the comparative group felt as though math was not fun or interesting; roughly 36% of the participants within the experiential group also responded that math was not fun. After completing the study, participants within the comparative group shifted their responses. Comparative group participants responded to the same statement as such: 50% agreed that math and science are fun, interesting subjects; 30% disagreed; and 20% remained neutral. Within the experimental group, however, 80% of the participants responded by stating that math and science

are fun, interesting subjects; 18% disagreed; and 2% did not respond to the statement. This shift in attitude, for both groups of participants, could be indicative of the presence, or lack thereof, of correlated instruction. Participants who experienced hands-on, fully correlated lessons altered their perceptions of mathematics and science and began to see the content areas as both fun and interesting. Those who were only exposed to paper-pencil activities went from enjoying math and science to beginning to dislike the subjects.

Teacher Interviews

As part of the study, teacher interviews were conducted in order to determine the mathematical readiness of students and the teachers' understanding of correlated instruction (see Appendix G). Three teachers were interviewed: Teacher A, who teaches 6th grade mathematics; Teacher H, who is the special education co-teacher for 6th grade; and Teacher W, who assisted with creating and running some of the correlated lessons within the study.

When asked how mathematically ready students are for 6th grade, all three teachers agreed that the majority of the students are not functioning at grade level. Teacher H mentioned that students "develop at different rates" and that by the end of 5th grade, most still have not mastered the necessary skills (see Appendix H). Teacher W recognized that a disconnect exists, although it is unknown as to where that disconnect occurs; "students are missing key pieces of information somewhere before entering middle school" (see Appendix I). Teacher H estimated that the average grade level equivalency of the students he services is 4.9 (see Appendix J).

Initial analysis of the interview responses showed that Teacher A felt his students were not engaged in typical, daily lessons; students were described as anxious about math. Teacher H and Teacher W both noted that students appear to be engaged in lessons that they are a part of. Teacher H even mentioned that students seem to be captivated by how well Teacher H and the

researcher work together to present lessons to students.

Each teacher can agree that the typical sixth grader is functioning at a mathematical grade level equal to anywhere from 3.5 to 4.9; obviously well below grade level. This makes it, in the opinion of those responding teachers, difficult to keep students engaged in daily lessons because they do not always have the foundation needed to understand what the lesson is talking about.

When it came to describing correlated instruction and what it looks like in the classroom, only Teacher W had a working knowledge. Both Teacher A and Teacher H believed that correlated instruction had to do with tying everything together so that the standards begin taught matched what was on the test. There was no mention of integrating science and mathematics by either Teacher A or Teacher H until the researcher asked specifically about embedding science standards into the mathematics curriculum. Teacher W, on the other hand, mentioned that at least two content areas are tied together and that it should be difficult to determine which content area is supposed to be the focus of the lesson. Teacher W discussed how both content areas are equally valuable to the lesson and therefore both are emphasized.

While all three teachers shared important information during their interviews, Teacher W's responses to where a teacher should begin when embedding science TEKS into the mathematics curriculum was what helped to tie all aspects of the study together. Teacher W stated that, when looking at embedding science TEKS into the mathematics curriculum, the teacher must first make sure that the lesson is relevant and meaningful for the students. It is not enough to create a fun, energized lesson focused on calculating the volume of a prism. The lesson must have meaning for the students; students need to know why it is important for their future. When a correlated lesson is designed, or any lesson, the teacher needs to understand why it is important for the students' future knowledge.

Mock STAAR Test

A Mock STAAR test, covering every mathematics TEK taught in sixth grade, was administered at the beginning of March. This test is a district-wide test which is given in order to assess where students are in terms of being ready for the state assessment in May. When comparing the results to last year's results (researcher's former sixth graders), current test results were 16% higher; 58% of the students passed the Mock STAAR as opposed to 42% last year. When examining assigned research groups, those in the experiential group grew more from one year to the next. Looking at the participants' scores as 5th graders, 72% of the participants in the experiential group showed growth; 85% were boys and 70% were girls.

While many of the participants may not have necessarily passed their Mock STAAR test, it is important to note that growth was observed. For several participants who missed passing in 5th grade by more than five questions, growth has now brought them within one to two questions of passing. Those participants who experienced the most growth, the greatest movement towards passing, came from the experiential group. This supports the hypothesis that there will be a positive gain in mathematics achievement on standardized tests when science standards are embedded within the mathematics curriculum.

Summary

Data collected and analyzed related to pre-surveys and post-surveys illustrate that students enter middle school with somewhat negative feelings towards mathematics and science and their abilities to perform mathematical tasks. When students are not provided opportunities to explore mathematics as it relates to science and in a hands-on manner, those negative feelings tend to increase with time; this was demonstrated in the responses to the post-survey given by those participants of the control group. Participants in the comparative group were only exposed

to paper-pencil activities, with minimal small group interaction, and went from enjoying mathematics and science on the pre-survey to disliking it on the post-survey; 65% on the pre-survey enjoyed the two subjects to 50% on the post-survey. As students are exposed to instructional practices that encourage correlation of content areas and are given opportunities to engage in conversations about mathematics, more positive feelings regarding mathematics emerge. Engagement and learning increase as students are exposed to cooperative learning techniques. “Cooperative learning can significantly enhance mathematics learning in the classroom . . .” (Slavin, 2010, para. 5).

Discussion of the Results

Each piece of data gathered and analyzed leads to the conclusion that embedding science standards within the mathematics curriculum does improve mathematics performance on standardized tests. Not only does performance on tests improve, but correlated instruction appears to positively strengthen students’ feelings about mathematics and how well they perform mathematical tasks.

Before taking part in any correlated lessons, participants mentioned disliking mathematics and science, as well as believing that members of the opposite sex often were better at math than they were. By the time the study was finished, those who were in the experiential group agreed at a higher rate to enjoying math and science. Participants in the experiential group also began to feel as though they performed equally as well as their peers on mathematical tasks.

The researcher did note that participants within the comparative group, by the end of the study, were more likely to agree that they would be happy if they did not have to take a math or science class in school. At the onset of the study, most participants across groups seemed to be indifferent or prefer to take a math or science class as a part of the standard curriculum. After

having sat through weeks of lessons in which participants were given worksheet after worksheet and paper-pencil activity after paper-pencil activity to complete, participants in the comparative group did not want to take another math or science class. When given statement number ten to rate on the Likert scale, the majority of the participants agreed that they would be happy to not have to take another math or science class; 75%.

Discussion of Results in Relation to Literature

Students enter the classroom at varying cognitive levels and progress through each stage of development at different rates. In order to design effective lessons that meet the different developmental stages of the students, educators face a number of challenges. “One of the important challenges in mathematics teaching is to help students make connections between the mathematics concepts and the activity” (Ojose, 2008, p. 28). Reflecting on responses from Teachers A and H, this is especially true when your students are well below grade level. When thinking about the participants in the experiential group, about 48% of them were functioning at a mathematical grade level of between 2.3 and 6.5 prior to the start of the study. Standardized tests are written at the grade level for which the test is meant, yet the participants are already labeled at a disadvantage. Using what Ojose (2008) stated, it was necessary to develop lessons that were not only correlated but that participants could relate to and see value in.

Due to the thought process which went in to creating each lesson, the researcher was able to ensure that authentic contexts existed. “Constructivist theories . . . suggest a major shift from learning science and mathematics as an accumulation of rote facts and procedures to learning science and mathematics in authentic contexts-as socially negotiated constructions and explanations used to make sense of the world” (Frykholm & Glasson, 2005, p. 128). This opened up the door for small groups, social interactions, cooperative learning, and hands-on

exploration.

