TEACHER PERCEPTIONS OF THE INTEGRATED MATHEMATICS CURRICULUM AND SUCCESSFUL PEDAGOGY AND BEST PRACTICES FOR IMPLEMENTATION

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Abstract

The purpose of this qualitative study was to find practices and pedagogical strategies for integrated mathematics educators to help students make connections between mathematical concepts and within the different strands of mathematics. The data were gathered from educators, administrators, and mathematics coaches in a suburban high school in Southeast Tennessee. The study was centered around two research questions: How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery? What practices help students make connections among strands of mathematics within the integrated mathematics curriculum? The data utilized in this study were collected via surveys, interviews, and educator observations. All data were analyzed through a sequence of open, axial, and selective coding, revealing prevailing themes for best practices and pedagogical strategies through the making of deliberate connections to the why, the real-world, and to other mathematics strands; highlighting and celebrating multiple solution pathways; utilizing tasks and projects; and establishing a culture of collaboration within the mathematics classroom. The information garnered in this study will help future integrated mathematics educators and school administrators by providing effective practices and strategies for helping students make and understand connections within the integrated mathematics curriculum.
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Dedication

This dissertation is dedicated to my family.

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CHAPTER 1: INTRODUCTION

Introduction and Background

The integrated mathematics curriculum is becoming more prevalent in the classrooms of high schools in the United States. The curriculum, though not a new concept, is rooted in the theory that students who are taught algebraic, geometric, and other mathematics concepts all together are more likely to demonstrate understanding of the interconnected nature of mathematics (Hanover Research, 2015). This interconnectedness is thought to improve student problem-solving skills in the math classroom.

Students, when exposed to a curriculum of algebra, geometry, and the other strands of mathematics, are more likely to notice the connections among the strands. Integration allows students to continue to build proficiency within the strands as well as help students realize relationships among the mathematics concepts and domains (Indiana Department of Education, n.d.).

The Common Core State Standards place emphasis on conceptual knowledge over procedural knowledge. They also focus on applying a plethora of mathematics skills rather than isolating those same skills (Brugger, 2014). The ability to decipher the mathematics concepts from any strand or domain is integral to developing mathematicians in the high school classroom; this ability is a form of problem-solving because problem-solving requires the student to select which mathematics concepts and procedures are pertinent to formulate solutions (Reys & Reys, 2009). The interconnectedness of the mathematics strands and students’ ability to recognize and utilize this interconnectedness help to heighten problem-solving abilities, which enables these students to become better mathematicians.

The use of mathematics in real-world applications is not neatly placed into one segment
of mathematics. Very rarely will an everyday situation involve only one aspect of mathematics. Engineers, architects, and other professions that require math proficiency do not solely rely on geometric concepts or algebraic principles. Instead of teaching in silos and building only one mathematics strand (Will, 2014), the integrated mathematics curriculum focuses on all types of mathematics in a logical order. Students of the integrated curriculum learn each mathematical strand each year (Strauss, 2013). This affords the student ample opportunity to build a well-rounded mathematics repertoire and use the best methods and concepts to solve real-world problems. The integrated curriculum prompts these aspiring professionals to use their mathematical knowledge to help solve common problems.

However, the obvious benefits of the integrated mathematics curriculum are not sufficient persuaders. Although the integrated curriculum closely resembles the mathematics teachings of numerous Asian countries, nations that obliterate the United States in regard to mathematics test scores (Harlow, 2015), less than 10% of United States’ high schools utilize the integrated curriculum (Dossey, McCrone, & Halvorsen, 2016). Studies indicated that students from integrated curriculums score higher on standardized tests than those from a traditional curriculum (Tarr, Grouws, Chávez, & Soria, 2013).

**Research Problem**

Research supporting the integrated mathematics curriculum is substantial. The integrated curriculum requires teachers, administrators, and all other school stakeholders to research best practices, find appropriate assessments, and transform their ideals pertaining to the flow of the class. Implementing the integrated curriculum forces teachers to change their pedagogy and delivery styles so students are given multiple opportunities to recognize the connections and relationships between the content and strands of mathematics.
Because the integrated mathematics curriculum is based on making and utilizing connections among content strands, teachers must be able to foresee the connections that their students may generate. To maximize the construction of meaning, professional development should be sought to help teachers understand which connections should be emphasized in the integrated curriculum, as well as how to develop those connections (de Araujo, Jacobson, Singletary, Wilson, Lowe, & Marshall, 2013). The integrated curriculum poses a new challenge for teachers, as they may be asked to grow as educators and modify their pedagogy.

**Purpose of the Study**

The purpose of this study was to find methods for educators to help students make connections between mathematical concepts and within the different strands of mathematics. The study researched and analyzed teacher efficacies and perceptions of the pedagogy, content delivery styles, and best practices that enable students within the mathematics classroom. The results of this study bolstered the current information regarding best practices and pedagogy for implementation of the integrated mathematics curriculum in classrooms.

This study identified these best practices and pedagogy for teachers to implement and maximize their students’ overall mathematics achievement. The study emphasized classroom practices because of their significant influence on achievement. Pedagogy is a precursor to effective teaching, and solid pedagogy allows teachers to utilize manipulatives and practices to build upon a student’s present knowledge and push him/her toward higher mathematical abilities (Bhowmik, B. Banerjee, & J. Banerjee, 2013). According to Laitsch (2003), the importance of teacher quality and classroom practice cannot be understated; the effect of quality pedagogy and practices affect student achievement on par and exceeding that of socioeconomic status. The teacher cannot control the level of knowledge students bring into the classroom or their
problems, but the teacher and school significantly impact student achievement via best practices and pedagogy.

**Research Questions**

The study was guided by two research questions:

1. How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery?

2. What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

**Rationale for the Study**

**Significance of the study.**

The study’s purpose was to identify best practices, valid pedagogy, and other delivery styles to help teachers better prepare their students for constructing meaning and recognizing connections in the integrated mathematics curriculum. Research, interviews, surveys, and observations elucidated these qualities and skills. In like manner, this study allows teachers, math coaches, and administrators to utilize the findings and become better educators for their students.

**Theoretical Framework.**

Constructivism was used as the theoretical framework for this study. Constructivism refers to the process in which a person identifies what is known, interacts with new information, and constructs or creates his/her own perceptions of the material. Constructivism is learning through experiences, and each new experience either confirms or changes the beliefs of the learner (Mallanda, 2011).
Constructivism was utilized because the purpose of the study was to find best practices and pedagogy to help ensure all students construct their own meaning. Constructivism refers to how students learn, as opposed to what they learn (Brooks, M. G. & Brooks, J. G., 1999). Teachers are not often considered in curriculum decisions, but they are integral in ensuring that students learn.

Constructivism is also an applicable framework for this study because teachers should be constantly discerning how their students learn. Teachers continuously learn from experience and often adjust their teaching practices and pedagogy to maximize student achievement.

Limitations and Delimitation.

The study was conducted within one school district in Southeast Tennessee. Participants interviewed, surveyed, and observed all taught within the same school, and other participants were employees in the research district. This sampling delimitation limited and restricted the findings and subsequent theories to schools with similar demographics. The study, while informational, may not be suitable for widespread comparison to different populations.

Researcher Positionality Statement

The researcher has taught four years at the high school level and one year at the middle school mathematics level. The researcher holds a Master’s Degree in Secondary Education and an Ed.S. in Curriculum and Instruction. For the previous two years, the researcher has been the Professional Learning Community leader for the Algebra 1 cohort. The State of Tennessee has enabled school systems to determine their mathematics curriculum, which allows schools to use various methods to help students prosper in mathematics. The researcher believes that the Integrated Mathematics Curriculum may help students make connections between mathematical
concepts and strands which, alongside improved teacher pedagogy and sound practices, would help enhance student understanding of mathematics.

The role of the researcher was to ensure that the study, the research, observations, interviews, and all data collection and analysis were free from bias. The theoretical framework, along with the research questions, provide the researcher with structure to identify and help teachers implement solid pedagogy and practices to help maximize student achievement.

**Definition of Terms**

Below is specific terminology related to the study; definitions are provided for clarification. Other terms are provided in the review of literature with cited sources.

- **Integrated Mathematics Curriculum:** Curriculum pathway that combines and reorders content from Algebra 1, Geometry, Algebra 2, and Probability and Statistics into a three-year sequence (Harlow, 2015).
- **Best Practices:** A method or technique that has consistently shown results superior to those achieved with other means, and that is used as a benchmark. (BusinessDictionary.com, n.d.).
- **Pedagogy:** the art (and science) of teaching (Bhowmik, B. Banerjee, & J. Banerjee, 2013).
- **Strands of Mathematics:** Refers to the content of different mathematics: Number sense, properties, and operations; measurement; geometry and spatial sense; data analysis, statistics, and probability; and algebra and functions. (National Assessment of Educational Progress, 2003).

**Summary**
The integrated mathematics curriculum is designed to allow students to make connections among the different strands of mathematics and use their understanding of the connections to produce solutions. The findings in this study are the perceptions of a group of instructors on which pedagogy and best practices work for their students. This provides teachers with pedagogy and best practices that aid in the implementation of the integrated curriculum by enabling students to construct their own meaning via the connections between concepts.

This study was organized into five chapters. The first chapter detailed the background information of the study, and the research problem and purpose of the study. The first chapter introduced the research questions and rationale for the study. The research imitations and delimitation were discussed, the researcher positionality statement included, and definitions for specific terminology were provided.

Chapter two consisted of a literature review regarding the integrated mathematics curriculum. The comprehensive review included studies and discussions concerning the following integrated mathematics curriculum topics: the composition of the integrated mathematics curriculum, the history of the curriculum, examples and instances of the integrated mathematics curriculum throughout the world, benefits and positive outcomes stemming from the integrated mathematics curriculum, topics concerning the implementation of the curriculum, best practices and pedagogy, constructivism in the integrated mathematics curriculum, and the perceptions and opposition to the integrated mathematics curriculum.

The third chapter provided the methodology of the study. Chapter four reported the results of the data obtained through the research, and chapter five provided detailed the implications, recommendations, and conclusions drawn from the data and the study.
CHAPTER 2: REVIEW OF LITERATURE

The Integrated Mathematics Curriculum

The Integrated Mathematics Curriculum is a mathematics course sequence that is becoming more prevalent in classrooms in the United States. The curriculum is predicated upon providing students with courses that emphasize making connections between algebraic, geometric, and statistics strands (Reys & Reys, 2009). The curriculum consists of three courses that blend concepts and topics from these strands of mathematics; this mix of concepts allows students to see the relationships among the strands and the unity among them (Beal, Dolan, Lott, & Smith, 1990). The curriculum stipulates that students can better develop connections among mathematics strands and concepts gradually with increased time (Community High School District 117, 2015). The elementary mathematics curriculum is integrated in nature, as concepts and skill development come from the multiple strands and are sequenced in an appropriate manner to foster connections between concepts. The integrated mathematics curriculum is designed to continue that technique throughout a student’s secondary mathematics career (Reys & Reys, 2009).

The Integrated Mathematics Curriculum centers around building students’ ability to think critically, problem solve, and work collaboratively in the learning process (Lee, 1999); this process is implemented in a student-centered fashion (Brown, 2012) where the teacher helps students recognize connections between the new content and previously mastered material (Mallanda, 2011). Mathematics is not a neatly assorted subject; the study of mathematics depends on the understanding of relationships among strands, and these relationships work together with numerous solving strategies in any one problem solving situation (Beal, Dolan, Lott, & Smith, 1990). Student proficiency in making and understanding these connections is
bolstered each year, and students are afforded constant opportunity to make connections and see the relationships while progressing in the curriculum (Indiana Dept. of Education, n.d.).

Integrated Mathematics is often viewed as opposite of traditional mathematics curriculums. The traditional math sequence in United States schools follows the general progression of Algebra 1, Geometry, Algebra 2 in a student’s freshman, sophomore, and junior school years, respectively. Similarly, the integrated curriculum utilizes the same algebra, geometry, and statistical standards and concepts in a reassembled format to highlight the connections within the mathematics (Fensterwald, 2014). The curriculum promotes understanding of the standards and concepts in relation to each other rather than in separate strands and courses (Beal, Dolan, Lott, & Smith, 1990). Proponents believe the integrated curriculum appeals to students who have an algebraic or geometric mind due to the notion that the curriculum highlights connections they likely understand and build from there (Mallanda, 2011).