It was the aim of the researcher to show that, when students are given the opportunity to communicate about mathematics and participate in hands-on, real-world lessons in which both mathematics and science are correlated, learning and retention of mathematics increases. Along with being better prepared for life, “reflective and critical thinking skills are developed as students make connections between school activities and their own life experiences” (Fraser, 2000, p. 29). With each lesson, as well as the pre and posttest data and the Mock STAAR data, it is evident that correlated instruction does lead to an increase in mathematics performance on standardized tests. While the comparative group participants did experience slight growth on their Mock STAAR, participants within the experiential group demonstrated the most growth from pretest to posttest for each lesson, as well as on the Mock STAAR. The survey data also showed that when students are only exposed to paper-pencil activities they tend to dislike the subject and find it boring.

With each correlated unit that was developed and implemented with the experiential group, the comparative group was administered a traditional lesson which involved worksheets and lessons from the district’s online platform, ALEKS. Regardless of the method utilized to present the material to the two groups of participants, the mathematics standards covered were the same throughout the course of the study and throughout each correlated unit.

As the units ended and posttests were administered, data was analyzed and examined for patterns. It was noted that, while the correlated units did have a positive impact on students’ academic performance, the participants within the comparative group seemed to perform slightly higher on the three posttests administered (one per correlated unit). Examining the participant data, it was noted that the number of participants changed from the initial start of

the study, and the data had to be recalculated. Due to several students transferring in to the researcher's classroom during the final weeks of the study, the total number of students assigned to the researcher grew. Transferring in so late in the study meant that Consent to Participate letters were not sent home and, therefore, permission to use individual student data for those 13 students was not requested. There was also a number of students that had been reassigned within the district; a couple students being assigned to the alternative school and a couple transferring to another campus. Eventually, these few students returned to the researcher's classroom but their data was not utilized within the final calculations due to the fact that the student was only present for the first unit and missed at least one entire unit. The researcher chose to not include those pieces of data if the participants were absent from the majority of the study.

Participants within the comparative group also had fewer students who were labeled as special education or 504. While the number of students under the special education umbrella, including 504, was small-approximately 12% of the participants-those students are functioning well below grade level compared to their same age peers.

Limitations

Several limitations impacted the study and were out of the control of the researcher. Limitations to the research study included: a total of 13 students transferred in to the researcher's classes throughout the last two weeks of the study, a total of eight students moved schools, five students in the comparative group neglected to finish the posttest, and only four seventh graders were given permission to participate in the study which led to the decision not to include seventh graders within the study.

Had the thirteen students who transferred in enrolled earlier, Consent to Participate letters would have been sent home with those students. Since there were only two weeks remaining in

the study, it was decided to exclude any of their potential data from the total population. Only those transfer students who enrolled during the onset of the study were included within the overall data collection process; this included approximately three participants, all of which were given Consent to Participate letters. One of the three withdrew three weeks upon enrollment, being sent to the alternative center for a month. Upon the participant's return, the student was only enrolled for two weeks before moving out of town; the data for this student was removed altogether from the study.

The eight students who moved schools had an effect on data to an extent. Two of the students left early enough in the study in that they had not completed much of the data pieces needed for the first correlated unit. Not much was needed in regards to eliminating their information from the representative data set in order to continue. The other six students moved mid-way through the second correlated unit. This meant that data had already been gathered and analyzed for the first correlated unit; pre and posttests scored and compared, percentages calculated, comparisons made. Once these participants moved, their information was removed from the data sets for both unit one and unit two and everything was recalculated for both units. This recalculation process added additional time on to the entire process needed to collect and analyze the data, which extended the time needed to implement and complete the final unit.

Had every participant within the comparative group finished their posttest, data results potentially may have been different. Those five participants may have increased the passing rate on the posttest enough to equal the passing rate of the other group. The participants that chose not to complete their posttests did so not because they did not understand the material, but because they claimed they just "did not want to do the work." Several of the participants have situations in which they are required specific accommodations every morning prior to attending

class. If these accommodations are not met, the participants rarely want to complete tasks. On the days in question, particularly the day of the posttest, accommodations were not met for some of the participants in question that morning before beginning their first period of the day. By the time they arrived at their mathematics class, they had shut down mentally and refused to work.

Another limitation was time. There were a couple of instances which hindered the research study, particularly the start date. A week into the start of the academic year, school was closed for a little over a week due to a hurricane. Due to the storm, the campus and the district lost instructional days that were not made up; students now had to work harder to prepare for the state assessment. Approximately three months later, the district missed another four days due to snow and ice. The total days missed, with the latest snow and ice days, was now 15 days. Had Mother Nature not decided to impact the area in such a way this year, the study could have incorporated a couple of more correlated lessons. The loss of instructional days, and therefore the delay in the start of the study, impacted not only the number of correlated units that were able to be completed but also the length of each correlated unit. It would have been ideal to have been able to run each correlated unit for at least a week and a half to two weeks, to really take the time to break down each topic being covered. Instead, time was rushed and the units were completed in approximately a week to 10 days; in some cases, close to two weeks were allotted.

While every student enrolled on the campus has an ALEKS account and has utilized it at least once, it appears as though not every student logs into the program and works regularly. As progress within ALEKS was verified, it was noted that only about half of the participants had been making any strides within the program, actually nearing their goal of 75% completion by this point of the academic year. Many participants have not been able to log in due to technical issues within the program itself, or due to misuse of their own chrome book. Several participants

have lost the use of a chrome book due to inappropriate searches on the Internet or repeatedly breaking the device. Such instances hinder performance within web-based programs.

The final limitation would be that the researcher was also the current mathematics teacher of every one of the sixth-grade participants. While there are three sixth grade math teachers on the campus, one of them teaches only the bilingual students (19 students) and one of them only teaches three classes of sixth grade math (50 students). The researcher teaches the remaining 166 students in the sixth grade. Both of the other teachers agreed to allow the researcher to use their overall data as a comparison piece, but they did not want to teach correlated lessons within their classes or alter their teaching in any way. They also felt that, if they sent letters home requesting permission to include their students' individual data in a research paper, the letters would not be returned due to lack of understanding.

While it is understandable that it is difficult to truly compare the two groups in relation to the Mock STAAR, the researcher's former sixth graders compared to the current sixth graders, it is important to use that comparison in regards to the understanding of whether or not correlated instruction assists in improving mathematical achievement. With the former group of sixth graders, the researcher did not delve as deeply into correlated instruction; only teaching two major units that were correlated at the beginning of the year. With the current group of sixth graders, a longer amount of time was spent teaching correlated units to the participants. Time and energy was put into developing lessons that highlighted mathematics, science, and some aspects of technology when feasible. Being able to incorporate these strengthened lessons into the curriculum and having the tools necessary to do so this year, has aided the researcher in being able to push the participants further with their knowledge and understanding. Each of these additional factors is what has led to the significant growth that has been seen from one year to

the next with the students. Each test that they complete, whether a teacher-made test, a district test, a screener to assess their mathematical grade level equivalency, or a test on ALEKS, shows growth.

Delimitations

Due to time constraints, the number of correlated units was cut back. Initially, it was planned to administer at least five correlated units over a period of a few months. Since there were some weather-related delays at the beginning of the academic year, the hurricane that shut down the district for a week and then the snow and ice days three months later, the study did not get started on time. As a whole, the district lost 15 days of instruction that the state of Texas is not forcing the district to make up. While it might appear to be a good thing that students and teachers do not have to give up holidays or stay in school for a portion of the summer, days are still lost and there is still a test to prepare for.

The study was initially going to begin in early September, immediately after Labor Day. Upon returning from the hurricane and getting students reacclimated to school, it was approximately the first of October before the study began. Once the calendars were established for the study, it was quickly noted that there would not be enough time to implement all five correlated lessons as originally planned, at the length that they were written. By the time the first unit was underway, the second round of bad weather struck our area and we lost the remainder of our days which totaled the 15.

Along with limiting the correlated lessons to only three big units, the participants were also limited. Initially, the researcher was going to include both the current sixth graders and the current seventh graders in the study. Seventh graders were not included within the study, because only four returned Consent to Participate letters granting permission. While those four

students could have been followed, it would not have given the researcher enough data in regards to seventh graders and how correlated lessons affect their mathematical achievement so they were not included.

Implication of the Results for Practice

Furner and Kumar (2007) have examined some of the reasons as to why students in k-12 across America struggle with mathematics and science and have discovered a need to reform education in these areas. “Efforts should be taken now to direct the presentation of science and mathematics lessons away from the traditional methods to a more student-centered approach” (Furner & Kumar, 2007, p. 1). It is essential that mathematics and science are taught in every classroom, however it is critical that teachers learn how to make the content meaningful and engaging for students. “In a test-driven curriculum where students and teachers are evaluated on student performance based on reading and mathematics standardized test scores, teaching meaningful science remains a challenge” (Furner & Kumar, 2007, p. 1).

What this means for mathematics and science teachers is stepping away from what is familiar and moving towards what is slightly unfamiliar. Familiarity lies in the traditional approach: warm-ups, guided lessons, homework, practice. The unfamiliar resembles the correlated approach: embedding science within math so that students cannot distinguish between the two. Both contents are taught simultaneously, focusing on those standards which complement one another.

In sixth grade mathematics, a correlated lesson might involve calculating area, perimeter, and volume of rectangles and parallelograms while covering mass and density in science. Educators can create meaningful lessons for students by focusing on real-world examples associated with cell phones and the best type of waterproof case or having students design their

ideal classroom.

Recommendation for Further Research

Although the data collected does show that embedding science standards within the mathematics curriculum improves mathematics achievement on standardized tests, more research is suggested. It is recommended that further research is conducted in which additional lessons are utilized. Rather than using only three correlated lessons, the recommendation would be to use six. This would mean, then, that the time frame for the study would have to be expanded. Expanding the time frame for the study would also allow more data to be collected to determine if the emergence of score increases noted within this study continue to emerge in other studies. Over the period of a few months, test scores within the experiential group increased. By expanding upon the time frame for the study and prolonging the course of the study, it would be hoped that an even higher increase in achievement would be noted.

It is also recommended that science become the focus of a similar study. While science is not tested at the state level for sixth graders in Texas, it is at 5th and 8th. Based on the data gathered here, as well as by previous researchers, correlated instruction leads to improved mathematics scores. What about science scores? For educators of science, who teach a grade level that is subjected to a state test, will scores improve if math standards are embedded within the science curriculum? We already know that they naturally go together, the next logical step, it seems, would be to determine whether math can help increase science scores.

It is also a recommendation that students' attitude and perception regarding mathematics, and the role that perception plays on achievement in mathematics, is specifically looked at. While this study included students' perceptions regarding mathematics and mathematical abilities, this study focused more on the relationship between correlated instruction and how such

instructional practices impact student achievement. Having examined the pre- and post-surveys administered within this study, and noting that participants who were exposed to correlated lessons went from 62% of the participants enjoying math and science to 80% of participants enjoying math and science leaves a lot to question. Conducting a study to determine student perceptions of mathematics, what causes these perceptions, and how these perceptions influence academic performance would be beneficial to the academic community.

Conclusion

Through the process of embedding science into the mathematics curriculum, students' comprehension of the mathematics TEKS was expanded. While students may not have necessarily mastered the content, that is, reached 80% or higher, success was achieved at some level. Although gender did not impact self-efficacy regarding mathematics, embedding science TEKS within the mathematics curriculum did. Being female or male had no significant part in how participants responded to survey questions, nor did it affect achievement on standardized tests according to this study. What was impacted, however, was the positive change in self-efficacy regarding mathematics overall when science is embedded within the mathematics curriculum. Throughout the learning process, participants developed an enjoyment of mathematics and science and began to visualize themselves completing mathematical tasks. By creating lessons that were engaging, that allowed for cooperative learning, that provided hands-on investigations, and that also opened the channels of communication regarding mathematics, the researcher ignited a flame in the participants that they did not know existed.

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Appendix A: Standardized Test Data

March 2016 STAAR Mathematics, Grade 5 Results

Results for Participants Enrolled in Sixth Grade During 2017–2018

School	Total Students	Raw Score	Scale Score	Percent Score	Approaches Grade Level (%)	Meets Grade Level (%)	Masters Grade Level (%)	Date Taken
Identified Campus	226	25.08	1514.13	50.16	53.54	15.93	3.1	3/1/16
Sister School 1	408	30.31	1578.53	60.62	71.57	32.35	11.52	3/1/16
Sister School 2	198	24.87	1514.26	49.74	53.03	20.71	6.57	3/1/16

Appendix B: Student Survey

Short Statements for Assessing Perceptions of Mathematics and Science

Respond to each of the following statements using the provided scale of 1–5. A response of 1 indicates that you “definitely disagree;” a response of 2 indicates that you “somewhat disagree;” a response of 3 indicates that you “are neutral;” a response of 4 indicates that you “somewhat agree;” and a response of 5 indicates that you “definitely agree.”

1. Mathematics and science lessons are difficult for me.

1	2	3	4	5
----------	----------	----------	----------	----------

2. Equations, expressions, and numbers in general seem confusing.

1	2	3	4	5
----------	----------	----------	----------	----------

3. Topics like weathering, erosion, force, and motion are difficult to understand.

1	2	3	4	5
----------	----------	----------	----------	----------

4. Mathematics and science are fun, interesting subjects.

1	2	3	4	5
----------	----------	----------	----------	----------

5. Mathematics lessons give me anxiety.

1	2	3	4	5
----------	----------	----------	----------	----------

6. Science lessons give me anxiety.

1	2	3	4	5
----------	----------	----------	----------	----------

7. I enjoy learning about geometry and measurement.

1	2	3	4	5
----------	----------	----------	----------	----------

8. I believe that other students always perform better than me when it comes to math.

1	2	3	4	5
----------	----------	----------	----------	----------

9. In general, I believe girls are the best at mathematics and science.

1	2	3	4	5
----------	----------	----------	----------	----------

10. In general, I believe boys are the best at mathematics and science.

1	2	3	4	5
----------	----------	----------	----------	----------

11. If I could go to school and not take mathematics or science, I would be happy.

1	2	3	4	5
----------	----------	----------	----------	----------

Appendix C: Pretest/Posttest

Mathematics and Science Assessment

The rectangle below represents the base of a rectangular prism. Use the ruler provided to measure the dimensions of the rectangle to the nearest centimeter.



The height of the rectangular prism is 12 centimeters. What is the volume of the rectangular prism?

- A** 32 cm³
- B** 20 cm³
- C** 360 cm³
- D** 240 cm³

Mrs. Torres is mailing a package that weighs 12.5 pounds. The post office charges by the ounce to mail a package. How much does the package weigh in ounces?

- A** 187 ounces
- B** 200 ounces
- C** 192.5 ounces
- D** 100 ounces

The table below shows the relationship between the perimeter and area of four squares.

Squares

Area, A (square units)	Perimeter, P (units)
1	4
4	8
9	12
16	16

Which equation can be used to find A , the area of a square that has a perimeter of P units?

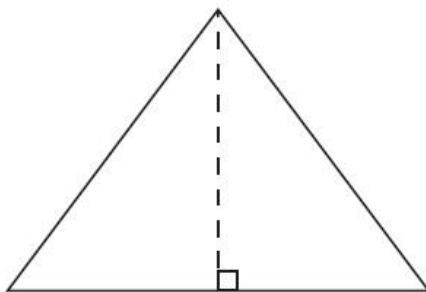
F $A = (P \div 4) \times (P \div 4)$

G $A = (P - 4)$

H $A = (P + 4) \times (P + 4)$

J $A = P$

Ms. Chen will paint a triangular tile. A drawing of the tile is shown. Use the ruler provided to measure the dimensions of the tile to the nearest centimeter.