According to Hanover Research (2015), integrated mathematics produces the ideal learning environment to promote mathematical understanding in the context of real-world applications. The integrated curriculum is infused with problem solving (Beal, 2000), and students are immersed in word problems and real-world applications that promote the formulation of problem-solving skills (Bailey, 2010). This is true because real-world applications are not derived from one strand of mathematics; these problems require an understanding of concepts and skills from multiple strands of mathematics requiring a variety of strategies to solve (Mallanda, 2011). To solve real-world problems, students must be able to select pertinent skills and concepts from their collection of mathematics understanding and apply them to solve the problem (Reys & Reys, 2009), and, in this manner, multiple standards and principles are
addressed, utilized, and practiced within each lesson (Bailey, 2010). Students are challenged by real-world applications, which helps develop their conceptual understanding and problem-solving skills (Lee, 1999).

The instruction students receive in their mathematics courses should focus on the development of student procedural fluency to better their understanding of the connections and correlation between the mathematics strands (Ferguson, 2016). To build this procedural fluency, the ideal integrated mathematics lesson would begin with the introduction of a context-based problem or a real-world application. The students attempt to solve the problem by utilizing select geometric and algebraic concepts and skills from their diverse repertoire of mathematics understanding (Murphysboro High School, n.d.). Ferguson (2016) emphasized the importance of procedural fluency and problem-solving skills and stated that the way students handle problem solving in the mathematics courses often reveals much about their ability to think and reason their way to solving complex problems in subsequent mathematics lessons and courses, as well as their future beyond school.

In the integrated curriculum, students are exposed to algebraic applications that utilize statistics and/or geometry throughout their secondary mathematics career. It is assumed that this exposure will provide a deeper understanding of mathematics for the student and enable them to become better problem solvers (Shaughnessy, 2011). Solid problem solvers can recognize familiar concepts in multiple representations; the curriculum allows students to see how these familiar concepts can be applied to multiple areas and types of problems. Lee (1999) provides an example of this characteristic with the concept of solving equations. Much of algebra focuses on this concept, and the skill of solving equations can easily be utilized in angle theories and other geometric concepts.
The Integrated Mathematics Curriculum seeks to build a student’s ability to understand and utilize the interconnectedness of mathematics strands (Indiana Dept. of Education, n.d) through skills practice and evaluation via real-world applications. The reliance on real-world situations instead of isolated skill practice increases rigor, honing student understanding of the math concepts and procedures (Lee, 1999). The three-course curriculum allows students to mature gradually as mathematicians, and Fensterwald (2014) stated that the conceptual understanding can be developed over a longer period of time and higher-level concepts can be revisited to gain better understanding. Integrated mathematics students are exposed to concepts and skills repeatedly in a multitude of contexts rather than experiencing them in isolated courses (Hanover Research, 2015).

**Integrated mathematics curriculum courses**

The integrated mathematics curriculum involves a sequence of three courses that all include concepts and standards of algebra, geometry, and statistics (Glendale Unified School District, 2017). Students, upon finishing their three-course integrated curriculum, are able to enroll in elective mathematics courses that are also found in the traditional mathematics course sequence (Community High School District 117, 2015).

The instruction within each class is geared towards providing students with the tools to solve problems with varied approaches (Michigan Dept. of Education, n.d.). Mathematics problems are not always neatly partitioned into simple processes or within a single strand of mathematics, so students need to understand that their avenue of solving could differ from others. Determining which approach is most effective or efficient helps students build mathematical procedural fluency and reasoning skills. In each integrated mathematics curriculum course, there are a plethora of topics pertaining to each of the mathematical strands. These topics
were previously taught as separate entities with very little correlation to other strands of mathematics. In these courses, these topics often complement one another and help further student mathematics understanding (Ferguson, 2016).

The integrated mathematics curriculum incorporates the same mathematics standards as courses taught in the traditional curriculum. The organization of the standards is the difference between the two curriculums. Rather than domain-specific courses where an overwhelming majority of concepts, skills, and procedures are from the same mathematics strand, the integrated mathematics courses weave standards in a logical progression to promote continuity across each of the strands (Glendale Unified School District, 2017).

In traditional mathematics courses, probability and statistics are a minor component of the course pacing guide and rarely covered until the fourth course in the traditional sequence. The integrated mathematics curriculum also incorporates statistical reasoning throughout each course. Probability and statistics standards, such as modeling data, regression, basic probability, and normal distributions can be exemplified in algebraic and geometric connotations (Ferguson, 2016). The statistical nature of real-world applications also provides students with opportunities to expand their understanding of specific concepts while strengthening their problem-solving capabilities.

Integrated mathematics courses, similar to the traditional curriculum, offers honors courses and support courses. The honors courses demand an increased understanding of the connections and similarities among mathematics concepts and require creative problem-solving involving concepts from different strands of mathematics, thus increasing the overall rigor. The support courses in integrated mathematics draw on student understanding of particular aspects of
mathematics and help students make sense of new material by filling in the gaps around the previously mastered content (Community High School District 117, 2015).

**Integrated Mathematics I.**

Integrated Mathematics I is the first course in the integrated mathematics sequence. The course replaces Algebra I for 9th grade students and incorporates many of the same standards taught in that traditional curriculum course. Integrated Mathematics I also covers numerous geometry standards and concepts, such as proofs, congruence, and construction of figures. The combination of these topics affords opportunity to solidify algebraic concepts taught early in the curriculum through the learning of geometric standards (Murphysboro High School, n.d.).

The main goal of Integrated Mathematics I is to extend the learning from middle grades mathematics courses, with the main areas of instruction centered around linear relationships, functions, and comparing and contrasting linear and exponential characteristics (Magnolia Public Schools, 2016). The curriculum also affords ample opportunity to utilize the learning of linear and exponential equations toward mastery of geometric concepts, such as congruence and angle relationships (Chun, King, & Gibson, 2013).

**Integrated Mathematics II.**

The Integrated Mathematics II course is the second course of three in the integrated mathematics curriculum. The course is designed for sophomore mathematics students who have shown mastery in the concepts of the previous integrated mathematics course.

According to Magnolia Public Schools (2016), quadratic functions is the main focus of the Mathematics II curriculum. The students in this course are able to determine the characteristics of quadratics, solve equations utilizing quadratics, and compare the behaviors of quadratic functions to previously learned functions, such as linear and exponential functions.
With the introduction of quadratic functions, students are better equipped to learn about equations and graphs of circles and ellipses, as well as the mathematics supporting the Pythagorean Theorem of right triangles.

With the introduction of quadratic functions in Integrated Mathematics II, the students are expected to be able to create equations and inequalities, identify key characteristics, and model linear, exponential, and quadratic functions (Chun, King, & Gibson, 2013). The students are also expected to be able to compare and contrast these functions and make sense of geometric concepts utilizing the different functions. Additionally, student geometric proof abilities are grown in this course through the introduction and mastery of differing proof formats.

Integrated Mathematics III.

Integrated Mathematics III is the third and final course in the integrated mathematics curriculum sequence, and a majority of students in this course are in 11th grade student population. It is equated to Algebra II in the traditional pathway and prepares students for success in their senior-level and post-secondary courses.

Mathematics III students are expected to have already mastered the concepts of linear, exponential, and quadratic functions. In this course, they will be introduced to polynomial, rational, and radical functions (Magnolia Public Schools, 2016). The students are expected to be able to compare and contrast the characteristics and key aspects of each type of function learned in all of their integrated mathematics courses. Triangle trigonometric concepts are bolstered in the Mathematics III curriculum and are expanded to include identities for non-right triangles (Chun, King, & Gibson, 2013). Mathematics III curriculum expands student understanding of probability and statistics through the concepts learned in both Integrated Mathematics I and II (Magnolia Public Schools, 2016).
The students in Mathematics III courses are able to access their prior knowledge of function characteristics appropriate for particular real-world problem-solving activities (Chun, King, & Gibson, 2013), and use that repertoire to create and contextualize problems through models and equations. Magnolia Public Schools (2016) stated that the Integrated Mathematics III curriculum is the setting in which students are expected to utilize the plethora of concepts and skills learned throughout their secondary mathematics careers and apply them toward solving tasks.

**History of the Integrated Mathematics Curriculum**

The Integrated Mathematics Curriculum, despite the recent wave of implementation and news on the subject, is not a new curriculum concept. The Integrated Mathematics Curriculum has been the subject of educational reform for over 100 years. The University Schools of Chicago utilized a form of the curriculum in the early 1900s, and subsequently, the School Mathematics Study Group of the 1960s also implemented a semblance of the integrated curriculum (de Araujo et al., 2013). It was not a widespread idea, though, until the later 1980s.

In 1987, the Mathematical Sciences Education Board constructed *A Framework for the Revision of the K-12 Mathematics Curriculum* (Beal, Dolan, Lott, & Smith, 1990) that outlined the principles of the integrated mathematics curriculum in the United States. The document details how mathematics in elementary and secondary schools should weave math concepts and strands together rather than teach them in separate courses. The *Integrated Mathematics Project – Policy Report* of 1989 went further in detailing the “new” curriculum. The report defined integrated mathematics, established the expected outcomes for students, teachers, and districts, and determined implications for departments of education at each level (Beal et al., 1990).
In response to the *Integrated Mathematics Project – Policy Report*, the NCTM developed their own addendum for secondary schools in 1989. The *Curriculum and Evaluation Standards for School Mathematics* was the NCTM’s statement of support for the integrated curriculum, stating that mathematics courses should no longer be teach the strands of math in isolation, but in three integrated courses. The NCTM believed that the integrated curriculum allows students to perceive math concepts from multiple perspectives and provides different viewpoints to solve problems (Beal et al., 1990). These documents provoked a few states to consider the integrated curriculum, including Washington, Oregon, New York, and Montana (1990).

George W. Bush’s *No Child Left Behind Act* of 2001 prompted state departments to examine and revise their mathematics standards. In this process, numerous states provided standards for the integrated mathematics curriculum (Reys, Dingman, Nevels, & Teuscher, 2007). In response to NCLB, 39 states incorporated the Integrated Mathematics Curriculum standards, either in addition to or replacing the traditional curriculum (Reys et al., 2007).

More recently, the implementation of the Common Core State Standards (CCSS) has contributed to an increased prevalence of the Integrated Mathematics Curriculum in the United States. The standards, similar to the curriculum, focus on utilizing the numerous concepts of mathematics and applying them to find solutions rather than learning via simple rote memorization of procedures (Brugger, 2014). The CCSS Initiative also called for students to be able to make sense of real-world problems, reason mathematically, and construct viable arguments (Dossey, McCrone, & Halvorsen, 2016). The integrated curriculum contends that students can achieve proficiency in these three mathematical practices by having a solid understanding of how the strands are interrelated and their connectedness to one another.
Despite being a topic of conversation since the 1990s, the push for an integrated mathematics curriculum was bolstered by the implementation of the CCSS (Will, 2014). The shared emphasis and values between the CCSS and the integrated curriculum were obvious, allowing the CCSS of 2009 to be a catalyst for the implementation of the integrated mathematics curriculum in the United States (Hanover Research, 2015). The integrated mathematics curriculum is not new; rather, it is the same mathematics taught and assessed in innovative ways (Murphysboro High School, n.d.).

**The Integrated Mathematics Curriculum Throughout the World**

Research has shown that students from classes utilizing the integrated mathematics curriculum consistently outperform students taught in the traditional manner (Stephan, Polly, Pugalee, & Cifarelli, 2016); further, most of the countries that outperform United States’ students are taught in an integrated math curriculum. The Integrated Mathematics Curriculum has shown to be more efficient in producing mathematicians and is more aligned with the high school math curriculums in Japan and Singapore (Harlow, 2015). International data also indicates disparities between achievement scores of students from the United States and of students from those countries, as well as South Korea (Holzmeyer, 2014).