Which measurement is closest to the area of the tile in square centimeters?

F 12 cm^2

G 24 cm^2

H 15 cm^2

J 30 cm^2

Xavier has a group of rectangular prisms. Each rectangular prism has a volume of 128 cubic centimeters and a height of 2 centimeters. The table shows the relationship between each prism's length, l , and width, w .

Rectangular Prisms

Width, w (centimeters)	Length, l (centimeters)
1	64
2	32
4	16
8	8

Which equation can Xavier use to find the length, l , in centimeters of a prism that has a width of w centimeters?

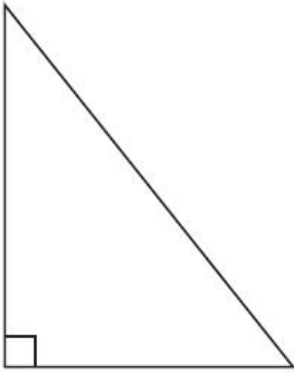
A $\frac{128}{2} = l + w$

B $2 \times 128 = l \times w$

C $\frac{128}{2} = l \times w$

D $2 + 128 = l \times w$

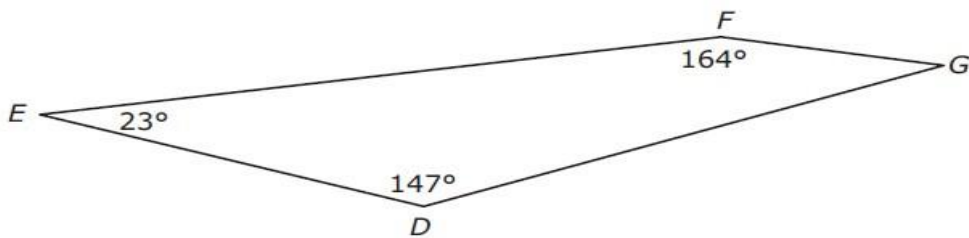
Use the ruler provided to measure the two figures below to the nearest centimeter.



Which of the following is closest to the combined areas of these figures in square centimeters?

- F** 31 cm^2
- G** 55 cm^2
- H** 37 cm^2
- J** 47 cm^2

What is the measure of $\angle G$ in the polygon below?



- A** 16°
- B** 23°
- C** 33°
- D** 26°

A farmer has a bale of hay with a mass of 36 kilograms. How many milligrams of hay are in the bale?

- F** 36,000,000 mg
- G** 36,000 mg
- H** 3,600,000 mg
- J** 360,000 mg

Which list best describes a landslide?

A

- Can occur after heavy rain
- Can take less than 1 minute to occur
- Causes lava to flow
- Increases the temperature of nearby land
- Causes ocean waves to increase in size

C

- Causes nearby air to move fast
- Increases the temperature of the air
- Causes rivers to flow faster
- Produces cracks in the ground
- Usually caused by volcanoes on the ocean floor

B

- Causes large amounts of soil to move at once
- Usually happens rapidly
- Can be caused by earthquakes or volcanoes
- Can change the direction of creeks and streams

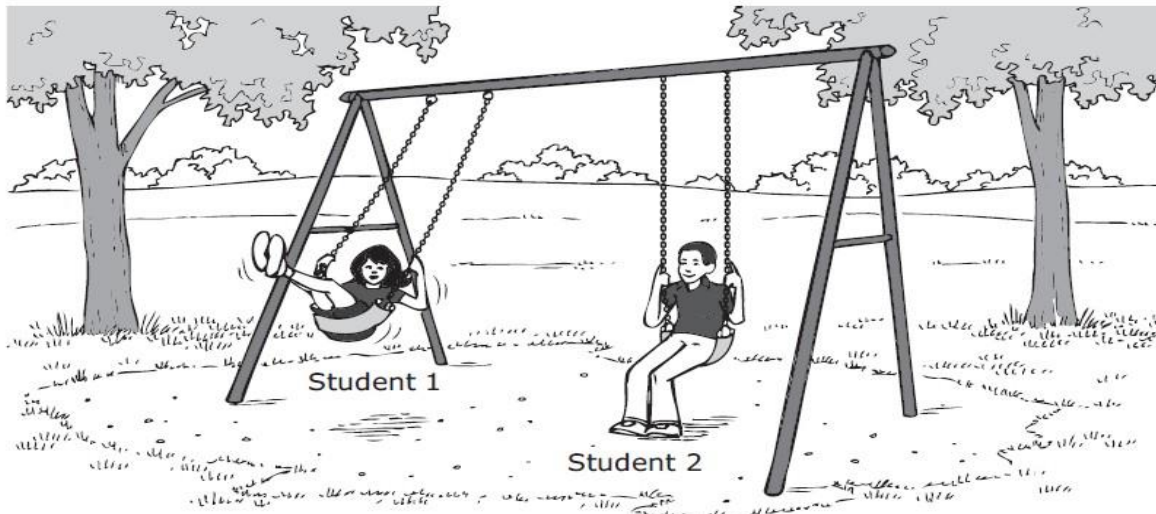
D

- Can cause tornadoes to form
- Removes soil from hillsides
- Occurs near volcanic eruptions
- Changes the shape of rivers

Erosion is one of the processes involved in the formation of sedimentary rock. Which of these best describes the process of erosion?

- F** Rocks are broken into smaller pieces that remain in the same location.
- G** Pressure compacts layers of sediment and turns them into rock.
- H** Pieces of rock or soil are carried from one place to another.
- J** Sediment grains fall to the bottom of a lake to form sedimentary layers.

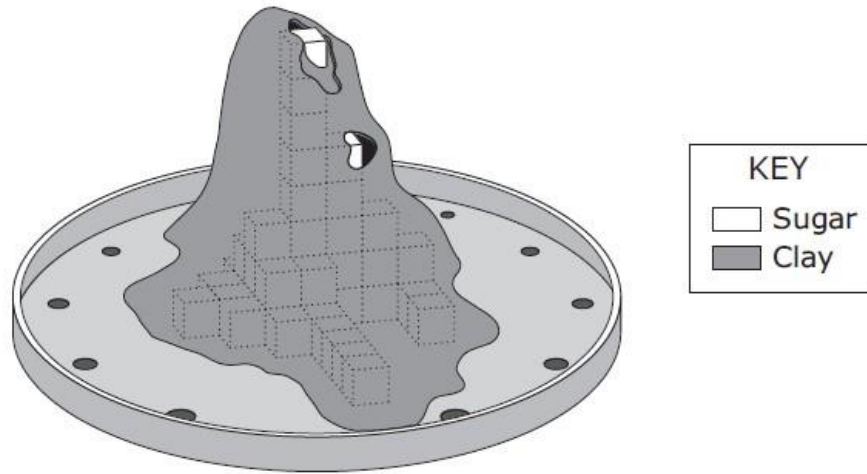
Two students are playing on a swing set. Student 1 is leaning back and extending her legs as she moves upward. Student 2 is sitting on the swing with his feet on the ground.



Which statement describes how position and work are related in this picture?

- A** Both students are doing work even if only one student is changing position.
- B** Student 1 is changing position because work is being done on the swing.
- C** Work done by Earth's gravity prevents Student 2 from changing position.
- D** Work is being done on both students by the swings because one swing is changing position.

Students constructed this model of a hill by covering sugar cubes with clay. The students placed the model in a large pan and poured hot water over it every day for a week.



What does the model best represent?

- A** A method for removing fossil fuels from hills
- B** The formation of caves in hills
- C** The formation of plains
- D** A method for separating minerals

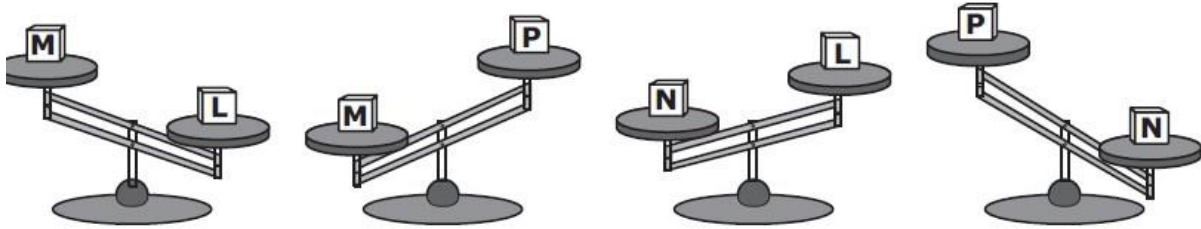
A student puts four objects in a bucket filled with water. The objects are listed below.

- Plastic ball
- Glass marble
- Metal paper clip
- Wood block

Which two objects are most likely less dense than the water?

- F** Wood block and metal paper clip
- G** Plastic ball and glass marble
- H** Metal paper clip and glass marble
- J** Wood block and plastic ball

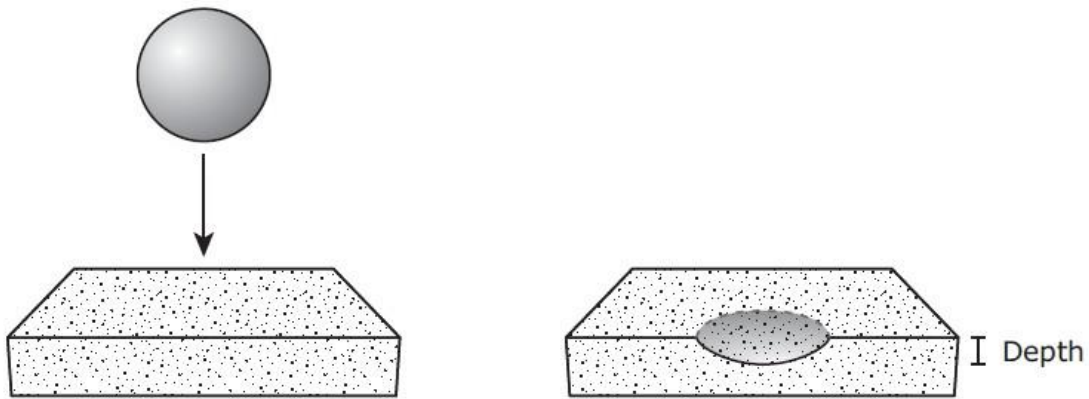
A student was asked to compare the masses of four blocks that were all the same size but made of different materials. The student used a balance to compare the masses of two blocks at a time. The student repeated this process three more times with different pairs of blocks and recorded observations.



Which list shows the blocks in order from least to greatest mass?

- F** Blocks N, M, L, P
- G** Blocks P, M, L, N
- H** Blocks N, L, M, P
- J** Blocks P, L, M, N

Students drop the same heavy ball onto identical blocks of soft clay from different heights. For each height they measure the depth of the dent the ball makes in the clay.



Why is the depth of the dent different in each trial?

- A** The size of the ball changes.
- B** The material of the ball changes.
- C** The mass of the ball when it hits the clay changes.
- D** The force of the ball when it hits the clay changes.

Appendix D: Post Lesson Reflection

Short statements to assess participant response to lesson (sample)

Using the following scale, respond to each of the statements regarding today's lesson/activity.

1 = "Disliked the lesson;" 2 = "No new learning;" 3 = "Learned something new;" 4 = "Enjoyed the lesson."

1. The lesson today involved designing a paper airplane and calculating flight distances based on added weight. (example lesson reflection)

1	2	3	4
----------	----------	----------	----------

Explain why you chose the number you did.

2. Today's lesson tied to TEK 6.4H, converting measurements within systems.

1	2	3	4
----------	----------	----------	----------

Explain why you did or did not enjoy the lesson.

3. Today, you were able to fly paper airplanes, measure distances flown, add objects of varying weights to the planes, and make calculations.

1	2	3	4
----------	----------	----------	----------

Explain the reasoning for your response.

4. How would you suggest your teacher improve the lesson?

Appendix E: Consent Form

Participant Consent Form

Research Study Title: The Effects Embedding Science Standards Within the Mathematics Curriculum Has on Students' Perceptions of Mathematics and Mathematics Achievement

Principal Investigator: Christina Giles

Research Institution: Concordia University-Portland

Faculty Advisor: Dr. Neil Mathur

Purpose and what you will be doing:

The purpose of this survey is to determine whether the integration of mathematics and science will lead to improved mathematics scores on the STAAR test. In order to determine whether this is an accurate assumption, Mrs. Giles will be incorporating science TEKS into the mathematics curriculum for some of the 6th and 7th grade students. We expect approximately 150 student volunteers, as well as two to four teacher volunteers. No one will be paid to be in the study. We will begin enrollment on September 1, 2017 and end enrollment on September 8, 2017. To be in the study, you will participate in mathematics class as normal. Participants will be given a survey prior to beginning the study. The survey will ask participants to respond to questions about their feelings towards math and science. Participants will be given a pretest, which will consist of 15-20 questions that have been taken from released STAAR tests in the areas of mathematics and science. Participants will be divided into two different groups. The control group will be taught lessons that only focus on the mathematics TEKS for their grade level.

Participants will work through class discussions, worksheets, and lessons developed by Mrs. Giles. The experimental group will participate in lessons that tie mathematics and science together. Participants within the experimental group will participate in hands-on, interactive lessons that have been designed to resemble labs. Participants will work in small groups to investigate science and mathematical concepts. Participants in both groups will be given the same survey and a posttest upon completion of the study. Participants within the experimental group will also be asked to complete a reflection at the end of each lesson. These reflections will assist in understanding whether the lessons were effective in teaching the targeted objectives. Doing these things should not take any additional time, as they are included within the regular school day. Mrs. Giles will use this data, along with the results of STAAR tests for the current academic year and previous two years, to determine if integrating content areas improves mathematics scores.

Risks:

There are no risks to participating in this study other than providing your information. However, we will protect your information. Any personal information you provide will be coded so it cannot be linked to you. Any name or identifying information you give will be kept securely via electronic encryption or locked inside a filing cabinet in Mrs. Giles' classroom. When we or any of our investigators look at the data, none of the data will have your name or identifying information. We will only use a secret code to analyze the data. We will not identify you in any publication or report. Your information will be kept private at all times and then all study documents will be destroyed 3 years after we conclude this study.

Benefits:

Information you provide will help Mrs. Giles and Brazosport ISD determine whether integrating content areas can improve mathematics scores on the STAAR test. If such a benefit does exist, your data could help to develop more content rich programs for the students of Brazosport ISD. You could benefit this by understanding the ways in which you best learn mathematics and science. By participating in integrated lessons, you could develop a greater understanding of the content which will lead to improved scores on future STAAR tests.

Confidentiality:

This information will not be distributed to any other agency and will be kept private and confidential. The only exception to this is if you tell us abuse or neglect that makes us seriously concerned for your immediate health and safety.

Right to Withdraw:

Your participation is greatly appreciated, but we acknowledge that the questions we are asking are personal in nature. You are free at any point to choose not to engage with or stop the study. You may skip any questions you do not wish to answer. This study is not required and there is no penalty for not participating. If at any time you experience a negative emotion from answering the questions, we will stop asking you questions.

Contact Information:

You will receive a copy of this consent form. If you have questions you can talk to or write the principal investigator, Christina Giles.

If you want to talk with a participant advocate other than the investigator, you can write or call the director of our institutional review board, Dr. OraLee Branch.

Your Statement of Consent:

I have read the above information. I asked questions if I had them, and my questions were answered. I volunteer my consent for this study.