The TIMSS test curriculum reports from 1999 and 2003 revealed that the United States scored lower than competing nations in mathematics proficiency. The report suggested that the United States’ most prevalent mathematics curriculum – the traditional curriculum – is partially responsible for the discrepancy (Brown, 2012). In these reports, U.S. scores rank 25th of 34 testing countries (University of Missouri-Columbia, 2013); almost every outperforming nation utilizes a form of an Integrated Mathematics Curriculum (Hanover Research, 2015). Further, American 15-year old students scored 40th out of 72 countries in the Program for International
Student Assessment. Specifically, American students averaged a score of 470; whereas Singapore, Japan, and other Asian countries’ average scores ranged between 532 and 564 (O’Donnell, 2017). The international integrated curriculum in Japan and Singapore helps students learn and use connections among mathematics strands, which is often attributed to the superior math proficiency and achievement scores in these countries (Strauss, 2013).

In 2008, Georgia adopted a version of the Integrated Mathematics Curriculum that specifically references the Japanese integrated curriculum (Brown, 2012), while some American schools are also implementing the curriculum and naming the courses International I, II, and III (Fensterwald, 2014). These examples are directly influenced by the integrated curriculums of Japan, Singapore, and South Korea, attempting to mimic the composition and success of the curriculums of these higher-performing nations.

Despite numerous studies and reports broadcasting the superiority of the mathematics curriculums and scores from Japan, Singapore, and South Korea, America remains the only country that separates algebra and geometry courses in the curriculum (Fensterwald, 2014). According to J. Michael Shaughnessy (2011), NCTM President, 90% of nations that compare math competency with the United States utilize an integrated mathematics approach; he further notes it is difficult for researchers to study and report on the comparisons between mathematics curriculums and benchmark assessments. These studies also indicated that there was little difference in student composition, time per content area or topic, or time specifically devoted to problem-solving or skill practice between the curriculums of the United States and the higher-performing countries. Other nations emphasize finding connections in mathematics and utilize different mathematics strands in problem-solving exercises (Mallanda, 2011). The only notable difference was the implementation of the Integrated Mathematics Curriculum in those countries.
Benefits and Positive Outcomes

In recent years, there have been numerous studies attempting to highlight similarities and differences between outcomes from the integrated and traditional mathematics curriculums. Many of the studies noted a boost, albeit small in some cases, in student achievement because of their immersion in the integrated mathematics curriculum as opposed to the more traditional curriculum (Stephan, Polly, Pugalee, & Cifarelli, 2016). Holzmeyer’s 2014 study of the Core Plus Mathematics Project – an integrated curriculum – showed that the students in the CPMP consistently performed better than their grade-level counterparts in strand-specific subjects on achievement tests. The CPMP students also showed greater proficiency in problem-solving, conceptual understanding, and interpreting mathematical representations.

Hanover Research (2015) studied 10th grade math students from Kansas and noted that the integrated mathematics students were more proficient than traditional curriculum students on their Kansas State Mathematics Assessments. The difference between student achievement scores in mathematics is even more stark when comparing minority and economically-disadvantaged students. According to Stephan, Polly, Pugalee, and Cifarelli (2016), students from these subgroups score significantly better if they learn mathematics in an integrated curriculum as opposed to a traditional curriculum. Students from integrated curriculums have also shown to be better prepared for the math portion of the ACT. Students in the integrated curriculum scored 4.2 points higher in the ACT Math than those on the traditional track of mathematics (Stephan, Polly, Pugalee, & Cifarelli, 2016).

Integrated mathematics curriculum students have been shown to achieve higher standardized test scores than those from traditional curriculums. In the University of Missouri-Columbia’s study, integrated mathematics students scored significantly higher than their
traditional curriculum counterparts (Hurst, 2013). According to Ferguson (2016), this is especially apparent for lower-performing students or those in high-needs schools. These students are enabled in their mathematics classes by the opportunity to make connections with the material they have already mastered, little as that may be, and utilize it toward mastery of new material. High-achieving students were also shown to benefit more from the integrated mathematics curriculum by showing higher growth scores (Hurst, 2013).

The integrated curriculum builds mathematics proficiency in students through real-world problems. The conceptual and computational requirements of these real-world examples are not specifically algebra or geometry problems; rather, solving these everyday mathematics problems requires one to proceed with a plethora of strategies from multiple strands of mathematics (Lemont High School, n.d.). Students in the integrated mathematics curriculum are taught standards from the different strands of mathematics within each curriculum unit. The Glendale Unified School District (2017) contended that since standards from the different mathematics strands are taught within each unit, the students are then able to utilize a collection of algebraic, geometric, and statistical concepts and skills to decide which skills are necessary in solving specific problems. The focus on selecting pertinent concepts from the different strands of mathematics builds student problem-solving skills (Reys & Reys, 2009). This manner of learning also helps students grow their abilities in predicting, reasoning, presenting solutions (Lee, 1999), and improved higher-order thinking and conceptual understanding (Holzmeyer, 2014).

According to Brown (2012), students enjoyed their integrated mathematics classes and the expectation of high engagement in class activities expected by their teachers. The students enjoyed the classes more, and they reported fewer negative attitudes toward their mathematics classes. This increase in engagement and enjoyment translated into an increase in achievement
on end-of-course exams in the three-year integrated curriculum implementation period that Brown observed in Georgia. In the same implementation period, Mallanda (2011) noted that students were less apt to forget content and lose their mathematics skills because of the interconnected nature of the Integrated Mathematics Curriculum.

**Implementation**

Implementation of a new curriculum is an arduous process that requires commitment from all stakeholders throughout. The 1989 *Integrated Mathematics Project – Policy Report* outlined the expectations for students, teachers, and school districts during the implementation process. The implementation process, as outlined in that document, requires a financial commitment from the districts to ensure inservice opportunities for teachers and to acquire appropriate technology and materials for the integrated curriculum (Beal, Dolan, Lott, & Smith, 1990). It is imperative that the school district invest financially in the implementation and professional development for teachers if the implementation of the Integrated Mathematics Curriculum is to be successful (Will, 2014).

Implementation is a multi-year process for school districts and teachers (Harlow, 2015). The process all but requires schools to offer traditional and integrated courses; upcoming 9th grade students would be enrolled in an integrated math course throughout their secondary mathematics career, and current students would continue working through the traditional curriculum (Brugger, 2014). This places a financial burden on districts and schools. They must purchase materials for the new integrated curriculum and must continue providing materials to support a traditional curriculum, especially early in the implementation process (Fensterwald, 2014)
For successful implementation to occur, there must be an increase in effective teacher competency through tailored professional development opportunities and an increase in available resources for teachers to utilize in their lessons and students to better themselves (Ferguson, 2016). Numerous school districts across the country provide professional development days devoted to teacher understanding of the curriculum. The Glendale Unified School District (2017) in California sets aside three full days devoted to professional development. Further teacher training is provided in textbook adoption years.

Lee (1999) stressed the importance of teacher professional development in the implementation process. The Michigan Department of Education (n.d.) determined that effective teacher preparation and professional development must be applicable to classroom instruction; specifically, teachers should be given opportunities to further develop their cooperative learning principles and strategies, alternative assessment tools, and strategies to further aid English Language Learners. These professional development opportunities for teachers should not be limited to overviews, but they should incorporate modeling lessons and collaborative practices for teachers to take with them to their classrooms (Mallanda, 2011).

The Integrated Mathematics Project - Policy Report calls teachers to attend to the provided inservice and professional development and improve their content knowledge, pedagogy, and understanding of which practices maximize student understanding and enable the students to make connections in the material. Teachers need to immerse themselves in new ideas and strategies on higher-order thinking sills within the integrated mathematics curriculum and allow their learning to influence their classroom practice and, in turn, student achievement (Laitsch, 2003). Teacher professional development is necessary when implementing the integrated curriculum so that teachers understand which connections should be made in the
curriculum and how to help students make the connections between their past learning and new mathematics concepts (de Araujo et al., 2013).

It is imperative for individual math departments to be active and collaborative in the early phases of implementation. Lee (1999) discussed how a successful implementation was spurred by a present and active leader who ensured the teachers were well-versed in the content, as well as strategies. The department head also ensured agreement on pacing and expectations for the phasing-in integrated curriculum and the phasing-out traditional curriculum, allowing teachers to focus more on their own daily lessons. These actions allow teachers to implement their learning in professional development within their own classrooms and see the discern the benefits of their acquired knowledge and the integrated curriculum together.

The previously noted duties of school systems and teachers are required during the implementation process. School systems must be proactive in their strategies for implementing the integrated mathematics Curriculum. The district should allow its math coaches, teachers, and administrators opportunity to analyze the curriculum (Mallanda, 2011). By allowing analysis by their own mathematical experts, the curriculum can be adjusted to help ensure smooth transitions, ensure buy-in at the school level, and develop procedures for future adjustments, if necessary. These experts in the system can also develop solid methods and plans for the curriculum at the classroom level and build professional development opportunities that they perceive their fellow educators may need to teach the new curriculum.

Hanover Research (2015) also noted that parent support and communication is imperative in the implementation process. Offering community forums and parent nights may diffuse opposition to the integrated curriculum by giving parents and other stakeholders opportunity to communicate concerns and provide feedback. This practice could also garner understanding and
support for the purpose and goals of the Integrated Mathematics Curriculum (Mallanda, 2011) and decrease potential for dissent.

The implementation process requires a multi-year commitment by all parties involved. All school policymakers and stakeholders should be fully aware of the funding required for implementation of the Integrated Mathematics Curriculum and the professional development necessary to ensure teachers are prepared for the curriculum (Beal, Dolan, Lott, & Smith, 1990). Funding is not the only challenge to the implementation, as secondary educators must overcome an additional challenge of implementing high expectations of the integrated curriculum with remediating prerequisite knowledge students bring from previous grade levels (Brown, 2012).

The implementation requires extensive commitment from all stakeholders. Policymakers, administrators, and teachers must utilize the available funds for integrated mathematics instructional materials and teacher preparation courses, and these stakeholders must maintain that commitment for continued success in the implementation of the new curriculum (Beal, Dolan, Lott, & Smith (1990). Brown (2012) notes that Georgia was not fully committed regarding funding or time to the implementation of the integrated curriculum. As a result, student gains were experienced but not to the level of expectation. Georgia teachers reported they need more materials and more time to perfect their instructional strategies for the integrated curriculum. Curriculum choice influences what is being taught within the mathematics classroom, but the implementation of the curriculum - the professional development and commitment to the curriculum - is much more important to student achievement (Mallanda, 2011).

Best Practices and Pedagogy
According to NCTM (2000) effective teachers know and understand the content they teach, the students they teach, and the pedagogical strategies necessary to best relay the content to the students. Effective teachers utilize quality pedagogy, which is the art and science of teaching (Bhowmik, Banerjee, B., & Banerjee, J., 2013). Pedagogy is the backbone of teachers and refers to the different grouping strategies, mediums, lecture styles, behavior management styles, among other teaching strategies. Teachers must couple these pedagogical strategies with best practices, or consistently superior student outcomes (BusinessDictionary.com, 2018), to be the most effective in growing student achievement. Effective pedagogy and solid practices are the difference makers for student learning, because the quality and nature of the lessons and assessments far outweigh the effects of curriculum design on student achievement (Kanold, 2014).

There is no universal set of effective strategies or best practices that work for all teachers, students, or in all classrooms (Bhowmik, Banerjee, B., & Banerjee, J., 2013). Teachers must be able to find the right blend of strategies and practice for them and their students to maximize student potential. According to Laitsch (2003), effectiveness is the most influential factor in student achievement, so it is imperative that teachers constantly improve their pedagogy and search for better practices to grow their students.

In the past, teachers were more likely to be lecturers than educators. The old process in mathematics was for the teacher to introduce and demonstrate a new skill or concept by performing themselves, and then students would be given opportunity to attempt to solve problems on their own; the final two steps in the process were assessments: individual work and quizzes or tests (Brown, 2012). This method of teaching leads to passive learning, and students are not always adept at this process. O’Donnell (2017) noted that one central notion of the
integrated mathematics curriculum is to boost student problem-solving skills through emphasis on learning by solving tasks. Students take ownership of their learning and experience mathematics rather than ingest it, reinforcing their understanding of mathematical processes.

In this manner, it is imperative that teachers understand that the students may have divergent ideas on how to solve their mathematics tasks (The Effective Mathematics Classroom, n.d.). The integrated mathematics curriculum focuses on students making connections between previously learned material from the multitude of different mathematics strands and current topics; teachers need to challenge students to think beyond standard procedures and invite the students to apply concepts and skills from other mathematics strands in order to solve current real-world problems.

The constructivist teacher, and a more integrative approach, necessitates that teachers involve the students in their own learning. Making mathematics education problem-centered allows teachers to employ discovery learning techniques, where students can communicate their ideas with one another and construct their own meaning with the material (Brown, 2012). Teachers need to make opportunities for students and encourage them to play and interact with the mathematics (Beal, 2000) in a problem, which is one way to spark interest and actively involve them in constructing their own knowledge (Holden & Lias, 2009). These real-world problems for integrated students to interact with should be relevant and should connect content acquisition with problem-solving skills (Dorsey, McCrone, & Halvorsen, 2016) for students to grow as mathematicians in the integrated curriculum.

Teachers can create opportunities for their students to construct their own meaning, even in lecture-based instruction. The types of questions asked by teachers can either inhibit or squander student learning opportunities. Teachers should ask questions that promote meta-
cognition within their students, meaning teachers should be allowing their students to formulate conjectures pertaining to which strategies or procedures would produce more specific answers or which would be more efficient to produce the correct solution (Killian, 2013). These questions should promote higher-order thinking and influence students to challenge one another’s thoughts and procedures in a constructive manner toward solving tasks (The Effective Mathematics Classroom, n.d.).

The problem-centered approach to the integrated curriculum needs collaboration to be utilized for student learning, because it is one of the most effective strategies for building conceptual understanding (Holzmeyer, 2014). The students need to work together on problems, activities, and completing tasks (Lee, 1999). They need to interact with manipulatives and concepts, then discuss their understanding with their groups (Beal, 2000). The students also enjoy cooperative learning and they are more engaged in the material (Brown, 2012). The students become more solid team members (Lee, 1999) and split up their duties in the collaborative learning process; they work and discuss the problem and concepts within their own group, but they also act as a resource for the groups around them (Beal, 2000). Discussing and explaining a concept or skill to others provides clarity for the student.

One strategy to increase collaboration through problem-centered instruction is to use guided discovery. According to Brown (2012), guided discovery pushes students through direct instruction, clearly modeled examples, visual manipulatives, and corrective and constructive feedback during problem-solving activities. The teachers introduce the new skill via a real-world problem that intrigues the students and build the new concept through prior experiences in the class. Then, the teacher demonstrates the skill and allows practice applications by the students; it is imperative for teachers to determine students’ capabilities to effectively differentiate the
instruction (Holden & Lias, 2009). The last phase in guided discovery is to provide real-world activities for the students to apply their learning (Brown, 2012). In this process, teachers must understand the variety of representations and procedures that students can utilize to solve the problem, and the teachers must promote these different ideas to the students (Holden & Lias, 2009).

Teachers should realize that guided discovery, or any strategy, will not always work best for the students. Educators need to find the right balance between problem-centered approaches, direct instruction, or any teaching strategy to help students construct their own meaning of the mathematics (Brown, 2012). In math, full understanding requires a high level of practicing skills; direct skill practice should be coupled with real-world problems and problem-solving activities to keep students interested in learning mathematics.

No matter which instructional strategy employed, teachers should provide students with the plan for the day. Activities and instruction should be built around clear goals, and the students should be informed of the goals for the day and how they will meet these goals (Holden & Lias, 2009). Students should know their roles in the classroom, especially when in groups, and they should be given clear expectations for the process and learning requirements for each activity (Lee, 1999). Teachers should also ensure understanding by modeling these roles, as well as any other norm to be expected of the students.

Teachers are called to develop students as mathematicians; providing opportunities for the students to interact with and solve real-world problems grows students into mathematicians (Bailey, 2010). Teachers need to be trained and prepared to utilize a variety of methods and strategies to help students make connections within the curriculum (Beal, Dolan, Lott, & Smith, 1990) and help maximize student achievement (Brown, 2012).
Solid pedagogy promotes student well-being, improves confidence of teacher effectiveness within students, and builds purpose for the students to be at school (Bhowmik, Banerjee, B., & Banerjee, J., 2013). These beliefs, expectations, and strategies that compose a teacher’s pedagogy are all ways in which the student develops efficacy toward math and school, as well as how they develop their own learning behaviors (Benbow, 1993). Solid pedagogy and best practices are as integral, if not more, to student achievement as socioeconomic status (Laitsch, 2003), which is why it is imperative for teachers to constantly seek to grow as educators.

The Integrated Curriculum and Constructivism

Constructivist principles place emphasis on how students learn rather than what they learn (Brooks, M.G. & Brooks, J.G., 1999). The constructivist mathematics teacher is constantly trying to help students bridge between their prior knowledge and new concepts. Effective teachers understand where their students are mathematically, and they facilitate learning so students can construct their own understanding of mathematics (Brown, 2012).

The integrated curriculum’s utilization of real-world applications and problem-solving activities is a prime environment for students to construct their own mathematical sense (Bailey, 2010). The real-world applications grant students opportunity to play with concepts and construct their own mathematical knowledge (Beal, 2000), and students can utilize concepts in a multitude of representations to connect the new knowledge to concepts and skills they have already mastered (Bailey, 2010). The students can make their own connections between concepts within the integrated curriculum (Holden & Lias, 2009).

Bhowmik, Banerjee, and Banerjee (2013) contended that effective teachers seek to build the students’ prior knowledge toward higher-order thinking and understanding of mathematics
concepts. Effective teachers in the Integrated Mathematics Curriculum bolster students’ abilities to make their own connections among mathematics strands, and then the students are better equipped to solve real-world applications in the classroom (Holden & Lias, 2009). Students in the curriculum build their own knowledge from the experiences solving these real-world problems (NCTM, 2000).

**Perceptions of the Integrated Mathematics Curriculum**

The Integrated Mathematics Curriculum has evoked a plethora of emotions and opinions since implementation of the curriculum has increased in the United States. These opinions are stark depending on the past experiences of the person and his/her perception of the capability of the school system implementing the integrated curriculum.

Parents have been one of the more vocal opponents to the integrated curriculum. In general, much of their displeasure stems from a lack of understanding. The parents either admit they do not understand the need for change, the curriculum itself, or the math that their children bring home with them. Some parents in affluent Californian communities were worried about the possibility of transitioning to a different curriculum despite their children’s mathematics proficiency in the current curriculum (Fensterwald, 2014). Parents may be concerned that the integrated curriculum will not prepare their children for standardized exams and college entrance requirements (Holzmeyer, 2014) despite the fact colleges around the country have rewritten their guidelines and requirements for admission. Many parents reported they did not understand the curriculum and were not able to help their children in their assignments (Brown, 2012).

Other stakeholders seem to share the same negative sentiments regarding the Integrated Mathematics Curriculum. In some Georgia schools, where implementation of the curriculum was admittedly not a priority (Brown, 2012), students complained that they did not understand
material being taught via problem-solving and other student-centered learning strategies. The data collected from these same schools showed a decline in student grades and an uptick in concern from parents and students.

In addition to student and parent distaste for the curriculum, a poll of Georgia mathematics teachers returned numerous negative responses; this opposition, according to former Fulton County (GA) Superintendent Robert Acosta, stemmed from a lack of teacher preparation for the switch to the integrated curriculum. Avis’s a believes the state did not adequately train and prepare teachers, nor did it provide sufficient funding for resources and materials.

Teachers and students in the integrated curriculum were not all spurned by the curriculum, and many held positive opinions toward the curriculum. Brown (2012) reported that students and teachers in Georgia public schools had positive experiences in the early implementation phases of the Integrated Mathematics Curriculum. Additionally, the classes were more fun and interesting for both teachers and students, and the students understood the different representations and real-world applications imposed in the curriculum.

According to Lee (1999), the students also believed the integrated curriculum helped them understand the relationships among strands of mathematics, which made them more conscious of applications in everyday life. These same students were enjoying math class (Brown, 2012), and noted they were intrigued by careers in mathematics and felt more prepared for higher-level courses (Lee, 1999). Teachers in Illinois observed growth in student higher-order thinking and problem-solving skills because of the integrated curriculum and their enjoyment of the course (Will, 2014). With student enjoyment of mathematics, coupled with
progress in achievement, many math teachers in Georgia felt the state should not pass legislation to de-emphasize the integrated curriculum (Brown, 2012).

**Opposition to the Integrated Mathematics Curriculum**

The Integrated Mathematics Curriculum, despite accounting for the mathematical proficiency of international students, is hampered by numerous factors. These factors include a lack of educator training, misconceptions about the curriculum, and financial hindrances. Implementing the integrated curriculum requires a significant change, because the traditional curriculum has been the curriculum of choice in most United States math classrooms for centuries (Will, 2014).

Parents and teachers in some states have opposed the curriculum, and they suggested that teachers are not fully prepared to implement the curriculum and the students may not be prepared to enter collegiate mathematics courses (Tatter, 2015). Many colleges and universities, however, have amended their entrance requirements to include acceptance of integrated mathematics curriculum courses (Glendale Unified School District, 2017). Completion of the three-course integrated mathematics sequence is equated to the completion of traditional mathematics courses. Students transferring in and out of the curriculum may have gaps in their mathematical learning and may not have sufficient background knowledge in their new mathematics course (Beal, Dolan, Lott, & Smith, 1990). There was also, at one time, a disconnect between the integrated curriculum and the standardized tests (Holzmeyer, 2014), causing problems in the implementation phase.

The integrated mathematics curriculum has been linked with the publicly controversial Common Core State Standards (CCSS). The integrated curriculum is not married to the CCSS, nor do the CCSS require implementation of the integrated mathematics curriculum (Campbell,
The CCSS are divided into domain-specific strands, such as algebra, geometry, statistics, and functions. These standards are not divided into grade-specific sections. This afforded opportunities for individual school systems to determine the curriculum and pacing for each grade level. The manner in which mathematics curriculum was organized into courses is in the discretion of the governing bodies of each education system. (Curriculum Leadership Institute, n.d.). The CCSS also provided guidance for which standards should be taught in each course of the traditional curriculum and the integrated mathematics curriculum. Though the integrated mathematics curriculum was not necessarily endorsed by the Common Core State Standards, it is a byproduct, and many states implemented the curriculum in response to the standards (Ferguson, 2016).

North Carolina schools are experiencing funding obstacles in implementing the integrated curriculum. Financial difficulties are translating into insufficient materials and textbooks to support the switch to the integrated curriculum (Will, 2014). The availability of materials designed specifically for the integrated curriculum has also been questioned (Holzmeyer, 2014); and, when available, the financial aspect of acquiring these materials places a significant burden on school systems.

Implementing the integrated mathematics curriculum requires significant commitment to the change. Changing from a traditional curriculum to an integrated mathematics curriculum would place students in mathematics courses without being taught prerequisite concepts and skills. This forces school districts to implement the integrated curriculum through phases, removing the possibility of student learning gaps due to the transition (Curriculum Leadership Institute, n.d.). To further complicate implementation, schools must determine specific policies for incoming transfer students and the students who are unsuccessful in the course being phased.
out. Maintaining both curriculum pathways during this phase-in process can drain funds, resources, and hinder teacher preparation.

J. Michael Shaughnessy (2011), NCTM President, mentions numerous reasons for opposition to the integrated curriculum: fear of change, the incorrect perception that colleges do not accept integrated math credits, and financial constraints. Conversely, he also noted that these reasons should not take precedent over the benefits and opportunities that the integrated mathematics curriculum presents.