Participant Name Date

Participant Signature Date

Investigator Name Date

Investigator Signature Date



Investigator: Christina Giles

c/o: Professor Neil Mathur

Concordia University – Portland

2811 NE Holman Street

Portland, Oregon 97221

Appendix F: Consent to Participate for Teachers

Teacher Consent Form

The intention of the research study, **The Effects Embedding Science Standards Within the Mathematics Curriculum Has on Students' Perceptions of Mathematics and Mathematics Achievement** has been fully explained to me. I understand that, by agreeing to participate in the study, I give permission to Mrs. Giles (researcher) to observe my classroom and collect all data pertinent to the study. I also understand that none of the data collected will have an effect on my teacher evaluation through the school district.

I hereby consent to participate in the research study as it has been described to me. I understand that my participation is completely voluntary, and that I can revoke my participation at any time.

Teacher Participant Signature

Date Consent Granted

Appendix G: Interview Questions

Questions Pertaining to Correlation

The questions below will be asked of each teacher participant half-way through the study and upon completion of the study. Responses will be recorded and transcribed for later reflection.

1. Thinking about your entire group of students, how engaged is the typical student during mathematics lessons?
2. Thinking about each of your students, on average, how mathematically ready are they when they enter 6th/7th grade?
3. Mathematical readiness covers a wide range of concepts and terms. Thinking about the ability levels of the students you service, what grade level ability do they seem to cluster around?
4. Knowing that a significant number of students might be performing below their current grade level, how can you help to improve their mathematical readiness?
5. Cooperative learning involves providing the opportunity for students to work with partners or small groups of students to understand a mathematical concept. How do you think cooperative learning could benefit your students? If you already implement some type of cooperative learning, what is it and how has it impacted your students' mathematical knowledge?
6. As a teacher, what does correlated instruction mean to you?
7. When looking at embedding science TEKS into the mathematics curriculum, where do you think would be a good place to begin so as to really observe an impact on ability and understanding?

Appendix H: Interview Transcript

Teacher A's Responses

R: Thinking about your entire group of students, how engaged is the typical student during mathematics lessons?

Teacher A: Satisfaction and engagement may not be the most common feelings among students in my classroom. I see a large majority of them are anxious about math.

R: Thinking about each of your students, on average, how mathematically ready are they when they enter 6th/7th grade?

Teacher A: Kids develop at different rates. Most of my students have not mastered most of the math skills by the end of fifth grade.

R: Mathematical readiness covers a wide range of concepts and terms. Thinking about the ability levels of the students you service, what grade level ability do they seem to cluster around?

Teacher A: Based upon the data from team tests and district tests, my students are around 3rd to 7th grade level.

R: Knowing that a significant number of students might be performing below their current grade level, how can you help to improve their mathematical readiness?

Teacher A: I can help to improve the students' readiness by offering tutorials, chunking assignments, having questions and answer sessions to get them engaged to discuss math.

R: Cooperative learning involves providing the opportunity for students to work with partners or small groups of students to understand a mathematical concept. How do you think cooperative learning could benefit your students? If you already implement some type of cooperative learning, what is it and how has it impacted your students' mathematical knowledge?

Teacher A: Cooperative groups can benefit my students by giving them a different perspective on how to do math, especially from their peers.

R: As a teacher, what does correlated instruction mean to you?

Teacher A: How we should instruct students in math.

R: When looking at embedding science TEKS into the mathematics curriculum, where do you think would be a good place to begin so as to really observe an impact on ability and understanding?

Teacher A: We should look at customary and metric measurement when embedding science TEKS into the math curriculum. This will give the students a real-world perspective on the concept.

Appendix I: Interview Transcript

Teacher W's Responses

R: Thinking about your entire group of students, how engaged is the typical student during mathematics lessons?

Teacher W: I would have to say, as an instructional technology coach, that students are typically engaged when I am in a classroom. Students usually want to take part in lessons that involve technology, so they listen attentively and want to participate.

R: Thinking about each of your students, on average, how mathematically ready are they when they enter 6th/7th grade?

Teacher W: Thinking about each of the times that I have been in a math classroom and assisted with a mathematics lesson over the past two years, I would have to say that the majority of the students are usually not working on grade level. I am not sure where the disconnect is at, where the lack of knowledge transfer is occurring, but students are missing key pieces of information somewhere before entering middle school.

R: Mathematical readiness covers a wide range of concepts and terms. Thinking about the ability levels of the students you service, what grade level ability do they seem to cluster around?

Teacher W: Reflecting on the students I have worked with in a math setting, the students definitely are not working at a 5th or 6th grade level. In my opinion, I would say that they are probably at a 3rd or 4th grade level, but I do not teach math so I could not say for certain.

R: Knowing that a significant number of students might be performing below their current grade level, how can you help to improve their mathematical readiness?

Teacher W: I know that several teachers on campus offer tutorials beginning the second week of school, just because they know that students are lagging behind. Many teachers also offer advanced tutorials, math clubs, UIL leagues, robotics clubs, and others avenues for students to explore their mathematical and scientific questions.

R: Cooperative learning involves providing the opportunity for students to work with partners or small groups of students to understand a mathematical concept. How do you think cooperative learning could benefit your students? If you already implement some type of cooperative learning, what is it and how has it impacted your students' mathematical knowledge?

Teacher W: Cooperative learning is a huge part of what I do every day. As a technology instructional coach, part of my job is offering assistance to teachers within their classrooms. This might look like helping them design lessons, finding technology to meet their lesson needs, or helping them to implement an online platform as a tool for learning within their classroom. When I do this, cooperative groups are huge. I love having students explore new avenues with partners and work through the technology together, learning from one another as they go.

R: As a teacher, what does correlated instruction mean to you?

Teacher W: Correlated instruction, to me, means making sure that at least two content areas are seamlessly tied together throughout the structure of the lesson plan. In order for correlated instruction to work, the two content areas must be taught so that it is difficult to determine which one is the main focus of the lesson. Both areas are equally important and both are emphasized.

R: When looking at embedding science TEKS into the mathematics curriculum, where do you think would be a good place to begin so as to really observe an impact on ability and understanding?

Teacher W: First, I think that the teacher really needs to look at the purpose behind the lesson. The lesson needs to be relevant to the audience. It needs to have meaning for the kids. It is not enough to teach the students about conversions or calculating volume of a prism. Kids need to understand why this is important for their future. In order to properly and effectively correlate such a lesson, the teacher needs to understand why it's important for the child's future knowledge.

Appendix J: Interview Transcript

Teacher H's Responses

R: Thinking about your entire group of students, how engaged is the typical student during mathematics lessons?

Teacher H: The class is very engaged throughout a lesson. Students are captivated by the collaborative teaching of Ms. G (researcher) and myself. Students are able to interact and converse with the teachers and other classmates.

R: Thinking about each of your students, on average, how mathematically ready are they when they enter 6th/7th grade?

Teacher H: The students in 3rd period are low academically. The students have made momentous improvements and the students' attitudes towards are changing. They actually know the information being taught and therefore have a positive attitude towards math. The students know that they can do well in math as long as they try. Some of the students are very gifted and will do very well with ease in 7th grade math. Others may not be as gifted as some of the other students but they have heart and try very hard, which will allow them to succeed in any setting.

R: Mathematical readiness covers a wide range of concepts and terms. Thinking about the ability levels of the students you service, what grade level ability do they seem to cluster around?

Teacher H: Like mentioned before, 3rd period is an academically low class. If I had to say, the

average grade level equivalency would have to be 4.9. However, the students are able to grasp the concepts being taught. The students sometimes have problems with memory recall, being able to remember a certain step or formula to solve a problem.

R: Knowing that a significant number of students might be performing below their current grade level, how can you help to improve their mathematical readiness?

Teacher H: The supports offered to the students are endless. Tutorials are offered almost every day and on Saturdays as well. Teachers can be readily reached by email for help on questions. Teachers are in constant communication with parents regarding missing assignments and work that needs to be redone or student needs that need to be met. Students also have the ability to retest and bring any low grades up to a 70%.