Summary

The Integrated Mathematics Curriculum is a shift from the traditional curriculum in the United States. Integrated mathematics builds skills and conceptual knowledge from algebra, geometry, and statistics over the course of three years (Tatter, 2015). The integrated mathematics curriculum weaves several mathematics topics into single courses, which is more in line with the curriculums of schools in countries that achieve at greater levels in mathematics (Hurst, 2013). Each year in the curriculum includes topic integration appropriate to student abilities through a problem-centered approach and emphasis on problem-solving. This emphasis provides a plethora of contexts for students to learn and reinforce concepts (Beal, Dolan, Lott, & Smith, 1990), and makes connections in their knowledge of the different strands of mathematics.

The integrated mathematics curriculum and the traditional mathematics curriculum are formulated around the same mathematics standards. The traditional curriculum focuses the learning of segmented standards into partitioned courses, whereas the integrated curriculum overlaps the standards in a way that demonstrates the relationships between algebraic and geometric concepts (Ferguson, 2016). This is integral to student learning, because algebra and geometry are not mutually exclusive. The traditional sequence of Algebra 1, Geometry, and
Algebra 2 is often abhorred for its lack of rigor and lack of development of procedural fluency; the perception of the integrated mathematics curriculum is that it helps build student conceptual understanding and promotes procedural fluency (Kanold, 2014). Student learning of the numerous geometric and statistical topics is enhanced through the incorporation of algebraic procedures or concepts, and vice versa.

Students from the integrated math classrooms generally achieve higher standardized test scores than those from traditional classes (Tarr, Grouws, Chávez, & Soria, 2013). The curriculum is utilized in countries like Japan, Singapore, and South Korea, and students from these countries outperform United States’ students in mathematics proficiency tests. O’Donnell (2017) stated that the integrated mathematical approach to learning taps into student metacognitive skills by helping them understand the connective relationships among concepts and the overarching strands of mathematics. Despite these points, the Integrated Mathematics Curriculum is implemented in less than 10% of United States’ high schools (Shaughnessy, 2011).

The CCSS have been a catalyst for change in that regard, however (Hanover Research, 2015). The integrated curriculum is beginning to grow in popularity among United States’ high schools, as many school systems are turning toward the integrated mathematics curriculum to better prepare their students for collegiate mathematics programs and real-world mathematical practice and applications (O’Donnell, 2017). Accordingly, teachers, school systems, and other stakeholders need to be prepared to fully commit to the implementation. Funding and training are incredibly integral to the success of integration, specifically teacher professional learning opportunities (Mallanda, 2011).
While the Integrated Mathematics Curriculum has proven to strongly correlate to high student achievement (Lemont High School, n.d.), teacher effectiveness is paramount; teacher effectiveness - proven pedagogy and best practices - makes the greatest impact on student achievement. Much of the success of students on standardized tests should be attributed to teacher competency rather than the scope and sequence of the topics within the curriculum (Kanold, 2014).

The subsequent aspects of this research focus on the pedagogical strategies and best practices of mathematics teachers in order to maximize student mathematics proficiency.
CHAPTER 3: METHODOLOGY

The purpose of this study was to find ways in which educators can better help students make connections through improved teaching pedagogy, best practices, and effective strategies. A qualitative approach was chosen to for this study to compile teacher perceptions of student achievement and understanding, as well as their perceptions of which practices and strategies boosted student proficiency in the Integrated Mathematics Curriculum.

This chapter was organized as follows: research questions, research approach, research setting and participants, data collection instruments procedures, ethical considerations, data analysis, and summary.

Research Questions

In this study, the qualitative data were acquired and analyzed regarding the following research questions:

1. How does the perceived connectedness of topics within the Integrated Mathematics Curriculum affect teacher pedagogy and content delivery?
2. What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

Research Approach

To sufficiently answer the posed research questions, the study utilized a qualitative model. The qualitative research model is designed to “reveal a target audience’s range of behavior and the perceptions that drive it,” (Qualitative Research Consultants Association, 2018). In order to effectively gather teacher, math coach, and administrator perceptions, surveys, interviews, and observations were utilized. These data sources provided descriptive data on
which practices and pedagogy are perceived to be the most suitable and effective for improving student mathematics achievement.

The surveys and interviews afforded the teachers, math coaches, and administrators opportunity to provide in depth analysis of the integrated mathematics curriculum along with successful practices and strategies that each individual has employed or observed in their tenure. The interview process enabled the educators and administrators to divulge personal recollections of their lessons that were successful.

The observations of successful mathematics teachers provided triangulation for the research. The observations were a first-hand account of the best practices and pedagogical strategies described by the educators, and their accounts of these practices and strategies were bolstered through the perceived understanding of the students via their reactions and performance on the in-class assessments.

The qualitative research model allowed the study to accumulate data through the surveys, interviews, and observations and make connections between responses and observations. The connections that were made allowed the study to make assumptions pertaining to the mathematics classroom and the pedagogy and practices that maximize student learning.

The assumptions made in this study are used to develop theories for which practices are best suited for the integrated mathematics classroom. As such, grounded theory was employed as the approach for data collection and analysis within the qualitative research model. The grounded theory approach enabled the use of interviews and observations of participants, developing conceptual ideas found in the coding and placed into categories. The grounded theory is known as a constant comparative method (Ruppel & Mey, 2017), allowing the compilation the
data and compare responses to formulate theoretical practices for later utilization in the Integrated Mathematics Curriculum.

**Research Setting and Participants**

The study involved a single school in suburban East Tennessee. The school is a high school composed of approximately 1,500 students with the following demographics: 3% African American, 91% White, 1% Asian, and 5% Hispanic. Of these students, 16% were considered economically disadvantaged and 7% of the students had disabilities (Tennessee Dept. of Education, n.d.). Teachers, administrators, and math coaches who were willing to volunteer were surveyed. Two teachers from each Integrated Mathematics Curriculum course, one system-level mathematics coach, and two school administrators were interviewed. One teacher from each academy – Science Technology Engineering & Math (STEM) Academy, Humanities Academy, Medical/Business Academy (MBA), and Freshman Academy – was observed. The interviews and observations allowed notation of any subtleties between pedagogy and best practice between grade levels and within each academy. The responses to the surveys influenced the questions posed in the interviews and the focus of the observations.

**Data Collection Instruments and Procedures**

Prior to data collection for the study, permission for research was granted by the Carson-Newman University Institutional Review Board. Permission was also received from the research school district to perform the study.

Data were collected through three mediums: survey, interview, and observation. The study first surveyed teachers, administrators, and math coaches pertaining to their efficacies and beliefs for inducing student understanding in the integrated mathematics classroom. A Likert-style survey was administered, asking teachers and math coaches to provide their level of
agreement regarding their beliefs on whether using particular practices and pedagogy in their mathematics instruction led to increased student achievement and understanding. The answer choices were rated as follows: *strongly disagree, disagree, neither agree or disagree, agree, strongly agree*. The survey also included open-response questions for teachers to provide other practices and pedagogy they use to increase student understanding and proficiency in the integrated classroom. The open-ended nature of these questions afforded participants opportunity to provide specific instances of their pedagogy and practices leading to increased student engagement and achievement. The responses gathered in the study were utilized in constructing individual interview questions and provided the framework for the observation aspect of the data collection phase. Survey participants were provided an informed consent form (See Appendix A) and the link to the survey, administered through Google Forms.

The second phase of the data collection process was the interviewing of willing educators and mathematics coaches, as per their response to a question in the initial survey concerning their willingness to participate in the interview process. Participants in the interviews were given their survey responses for member checks and to expound upon their open response answers; questions were asked regarding their own specific responses in the surveys. Remaining interview questions were asked to garner a better understanding of the practices and pedagogy to help students make connections among mathematics strands in the integrated curriculum. With constructivism as the theoretical framework of the study, the research investigated ways in which educators help students construct their own meaning and understanding of new concepts using known, mastered skills. The direction of each participant’s interview relied on the direction of the discussion of pedagogy and best practices. Thus, allowing the participants to display their
personal efficacies on the integrated mathematics curriculum as well as their own personal experiences in the classroom.

The third and final aspect of the data collection process were observations of mathematics educators. The observations were conducted to witness the pedagogy, delivery styles, and practices of the educators from multiple academies; the students in these academies are grouped by learning style, interests, and aptitude testing, providing opportunity to view differentiated instructional techniques and practices. The constructivist nature of the study made these observations necessary, as they were a display of the participant’s efficacies and beliefs of effective pedagogy and best practices for helping students make connections within the integrated mathematics curriculum; observing participants of the different levels of the integrated mathematics curriculum and from multiple academies exemplified the effective strategies tailored for specific learners. Participants were chosen from the same pool of participants that indicated their willingness to participate in the initial survey.

**Ethical Considerations**

The study began with the authorization process from the Carson-Newman University Institutional Review Board. Upon authorization by the IRB, permission to conduct the study was granted from the research district and the principal of the research school. Potential participants were contacted and interest in participation in the study was gauged. System, school, principal, and participant identities are not revealed for the sake of confidentiality; rather, pseudonyms were assigned to identify participants.

Anonymity was ensured for the duration of the study, and participants were informed of the procedure, purpose, and confidentiality preserved throughout the study. Participants signed an informed consent document prior to interviews, surveys, and observations. Permission to
audio record interviews was required and granted by the participants in that portion. Notes, conversations, and answers were transcribed in the report, with participant checks to ensure consistency, reliability, and a lack of bias were preserved. A peer debriefing colleague further ensured a lack of bias throughout the study and established credibility (Cooper, 1997) of the study in regard to the integrated mathematics classroom. The peer debriefer probed for the possibility of bias prior to data collection, evidence of bias and meaning within the data collection process and the analysis of each set of data.

**Data Analysis**

For each of the data sources, the same sequence of coding strategies was utilized to find relationships and categorize data: open coding, axial coding, then selective coding. The Likert-scale portion of the survey requires Spearman’s coefficient to analyze the strength of relationships between variables, and the open response answers were read, analyzed, and grouped into concepts. Interview responses were recorded, with the consent of the participant, and transcribed. Notes were taken during the observation, which were compiled alongside the interview transcripts and notes.

As the initial analysis of data, open coding was employed to determine concepts and connections among survey responses. Khandkar (n.d.) suggests grouping raw data based on their properties and dimensions, and to name them accordingly. The raw data was examined and grouped into related responses by their connectedness to the many aspects of pedagogy and best practice. Axial coding allowed the categories and concepts developed in the open coding process to be compared and contrasted. In doing so, commonalities were found within the survey results, interview answers, and the observations in the classrooms, as the axial coding process requires examination of the big, overarching concepts and categories in order to make
specific connections among data entries. Relationships among these categories and concepts were found. Selective coding was used to determine which responses highlighted desired and intriguing practices and pedagogy.

Data was analyzed as it was collected. The data resulting from the survey responses was analyzed first. The categories and concepts developed in this analysis provided the framework for the interview questions. The surveyed pedagogy and practices that enabled students to make connections or construct their own meaning were integral to selecting interview participants and questions, as the theoretical framework is constructivism. The interview participants bolstered their survey responses with specific instances where certain practices and pedagogical strategies helped students make connections among mathematics strands and their prior knowledge; observed participants were able to provide visual representations of their survey responses while exemplifying practices and strategies for building student understanding.

Throughout the data collection and analysis process, participants were granted opportunities to check their responses to ensure their participation in the study was accurately reflected. The interview process and observations enabled educators to expound and exemplify their own responses with specifics. The participants were granted opportunities to delve deeper into their responses and the study’s analysis of their responses to ensure the study was bias free.

Summary

This study utilized a qualitative research model to be more descriptive of the best practices and pedagogy that teachers believed to be most effective in enabling students to better understand mathematics in the Integrated Mathematics Curriculum. Grounded theory was implemented to collect and analyze data via interviews, surveys, and observations, and categories consisting of related responses were identified and constantly compared (Ruppel &
Mey, 2017). The responses, efficacies, and techniques of the teachers, math coaches, and administrators provide sufficient regard to the posed research questions and allow inference to best practices and pedagogy for instruction in the Integrated Mathematics classroom.
CHAPTER 4: PRESENTATION OF FINDINGS

Introduction

The purpose of this study was to determine ways educators help students make connections among the different strands of mathematics. To best gauge educator efficacies of the subject, the study focused on the efficacies and perceptions of best practices and pedagogy utilized in instruction of integrated mathematics curriculum. All three phases of data collection and research in the study were all completed during normal school hours. A teacher survey was utilized through Google Forms, and was distributed to educator and administrator school emails; interviews were conducted in participants’ planning periods and were recorded and transcribed to afford participant member checks; observations were utilized during a participant’s desired integrated mathematics class and notes were taken on Google Docs.

Two research questions were the guides for this study:

3. How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery?

4. What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

Description of Participants

A majority of the study was conducted within a suburban East Tennessee high school, with the only exception being the inclusion of a district-wide employee. The high school has approximately 1,500 enrolled students from grades 9-12. The survey was sent to the school’s entire mathematics faculty (15 teachers), all five school administrators, and one county-level administrator. The survey garnered 15 total participants, including 13 of the school’s mathematics faculty, one school administrator, and one district-wide mathematics coach; 10 of
the participants were female and 5 were male. The 12 mathematics educators from the school represented each integrated mathematics course and each of the school’s four learning academies (STEM, Humanities, MBA, and Freshman Academies).

Of these 15 participants, 10 indicated, via a survey question, their willingness to continue participation in the study into the interview and observation processes. Each of the 10 were utilized in one of the remaining data collection instruments. Six participants were strategically selected to be interviewed, with participants representing each of the four academies. One participant from each academy was selected to be observed. Table 4.1 below depicts the number of participants within each academy, integrated mathematics course taught, and role.

Table 4.1

Categorization of Participants by Subject and Academy

<table>
<thead>
<tr>
<th>Subject</th>
<th>Freshman Academy</th>
<th>Humanities Academy</th>
<th>STEM Academy</th>
<th>MBA Academy</th>
<th>Total Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Math 1</td>
<td>5</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Integrated Math 2</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td>Integrated Math 3</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Administration</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
**Data Collection Process**

An educator survey was the first component of the data collection process. The survey was administered via Google Forms to the entire mathematics faculty and administration at the participating high school. Fifteen participants voluntarily completed the survey with the assurance that responses would remain anonymous. The survey was utilized to gauge educator perceptions and efficacies regarding aspects of the integrated mathematics curriculum and their preferences of strategies and practices to enable students within their mathematics instruction.

Of the 15 responding participants, 10 indicated their willingness to further their involvement in the study, six of whom were selected to be interviewed. The interviews allowed educators and mathematics coaches to elaborate on their beliefs, efficacies, and practices indicated in the survey. The participants were provided their survey responses and could review their responses for any misconceptions from their survey. The interviews were audio recorded and transcribed to allow the study to better gauge their perceptions and efficacies of the integrated mathematics curriculum and their role as educator within the students’ learning of the curriculum. The interview questions were based on each participant’s survey responses, which provided the participant ample opportunity to elaborate on specific instances of the practices and strategies he/she has used within his/her instruction. The data collected in the interview process helped prompt the research toward answering the initial research questions.

Observations were the third phase of the data collection process. Four educators, one from each of the school’s academies, were observed with the intent of first-hand accounts of solid pedagogy and best practices associated with student achievement. Notes were recorded during the observation of each participant.

**Description of the Survey**
To gain a base understanding of teacher perceptions and understanding of practices and pedagogy for teaching integrated mathematics, an online survey was disseminated to all participants. The survey included ranking, Likert-style, and open response questions. Reference Appendix A for specific survey questions and format.

**Survey Findings**

Upon completion of the survey data collection, the data were coded and analyzed for themes among participant’s efficacies and perceptions of the integrated mathematics curriculum and the pedagogy and practices associated. Questions 1 and 2 asked participants their familiarity with the curriculum and their comfort with teaching the numerous strands of mathematics, with participant responses rating from 1 (least) and 5 (most). In Question 1, participants’ average familiarity of the principles of the integrated mathematics curriculum was a 4.2 out of 5. In Question 2, participant comfort level in teaching each of the mathematics strands was a 4.13 out of 5. Table 4.2 depicts the responses – and the percentages in parentheses – to questions 1 and 2.

**Table 4.2**

*Rating scale responses for participants’ personal level of familiarity with the integrated curriculum and their comfort level for teaching the many strands of mathematics.*

<table>
<thead>
<tr>
<th>Question</th>
<th>1 (least)</th>
<th>2</th>
<th>3 (20)</th>
<th>4</th>
<th>5 (most)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 1</td>
<td>0 (0)</td>
<td>0 (0)</td>
<td>3</td>
<td>6 (40)</td>
<td>6 (40)</td>
</tr>
<tr>
<td>Question 2</td>
<td>0</td>
<td>0</td>
<td>4 (27)</td>
<td>5 (33)</td>
<td>6 (40)</td>
</tr>
</tbody>
</table>

Questions 1 and 2 help to provide validity to the responses of the participants. Their perceived understanding of teaching the integrated mathematics curriculum builds confidence in the strategies they propose to help students make connections within instruction.
Table 4.3 displays the data collected from Questions 3-6. These questions required participants to state their level of agreement on the following topics: the importance of real-world connections, the importance of emphasizing connections to other mathematics strands, the effect of discovery learning on student understanding, and the effectiveness of system professional development, respectively.

Table 4.3

*Likert Scale Survey Responses*

<table>
<thead>
<tr>
<th>Question</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neither Agree nor Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Question 3</strong></td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td><strong>Question 4</strong></td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td><strong>Question 5</strong></td>
<td>0</td>
<td>0</td>
<td>4</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td><strong>Question 6</strong></td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>2</td>
</tr>
</tbody>
</table>

The integrated mathematics curriculum is predicated upon the notion that students learn best when presented material in a logical progression, as opposed to segmented algebra or geometry concepts. Participant responses to Questions 3 and 4 indicated that the teachers strongly favor the same ideals as the integrated mathematics curriculum. One hundred percent of participants agree or strongly agree that students need to be provided real world connections within their mathematics instruction, and 93% of participants agree or strongly agree that mathematics instruction should emphasize the connections between mathematics strands within their mathematics instruction.
Table 4.4 depicts the frequency participants bridge concepts among mathematics strands and utilize tasks within their mathematics instruction.

<table>
<thead>
<tr>
<th>Question</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 7</td>
<td>0</td>
<td>1</td>
<td>5</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Question 8</td>
<td>0</td>
<td>0</td>
<td>7</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

Table 4.4 demonstrates that over half of the participants are deliberately incorporating ways to help students make connections within their instruction, with another 33% doing so at least some of the time. The participants in this study also indicated that tasks are utilized at a substantial frequency to make students think through their mathematics repertoire and utilize pertinent information to solve problems, as shown via the 100% response rate of using tasks at least sometimes.

**Open-ended Question 9.**

Question 9 from the initial survey was the first open-response question. The response data were analyzed, and prevailing themes became apparent. Table 4.5 below details the themes and findings from Question 9.
Table 4.5

What practices and pedagogy strategies are, in your opinion, integral to successful mathematics instruction?

<table>
<thead>
<tr>
<th>Participant/Subject</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1/Math 2</td>
<td>Share. Pair Group Discovery/Peer mentoring/ Project based learning</td>
</tr>
<tr>
<td>P3/Math 1</td>
<td>I do not have all of the latest formal names for the practices and strategies so I will do my best to describe what I believe to be the integral parts of mathematics instruction. I know students need to connect each lesson to a bigger picture they find value in. That big picture may be something real-world or just something that strikes their interest. Either way, the many details and tiny rules of math that we are required by the state to teach every student regardless of where they are headed in the future need to explore in many ways so that students have the opportunity to make that big picture connection. To do this, students take detailed notes, complete problems that apply each detail, then hopefully apply those skills to a larger project or context that connects with the real-world.</td>
</tr>
<tr>
<td>P4/Math 2</td>
<td>The introduction of topics and creating a solid foundation of understanding before introduction of more in-depth problems is crucial.</td>
</tr>
<tr>
<td>P5/Math 1</td>
<td>Making sure the students understand the basics.</td>
</tr>
<tr>
<td>P6/Math Coach</td>
<td>Teaching standards graphically, numerically, algebraically, and verbally is pivotal to student success with mathematics instruction, specifically for integrated mathematics. Sharing with students the why and the purpose and the connections to mathematics is also vital to their success.</td>
</tr>
<tr>
<td>P7/Math 2</td>
<td>Group discussion of mathematics; Discovery of mathematical principles; Tasks; Real world applications</td>
</tr>
<tr>
<td>P8/Math 3</td>
<td>Numerical, algebraic, and graphical examples should be taught so students can make connections to all models.</td>
</tr>
<tr>
<td>P9/Administrator</td>
<td>N/a</td>
</tr>
<tr>
<td>P10/Math 1</td>
<td>think-time; partner work; encouraging students to talk out loud about their process presenting the information differently for students; investigation activities; practice/work time; critical thinking problems</td>
</tr>
<tr>
<td>P11/Math 2</td>
<td>I use the workshop method pretty consistently in my instruction and students seem to respond well and it helps break up the block schedule.</td>
</tr>
<tr>
<td>P12/Math 1</td>
<td>A scaffolding approach where the teacher demonstrates an &quot;I-do, You-do&quot; method. This is coupled with a primary focus on conceptual understanding.</td>
</tr>
<tr>
<td>P13/Math 1</td>
<td>sufficient time to practice skills learned, exploration of concepts before teaching, projects that apply the skills learned</td>
</tr>
<tr>
<td>P14/Math 3</td>
<td>Tasks, allow students to retake, group discussions, productive struggle</td>
</tr>
<tr>
<td>P15/Math 1</td>
<td>Scaffolding, group discussions, tasks</td>
</tr>
</tbody>
</table>
Analysis of the responses to Question 9 revealed certain themes regarding the practices used in integrated mathematics classrooms.

**Table 4.5a**

*Key Findings from Open-ended Question 9*

<table>
<thead>
<tr>
<th>Key Findings</th>
<th>Number of Participants (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group/Partner Discussions and Discovery</td>
<td>6 (40)</td>
</tr>
<tr>
<td>Connecting the Why, the Real-world, and Other Mathematics</td>
<td>5 (33)</td>
</tr>
<tr>
<td>Scaffolding</td>
<td>4 (27)</td>
</tr>
<tr>
<td>Sharing Work and Thinking with the class</td>
<td>4 (27)</td>
</tr>
</tbody>
</table>

In analyzing participant responses, certain ideals were prevalent. Forty percent of participants believe that mathematics instruction should include group or partner discussions about the mathematics being learned, or these groups should discover mathematics among themselves. The emphasis was on learning as a group. In these groups, Participant 13 shared that these opportunities should be an “exploration of concepts before teaching” or be “projects that apply the skills learned” in the lesson.

Participants believe that there should be substantial thought and effort placed into making deliberate attempts to provide a “why” for learning, with 33% of participants mentioning that connecting the real-world or other mathematics concepts with the why of the lesson is integral to success. Participant 3 stated “students need to connect each lesson to a bigger picture they find value in. That big picture may be something real-world or just something that strikes their
interest.” Students need to be given meaning to their learning; Participant 6 stated that the why, the purpose, and mathematical connections are “vital” to student success and mastery of content.

Additionally, 27% of participants discussed sharing work and thinking with the class. Participant 10 stated that students should be given the opportunity and encouraged to think and talk out loud with their peers to help with the mathematical processes and concepts. Participant 2 shared that having to present their work and understanding to the class is an important aspect of integrated mathematics instruction.