R: Cooperative learning involves providing the opportunity for students to work with partners or small groups of students to understand a mathematical concept. How do you think cooperative learning could benefit your students? If you already implement some type of cooperative learning, what is it and how has it impacted your students' mathematical knowledge?

Teacher H: Cooperative learning is used on a regular basis in class. It helps to build social skills among the other students and provides added support for the students. The students are able to discuss their different viewpoints and ways that they got the right answer. Even if a student gets the wrong answer, the students help guide the other to the proper answer. Another benefit is a particular student might use a method that helps another student remember the steps or formula that the teachers may not have known.

R: As a teacher, what does correlated instruction mean to you?

Teacher H: As a teacher, correlated instruction means tying things all together. Making sure that what you are teaching aligns with your test, TEKS and whatever is going to be on the standardized test.

R: When looking at embedding science TEKS into the mathematics curriculum, where do you think would be a good place to begin so as to really observe an impact on ability and understanding?

Teacher H: Science and math depend on each other. You need to be able to measure, round and many other abilities. I believe that the best place to start would be in measurement because you are constantly finding out how much of a substance is in an object or putting the right amount of a substance into something.

Appendix K: T Test Results

Table 12

Means and Standard Deviations of Average Growth in Test Score Gains of Math

Gender	<i>M</i>	<i>SD</i>	<i>n</i>
Female	3.34	2.37	32
Male	3.38	2.33	53

Table 13

Perception and Test Score Differences Between Students Who Learned Math Traditionally (Comparative) or Learned with Science Embedded in the Curriculum (Experiential)

Comparisons	Comparative		Experiential		<i>t</i> (83)	<i>p</i>	<i>Eta</i> ²
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>			
Student Test Scores	3.19	2.21	3.47	2.38	.54	.59	n/a
Student Perceptions	-.75	.41	.58	.38	15.49	<.001	.74

Table 14

Multiple Comparisons of Perception and Test Score Differences Between Students Who Learned Math Traditionally (Comparative) or Learned with Science Embedded in the Curriculum (Experiential)

Comparisons	Comparative		Experiential		<i>p</i>
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>	
Male Test Scores	3.63	2.41	3.00	1.96	.215
Female Test Scores	2.71	1.93	3.64	2.52	.413
Male Perceptions	-.85	.40	.73	.44	.133
Female Perceptions	-.64	.41	.53	.34	.053

Table 15

Means and Standard Deviations of Average Growth in Perceptions of Math Efficacy

Math Instruction Type	<i>M</i>	<i>SD</i>	<i>n</i>
Science Embedded	.58	.38	49
Traditional	-.75	.41	36

Appendix L: Pre-Survey Results for Experiential Group

Table 2

Pre-Survey Results: Experiential Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	16	47	38
2.Equations, expressions, & numbers in general seem confusing.	20	58	20
3.Topics like weathering, erosion, force, & motion are difficult to understand.	20	58	22
4.Math & science are fun, interesting subjects.	62	20	16
5.Math lessons give me anxiety.	20	55	24
6.Science lessons give me anxiety.	18	62	16
7.I enjoy learning about geometry & measurement.	36	24	40
8.I believe that other students always perform better than me when it comes to math.	31	42	24
9.I believe that members of the opposite sex are better at math & science than I am.	13	60	22
10.If I could go to school and not take math or science, I would be happy.	16	60	20

Note. Pre-survey given prior to the start of the correlated units.

Appendix M: Pre-Survey Results for Comparative Group

Table 3

Pre-Survey Results: Comparative Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	28	30	42
2.Equations, expressions, & numbers in general seem confusing.	21	58	19
3.Topics like weathering, erosion, force, & motion are difficult to understand.	9	74	16
4.Math & science are fun, interesting subjects.	65	16	19
5.Math lessons give me anxiety.	30	47	23
6.Science lessons give me anxiety.	23	65	14
7.I enjoy learning about geometry & measurement.	35	28	37
8.I believe that other students always perform better than me when it comes to math.	35	35	30
9.I believe that members of the opposite sex are better at math & science than I am.	26	49	23
10.If I could go to school and not take math or science, I would be happy.	21	60	19

Appendix N: Post-Survey Results for Experiential Group

Table 16

Post-Survey Results for the Experiential Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	16	47	38
2.Equations, expressions, & numbers in general seem confusing.	20	58	20
3.Topics like weathering, erosion, force, & motion are difficult to understand.	20	58	22
4.Math & science are fun, interesting subjects.	80	18	0
5.Math lessons give me anxiety.	20	55	24
6.Science lessons give me anxiety.	18	62	16
7.I enjoy learning about geometry & measurement.	36	24	40
8.I believe that other students always perform better than me when it comes to math.	31	42	24
9.I believe that members of the opposite sex are better at math & science than I am.	5	68	27
10.If I could go to school and not take math or science, I would be happy.	10	70	20

Appendix O: Post-Survey Results for Comparative Group

Table 17

Post-Survey Results for the Comparative Group

Statement Number	Percent Who Agree	Percent Who Disagree	Percent Who Are Neutral
1.Math & science lessons are difficult for me.	28	30	42
2.Equations, expressions, & numbers in general seem confusing.	21	58	19
3.Topics like weathering, erosion, force, & motion are difficult to understand.	9	74	16
4.Math & science are fun, interesting subjects.	50	30	20
5.Math lessons give me anxiety.	30	47	23
6.Science lessons give me anxiety.	23	65	14
7.I enjoy learning about geometry & measurement.	35	28	37
8.I believe that other students perform better than me when it comes to math.	35	35	30
9.I believe that members of the opposite sex are better at math & science than I am.	15	60	25
10.If I could go to school and not take math or science, I would be happy.	65	35	0

Appendix P: Mock STAAR Data, March 2018

Table 18

Mock STAAR Data Comparisons

Teacher Name	Total Students	Percent at Approaches Grade Level (passing)	Percent at Meets Grade Level (on grade level)	Percent at Masters Grade Level (commended)
Researcher	143	58.04	11.89	1.4
Teacher A	48	33.33	4.17	0
Campus	210	50	9.05	0.95
District	889	62.09	18.45	3.71

Note. There are 19 bilingual/ESL students not figured into these numbers because the teacher was not a part of the study.

Appendix Q: Statement of Original Work

The Concordia University Doctorate of Education Program is a collaborative community of scholar-practitioners, who seek to transform society by pursuing ethically-informed, rigorously-researched, inquiry-based projects that benefit professional, institutional, and local educational contexts. Each member of the community affirms throughout their program of study, adherence to the principles and standards outlined in the Concordia University Academic Integrity Policy. This policy states the following:

Statement of academic integrity.

As a member of the Concordia University community, I will neither engage in fraudulent or unauthorized behaviors in the presentation and completion of my work, nor will I provide unauthorized assistance to others.

Explanations:

What does “fraudulent” mean?

“Fraudulent” work is any material submitted for evaluation that is falsely or improperly presented as one’s own. This includes, but is not limited to texts, graphics and other multi-media files appropriated from any source, including another individual, that are intentionally presented as all or part of a candidate’s final work without full and complete documentation.

What is “unauthorized” assistance?

“Unauthorized assistance” refers to any support candidates solicit in the completion of their work, that has not been either explicitly specified as appropriate by the instructor, or any assistance that is understood in the class context as inappropriate. This can include,

but is not limited to:

- Use of unauthorized notes or another's work during an online test
- Use of unauthorized notes or personal assistance in an online exam setting
- Inappropriate collaboration in preparation and/or completion of a project
- Unauthorized solicitation of professional resources for the completion of the work.

I attest that:

1. I have read, understand, and complied with all aspects of the Concordia University-Portland Academic Integrity Policy during the development and the writing of this dissertation.
2. Where outside sources were used in the collection of information and/or material which was used in the development of this dissertation, all outside sources have been properly referenced and all permissions required for the use of the information and/or materials has been obtained, in accordance with the research standards set forth in the *Publication Manual of The American Psychological Association*.