**Open-ended question 10.**

Question 10 from the survey asked participants to detail how they believed the practices they mentioned in the previous question helped students make connections among the different strands of mathematics. Table 4.6 depicts the key findings of the responses.
Table 4.6

*How do the practices and strategies listed in Question 9 help students make connections among the different strands of mathematics?*

<table>
<thead>
<tr>
<th>Participant/Subject</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1/Math 2</td>
<td>Safe place to make mistakes/ ask questions/ build off each other’s strengths. Also, when they apply math to meaningful real-world applications it gives significance to the process.</td>
</tr>
<tr>
<td>P2/Math 3</td>
<td>It helps make the learning more on the student.</td>
</tr>
<tr>
<td>P3/Math 1</td>
<td>By linking the detailed lessons to a larger project or real-world project (not all lessons allow for this connection) the different strands can be brought in as needed. Real life connection with math is difficult to see because real life doesn't use just a single lesson of math. It uses many concepts (and strands) together. This is why integrated math leads to real life connection more than the traditional path. There is still a lot of work to do to make all lessons connect with real-world but integrated math is a good start.</td>
</tr>
<tr>
<td>P4/Math 2</td>
<td>Students can only develop a deeper understanding of a topic when they understand basics of mathematics.</td>
</tr>
<tr>
<td>P5/Math 1</td>
<td>It helps them to understand how it all connects.</td>
</tr>
<tr>
<td>P6/Math Coach</td>
<td>The practice of teaching graphically, numerically, algebraically, and verbally help students connect mathematics algebraically and geometrically. They are more likely to understand how algebraic concepts are applied in a geometric setting and how geometric truths and properties support the algebraic process.</td>
</tr>
<tr>
<td>P7/Math 2</td>
<td>Students can connect prior knowledge of a variety of concepts to build their understanding of other principles.</td>
</tr>
<tr>
<td>P8/Math 3</td>
<td>I believe they will truly understand mathematical process at any level if these numeric, algebraic, and graphical connections are made.</td>
</tr>
<tr>
<td>P9/Administrator</td>
<td>N/a</td>
</tr>
<tr>
<td>P10/Math 1</td>
<td>During investigation/critical thinking activities, students are able to use their prior knowledge (learning from different strands of mathematics) to help them solve problems.</td>
</tr>
<tr>
<td>P11/Math 2</td>
<td>The workshop method helps students start vying for themselves and for their own learning. They also learn that mistakes are not final, that they just need to work at it from whatever point they’re at.</td>
</tr>
<tr>
<td>P12/Math 1</td>
<td>Ideally, if a student is able to understand the overall concept (the &quot;Why?&quot;) then it will provide reason and purpose for learning the procedures (the &quot;How?&quot;). If the concept is the primary focus of the lesson, then this allows for multiple connections to be made across all strands.</td>
</tr>
<tr>
<td>P13/Math 1</td>
<td>Exploration: they may be able to pull from skills they have already learned in order to help them explore and discover new content knowledge. The students also are engaged since these are generally real-world contexts. Projects: typically pull in multiple skills into one larger product students are producing.</td>
</tr>
<tr>
<td>P14/Math 3</td>
<td>Students can discuss any mistakes they have made and compare their work to what others have done. The group discussions tend to lead students to ways to fix any mistakes made and help understand content.</td>
</tr>
<tr>
<td>P15/Math 1</td>
<td>Scaffolding helps students build on their current understanding towards higher order thinking and mastery. Group discussions allow students to talk about their learning with one another or with the class. The students help one another in their understanding as they can relate better with their peers. Tasks require students to use all kinds of mathematical knowledge. Oftentimes they are not required to start with difficult concepts/skills but work up to the more difficult aspects. Tasks also allow students to work alongside one another and drive their own understanding from and with their peers.</td>
</tr>
</tbody>
</table>
Table 4.6a

*Key Findings from Open-ended Question 10*

<table>
<thead>
<tr>
<th>Key Findings</th>
<th>Number of Participants (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safe Place for Mistakes</td>
<td>4 (27)</td>
</tr>
<tr>
<td>Provide Significance for the Mathematics</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Understand the Basics/Make Connections</td>
<td>9 (60)</td>
</tr>
</tbody>
</table>

Question 10 asked participants why they believed their practices and pedagogical strategies were integral to helping students make connections within the integrated mathematics classroom. In analyzing responses, 27% of participants believe their practices help promote a safe place for students to make and learn from mistakes. Participant 11 stated, “Mistakes are not final, they just need to work at it from whatever point they’re at.”

Sixty percent of the participants believe their practices and pedagogy help students to better understand the basics, which promote the development of mathematics connections within the students. Participant 4 stated “Students can only develop a deeper understanding of a topic when they understand basics of mathematics.” Promoting the connections to the real-world, teachers better prepare their students for future mathematics problems they may face. Participant 3 stated that when “linking the detailed lessons to a larger project or real-world project, the different strands can be brought in as needed.” Real life doesn't use just a single lesson of math. It uses many concepts (and strands) together.

Providing significance, or a why, for the mathematics lesson was also a key element found in the data. Participant 12 answered “If a student is able to understand the overall concept (the "Why"), then it will provide reason and purpose for learning the procedures (the "How?").”
Open-ended question 11.

Participants were asked to provide any practices and strategies they have utilized to pique student interest and heighten engagement in the mathematics classroom. Participant responses were analyzed, and more themes were apparent. The response themes and prevalence in participant responses are listed in Table 4.7.

Table 4.7
What strategies and practices have you used to promote student engagement in the integrated mathematics classroom?

<table>
<thead>
<tr>
<th>Participant/Subject</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1/Math 2</td>
<td>Project based learning/ Cross curricular projects</td>
</tr>
<tr>
<td>P2/Math 3</td>
<td>Students bringing their work up to the board and have students talk through their own work.</td>
</tr>
<tr>
<td>P3/Math 1</td>
<td>Our district has trained us in Kagan Strategies. These have helped with engagement. Each class and each student are different so having many strategies to choose from is helpful. Other things have been games, competitions, using geometric tools, and discovery lessons.</td>
</tr>
<tr>
<td>P4/Math 2</td>
<td>Expanding on understanding of quadratic functions by building rockets and calculating the flight paths and the equation associated with the flight. Taking a selfie that includes a parabolic curve &amp; graphing it with all details.</td>
</tr>
<tr>
<td>P5/Math 1</td>
<td>question &amp; answer, group activities, class activities or projects, interactive lessons</td>
</tr>
<tr>
<td>P6/Math Coach</td>
<td>Implementing Kagan structures and clock appointments (where each student has 4 different partners assigned at a certain &quot;time&quot; deemed by the teacher) promote student engagement. Also, setting a culture of collaboration with the students and a &quot;math family&quot; was imperative to their ability to work together. My students would all be giants throughout the year &quot;for if I have seen farther than others, it's because I have stood on the shoulders of giants.&quot; I was not the only giant in the classroom and students knew we all depended on each other. Lastly, I gave problems and scenarios and tasks to students that weren't easy-that required them to engage and work together. This high expectation I set for the courses promoted student engagement and learning.</td>
</tr>
<tr>
<td>P7/Math 2</td>
<td>Kagan Strategies; Sit and work in groups; Discussion of mathematical problems in groups; Quizlet live</td>
</tr>
<tr>
<td>P8/Math 3</td>
<td>Students are encouraged to work individually, with partners, and in groups.</td>
</tr>
<tr>
<td>P9/Administrator</td>
<td>N/a</td>
</tr>
<tr>
<td>P10/Math 1</td>
<td>Online resources - Kahoot, Quizlet live, Quizizz; Scavenger Hunt - Walk around the room; Whiteboard Activities; Projects</td>
</tr>
<tr>
<td>P11/Math 2</td>
<td>Promoting the productive struggle into students, creating a growth mindset and showing students anyone can learn math with enough practice</td>
</tr>
<tr>
<td>P12/Math 1</td>
<td>cooperative learning groups, project-based learning, immediate response technology</td>
</tr>
<tr>
<td>P13/Math 1</td>
<td>group work, interactive notes, use of color coding, hands-on</td>
</tr>
<tr>
<td>P14/Math 3</td>
<td>Kagan, group work</td>
</tr>
<tr>
<td>P15/Math 1</td>
<td>Kahoot, Kagan Strategies, partner practice (sage and scribe)</td>
</tr>
</tbody>
</table>
Participant responses in Question 11 revealed three central ideals of the participants. These educators and administrators believe that a “Culture of Collaboration” should be implemented in classrooms throughout, with 47% of participants highlighting its importance in their classrooms. Forty percent mentioned Project-based Learning and Discovery Learning as an integral practice for heightening student engagement, and 33% noted they utilize Kagan strategies.

The premise of culture of collaboration derived from the following response from Participant 6: “setting a culture of collaboration with the students was imperative to their ability to work together.” This participant also stated that the teacher cannot be the only one with mathematical wisdom; the students needed to also depend on one another, also. Participant 15 mentioned “sage and scribe” as a method to engage students with the mathematics and with one another. Participant 11 stated that students need to participate in productive struggles together. They need to develop a growth mindset and know anyone can learn.

Open-ended question 12.

In the final open-ended question of the survey, participants described their utilization of technology to supplement their integrated mathematics instruction, help make connections
among mathematics strands, or increase student engagement. The responses were analyzed and categorized in Table 4.8.

**Table 4.8**

In your integrated mathematics classes, how have you utilized technology to supplement instruction, help make connections among mathematics strands, or enhance student engagement?

<table>
<thead>
<tr>
<th>Participant/Subject</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1/Math 2</td>
<td>Document camera/ Interactive math websites/ Graphing calculator applications</td>
</tr>
<tr>
<td>P2/Math 3</td>
<td>Google classroom to give students access to the notes.</td>
</tr>
<tr>
<td>P3/Math 1</td>
<td>Teaching 9th graders offers great enthusiasm for the TI-84 calculator. They are amazed at every feature it does. Implementing this now instead of in later grades has proven to enhance engagement. Students are also shown how to research math topics on their own (videos aren't always the most engaging, but they love using their phones). Due to limited availability, whole class technology isn't used.</td>
</tr>
<tr>
<td>P4/Math 2</td>
<td>Having students submit a selfie that describes a selfie, then graph it on computer with Desmos technology, and describe all pertinent data. Using google classroom</td>
</tr>
<tr>
<td>P5/Math 1</td>
<td>I use the smart board and calculators</td>
</tr>
<tr>
<td>P6/Math Coach</td>
<td>The TI-84 calculator supported students' understanding graphically, numerically, and algebraically. I would teach each standard with each methodology and then allow students to solve subsequent problems as they saw fit. The document camera also provided a great environment for students to share different solution pathways and make connections between approaches--which kept students engaged to see if their way was validated.</td>
</tr>
<tr>
<td>P7/Math 2</td>
<td>Creating and analyzing graphs in Desmos Quizlet Live for student engagement</td>
</tr>
<tr>
<td>P8/Math 3</td>
<td>We use the graphing calculator at our desks and use the calculator with the Smart board.</td>
</tr>
<tr>
<td>P9/Administrator</td>
<td>N/a</td>
</tr>
<tr>
<td>P10/Math 1</td>
<td>Review Games online Desmos tools and games online</td>
</tr>
<tr>
<td>P11/Math 2</td>
<td>I use Desmos a lot. Kahoot for review. A smart board every day. I also use my pocket lab to demonstrate data collection and regression. I also use Mathalicious for tasks.</td>
</tr>
<tr>
<td>P12/Math 1</td>
<td>It has been used to provide extra support material and additional resources to different lessons. I am able to gain immediate feedback as to the progress of students through quick response platforms.</td>
</tr>
<tr>
<td>P13/Math 1</td>
<td>I use technology to present material, but don't use it often for students to complete tasks.</td>
</tr>
<tr>
<td>P14/Math 3</td>
<td>I have done flipped classrooms and use websites like Desmos to compare functions.</td>
</tr>
<tr>
<td>P15/Math 1</td>
<td>Kahoot, graphing calculator aid through computer program, Google Classroom for turning work in and accessing notes and other class work, Document Cam to show students the multiple solution pathways</td>
</tr>
</tbody>
</table>
Table 4.8a

**Key Findings from Open-ended Question 12**

<table>
<thead>
<tr>
<th>Key Findings</th>
<th>Number of Participants (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Graphing Calculator Applications</td>
<td>10 (67)</td>
</tr>
<tr>
<td>Google Classroom</td>
<td>3 (20)</td>
</tr>
<tr>
<td>Interactive Websites</td>
<td>5 (33)</td>
</tr>
<tr>
<td>Document Camera</td>
<td>4 (27)</td>
</tr>
</tbody>
</table>

Participant responses, when analyzed, showed that the educators preferred four primary types and examples of technology to use in the mathematics classroom: graphing calculator applications, Google Classroom, interactive websites, and the document camera. Participants 2 and 15 mentioned Google Classroom’s use as a hub for lesson notes and supplemental materials. Thirty-three percent of participants noted interactive websites to help highlight and supplement specific mathematics lessons for their students.