Digital Signature

Christina M. Giles

Name Typed

April 24, 2018

Date

Figure 1. Pre-Survey Results Comparing Comparative and Experiential Groups

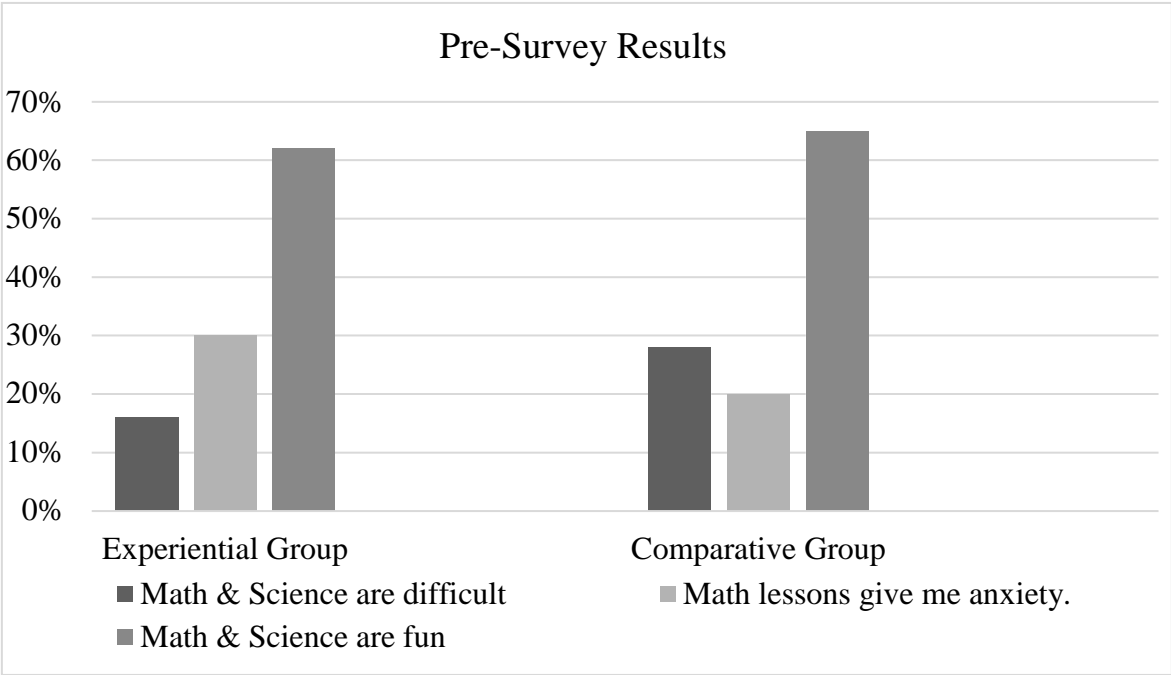


Figure 2. Correlated Unit 1 Pre and Posttest Data for Experiential Group

Experiential Group Participants		
Participant ID	Pretest Score	Posttest Score
1005	35%	38%
1007	13%	50%
1009	33%	53%
1011	13%	40%
1012	30%	33%
1014	50%	50%
1016	35%	63%
1022	0%	58%
1076	50%	78%
1002	60%	58%
1017	10%	23%
1018	0%	45%
1019	13%	65%
1024	20%	53%
1025	13%	25%
1072	38%	65%
1073	25%	NONE/Absent
1075	30%	40%
1077	50%	78%

1078	18%	33%
1079	25%	68%
1080	33%	80%
1082	38%	65%
1083	50%	63%
1084	60%	55%
1085	33%	63%
1086	53%	53%
1087	60%	85%
1088	33%	53%
1089	43%	40%
1090	65%	73%
1092	48%	70%
1097	63%	75%
1098	28%	63%
1099	63%	80%
1100	25%	95%
1101	50%	65%
1102	65%	95%
1103	28%	80%
1104	45%	40%
1105	55%	68%
1106	48%	70%

1107	38%	75%
1108	43%	70%
1109	48%	80%
1110	50%	55%
1111	NONE/Absent	38%
1112	50%	45%
1113	8%	33%
1114	50%	65%
1115	48%	78%
1119	63%	65%
1120	40%	90%
1121	53%	90%
1122	NONE/Absent	NONE/Absent
1123	58%	83%
1125	63%	53%
1126	25%	55%

Note. Participant ID numbers represent those students placed within the experiential group.

Scores represent passing rates on both the pretest and the posttest.

Figure 3. Correlated Unit 2 Pre and Posttest Data for Experiential Group

Experiential Group Participants		
Participant ID	Pretest Score	Posttest Score
1005	25%	42%
1007	13%	42%
1009	63%	67%
1011	0%	54%
1012	25%	42%
1014	63%	58%
1016	38%	42%
1022	21%	71%
1076	83%	96%
1002	75%	NONE/Absent
1017	38%	33%
1018	33%	21%
1019	29%	67%
1024	25%	42%
1025	29%	21%
1072	17%	92%
1073	29%	63%
1075	38%	79%

1077	75%	88%
1078	17%	42%
1079	92%	92%
1080	25%	79%
1082	17%	50%
1083	21%	92%
1084	21%	71%
1085	79%	67%
1086	67%	46%
1087	71%	92%
1088	67%	96%
1089	50%	71%
1090	58%	88%
1092	71%	71%
1097	71%	96%
1098	75%	83%
1099	58%	79%
1100	83%	96%
1101	92%	92%
1102	88%	96%
1103	25%	96%
1104	79%	79%
1105	83%	83%

1106	100%	96%
1107	100%	96%
1108	92%	96%
1109	96%	100%
1110	13%	96%
1111	67%	92%
1112	75%	83%
1113	0%	50%
1114	46%	100%
1115	83%	79%
1119	NONE/Absent	96%
1120	92%	83%
1121	42%	100%
1123	88%	92%
1125	88%	92%
1126	NONE/Absent	88%

Note. Participant ID numbers represent those students placed within the experiential group.

Scores represent passing rates on both the pretest and the posttest.

Figure 4. Correlated Unit 3 Pre and Posttest Data for Experiential Group

Experiential Group Participants		
Participant ID	Pretest Score	Posttest Score
1005	21%	67%
1007	29%	83%
1009	29%	67%
1011	43%	67%
1012	14%	92%
1014	50%	58%
1016	50%	92%
1022	0%	58%
1076	57%	75%
1002	29%	67%
1017	29%	83%
1018	29%	67%
1019	36%	58%
1024	29%	58%
1025	14%	NONE/Absent
1072	57%	100%
1073	NONE/Absent	17%
1075	36%	67%
1078	71%	75%

1079	93%	67%
1080	NONE/Absent	NONE/Absent
1082	86%	83%
1083	64%	75%
1084	57%	75%
1085	50%	92%
1086	57%	67%
1087	NONE/Absent	67%
1088	30%	83%
1089	50%	67%
1090	64%	83%
1092	64%	67%
1097	71%	83%
1098	79%	67%
1099	71%	75%
1100	86%	92%
1101	100%	83%
1102	64%	83%
1103	71%	83%
1104	79%	92%
1105	79%	75%
1106	79%	92%
1107	79%	83%

1108	71%	67%
1109	57%	83%
1110	0%	67%
1111	86%	83%
1112	57%	50%
1113	14%	25%
1114	50%	83%
1115	64%	75%
1119	NONE/Absent	83%
1120	71%	83%
1121	79%	100%
1123	71%	83%
1125	93%	92%
1126	79%	67%

Note. Participant ID numbers represent those students placed within the experiential group.

Scores represent passing rates on both the pretest and the posttest.

Figure 5. Mock STAAR Comparisons