A majority of the participants (67%) noted their utilization of either Desmos or the TI emulator software. These educators mentioned how these graphing calculator applications help students use their calculators to provide meaning to the mathematics or to help find solutions to the tasks at hand. Participant 3 mentioned using the TI emulator to help younger students to better understand the powers that are in the calculator. Participant 6 referenced those same powers in the calculator and stated that the calculator allows students another way to solve problems and tasks “how they see fit.”

The document camera was referenced in a similar manner. Specifically, Participants 6 and 15 shared that the document camera allows teachers and students to show their work on their papers. These participants utilized the document camera to highlight how mathematics processes
can be different but still result in the same, correct solution. According to Participant 6, educators use the document camera to “share different solution pathways and make connections between approaches--which kept students engaged to see if their way was validated.”

Questions 13 and 14.

Questions 13 and 14 were multiple select items. The participants were asked their level of experience teaching mathematics and whether they have taught each of the three integrated mathematics courses and levels within the courses.

Of the 15 participants, 14 currently, or have previously, taught mathematics. The data for these 14 participants’ responses are presented in Table 4.9 and Table 4.10, which provide visuals for these responses.

Table 4.9

*Participant Years of Experience*

<table>
<thead>
<tr>
<th>Years of Experience</th>
<th>Number of Participants (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 5 years</td>
<td>5 (36)</td>
</tr>
<tr>
<td>5-10 years</td>
<td>2 (14)</td>
</tr>
<tr>
<td>More than 10 years</td>
<td>7 (50)</td>
</tr>
</tbody>
</table>
Table 4.10

Participant Courses Taught

<table>
<thead>
<tr>
<th>Integrated Mathematics Course/Level</th>
<th>Number of Participants (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated Mathematics 1</td>
<td>8 (57)</td>
</tr>
<tr>
<td>Integrated Mathematics 2</td>
<td>8 (57)</td>
</tr>
<tr>
<td>Integrated Mathematics 3</td>
<td>9 (64)</td>
</tr>
<tr>
<td>Honors Level</td>
<td>12 (86)</td>
</tr>
<tr>
<td>Inclusion/Co-taught Level</td>
<td>8 (57)</td>
</tr>
</tbody>
</table>

Analysis of the Participant Interview Data

The second data collection phase included interviews of six of the participating educators. The educators chosen to be interviewed indicated their willingness to contribute further to the study via a question in the initial survey. The interviewed participants, their school learning academy, and their primary integrated mathematics course are listed in Table 4.11 below.
Table 4.1

<table>
<thead>
<tr>
<th>Participant</th>
<th>Academy</th>
<th>Primary Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>MBA</td>
<td>Integrated Math 3</td>
</tr>
<tr>
<td>P2</td>
<td>Humanities</td>
<td>Integrated Math 2</td>
</tr>
<tr>
<td>P6</td>
<td>Mathematics Coach</td>
<td>N/A</td>
</tr>
<tr>
<td>P7</td>
<td>STEM</td>
<td>Integrated Math 2</td>
</tr>
<tr>
<td>P12</td>
<td>Freshman Academy</td>
<td>Integrated Math 1</td>
</tr>
<tr>
<td>P14</td>
<td>STEM</td>
<td>Integrated Math 3</td>
</tr>
</tbody>
</table>

The questions asked in the interview process were predominantly focused upon clarification and details of participants’ survey responses. All participants were asked how they help their students make connections to the real world and how they help make connections to other mathematics strands within their instruction. The participants were also asked to expound upon their responses and provide detailed responses to specific pedagogy and practices they have used in their integrated mathematics class. A peer debriefing colleague, who did not participate in the study, probed for bias and possible misunderstandings within survey and interview questions. The interviews were conducted individually in a school setting during a timeframe chosen by the participant. Each participant chose to conduct the interview during his/her planning periods, other than one participant who chose to be interviewed immediately following the school day.

Through the data collected in these interviews, themes highlighted from the coding phase of the initial survey were even more prevalent throughout the interviews. The four main themes were as follows:
1. The building and maintaining of a culture of collaboration

2. Finding, celebrating, and promoting multiple solution pathways

3. Making deliberate connections to the real world, other mathematics strands, and the “why” of the lesson

4. The use of discovery learning and tasks

The responses to interview questions are noted below and categorized according to which theme most closely associated.

**Culture of Collaboration.**

Five of the interview participants mentioned collaboration as an effective strategy and practice to help students make connections in the integrated mathematics curriculum.

Participant 6 stated “No one gets anywhere without someone teaching them something.” The teaching should not only come from the teacher. Participant 6 further stated that the teacher should not be the only person with a wealth of knowledge, that the students have that wealth among themselves. Participant 2 said “I don’t like being the person in the front all the time doing the work. They need to be able to own it themselves and be proud of their work.”

Participant 12 identified the need for roles within collaborative learning and that the culture of the classroom must include fulfilling each role within a group, or the group does not work. Participant 7 stated that the students need to be comfortable with one another and hold each other accountable within the collaborative learning activity.

Participant 6 quoted Sir Isaac Newton “If I have seen farther than others, it’s because I’ve stood on the shoulder of giants,” and followed with the understanding that all students should have the role of giant at some point in the class. Participant 7 detailed the use of Quizlet Live to further that point. In Quizlet Live, each group has multiple participants and each participant has
multiple possible answers to a problem. Only one participant has the correct solution, so that student needs to be comfortable in the role of giant for his/her peers in that moment.

Participant 14 stated that collaboration helps with engagement; using Kagan strategies prompts students to talk about mathematics, which makes it more likely the lesson will be meaningful. Participant 7 also stated that the students, when provided time to stand up, walk around, and talk to their friends, are going to be more engaged. Subsequently, this engagement will enhance their learning. These instances, according to Participant 6, ensure the students are “doing the mathematics, constructing their own understanding, and helping their peers along the way”.

Participant 2 stated that the culture must make accommodations for mistakes. “It’s okay to be wrong as long as we work to fix it.” Participant 2 said that the students should know and believe that their greatest learning occurs after a mistake is made. Participant 14 detailed that it is acceptable for students to make mistakes, as long as they understand it’s acceptable to be wrong at times in mathematics; to learn from that mistake and attempt a different method or hypothesis.

Participant 7 stated that students must not be daunted by mistakes in the classroom; mistakes are not permanent, and the collaborative learning activity provides opportunity for students to critique each other’s understanding and overcome any misconceptions.

Participant 14 stated that productive struggle is important in the classroom. “Productive struggle allows students to see how their misconceptions about solving a problem can be overcome.” Participant 14 mentioned that seeing a mistake and how to overcome the mistake can impact how well the correction is learned and applied in future problems for the student.
making the mistake, as well as the students who are interacting and collaborating with that student.

**Multiple Solution Pathways.**

Three of the interview participants specifically mentioned the importance of highlighting multiple solution pathways. Participant 6 stated that teachers need to instill in their students that mathematics does not always follow one set procedure; students need to make connections to how they work problems and how others work the same problem, then discuss how or why both procedures were used to reach identical solutions.

Participant 2 stated that hovering is an effective practice for teachers to utilize while the students are working problems because it allows the teacher to discern how the students are working the problems. If two students are working the same problem differently, teachers should have these students present their work to the class to show the different solution pathways.

Participant 6 discussed the importance of highlighting different solution pathways for the students, stating “We have to create mathematical thinkers who jump into a problem and just try something, and if that something doesn’t work try something else.” Participant 6 stated that teachers can build mathematicians by promoting and celebrating different solution pathways when they occur, and, by showing that there are a plethora of ways to solve many mathematics problems, students become comfortable in attempting problems with whatever tools they deem acceptable.

Participant 7 stated that some students are not on grade level with certain concepts and procedures, but by promoting and celebrating different solution paths, they look for ways they can solve the problem. Participant 2 mentioned that promoting this type of problem-solving can
help other students when working collaboratively; students can discuss their procedure and realize more efficient pathways or better their own understanding.

Participant 6 noted the use of the document camera to help highlight and celebrate students who developed different solution pathways. This participant allowed students who worked problems in different ways to demonstrate their understanding of the problem through their own lens.

**Deliberate Connections to the Real-world, Other Strands and the Why.**

All six of the interview participants noted the importance of highlighting connections within the integrated mathematics curriculum and in their mathematics instruction. The participants mentioned deliberately helping the students realize connections to why students should learn the material, connections between learning concepts and real-world concepts, and connections to concepts and skills from other mathematics strands. Participant 12 noted that connecting the why, or real-world concepts, or other strands of mathematics must be deliberate, “Planning for the analogies and contexts allows the teacher to set up students to find worthwhile connections that give the mathematics meaning and make it relevant for the students.”

**Connecting to the why**

Numerous interview participants mentioned that it is important for educators to provide rationale for why students are learning the concepts in class. Participant 12 stated that this is the hardest question teachers are asked – why do they need to know this? Participant 6 emphasized the importance of connecting the why and stated that providing the purpose behind the learning provides much more buy-in and helps students take responsibility for their learning because they now want to learn about the concept. Participant 6 further stated that if the buy-in is not instilled, student ability to apply the new concept or skill is missed, or at least hindered. Participant 14
also mentioned the why helping students buy into the lesson, “The why provides context, and if you can get them to buy-in for the why, you can get them to be successful.”

Participant 1 said that students need to know why they need to give their next 90 minutes of attention. Participant 6 discussed how engaging the students in the content is crucial to student learning, because it instills wonder in the mathematics behind a concept.

Frequently, the why is a connection to the real world or to other mathematics strands. Participant 12 stated that, to make the mathematics relevant to the students, real-world connections often pique their interest and give them the why of the lesson. The real-world connection fosters student interest.

**Connecting to real-world concepts**

Participant 14 emphasized the importance of utilizing a real-world context in problems by mentioning the EOC’s use of these contexts. The participant stated that utilizing these contexts and concepts throughout the school year helps prepare students for the problems they will see in life and on the primary state test.

Participant 6 also noted the importance of real-world contexts and concepts by mentioning how educators should be involved in professional development that afford educators the opportunity to experience their content within the real-world and then relay those experiences to the students to help bolster the mathematics instruction.

Participant 14 stated that providing a real-world context to a lesson’s mathematical concepts and skills helps students understand why they are learning because it offers students tangible connections. According to Participant 7, real-world concepts are integral. Participant 7 noted that the use of tasks offers a real-world context and connects the mathematics learned to a possible situation and area of use.
One such task, used by both Participant 14 and Participant 2, involves volume of a box. Participant 2 stated that the box task does not utilize a math problem and tie in a real-world topic; rather, to find the maximum volume, a student must take the real problem of trying to fit a product into a box and identify the mathematics behind which dimensions allow the product to fit in the box.

Participant 1 stated that numbers and regression are a good topic to utilize real-world concepts within the mathematics class, specifically mentioning Nike’s and Under Armour’s sales. “Students are interested in their shoes and money, especially, so connecting their interests and the real-world importance of money help make instruction relevant.”

Participant 7 stated that Desmos helps with connecting real-world concepts to mathematics instruction. Desmos allowed Participant 7’s students to transpose quadratics onto pictures of real-world topics of their interest and find equations that fit their picture. Desmos also helped students understand what the roots of the quadratic meant in terms of their real-world context. Participant 7 stated that the use of the real-world connection reinforces the students’ understanding of mathematics concepts, and they “imprint the learning onto their minds for future use.”

Participant 12 stated that even real-world ideas can provide a framework for mathematical understanding. Participant 12 shared that mathematics proofs can be bolstered through the parallels of proving guilt or innocence in the real world. The participant detailed how the freshman in the class were piqued by mathematical proofs because of how the evidence must develop to prove a hypothesis is similar to proving that their love interest is cheating on them – a context that is relevant to young high school students.
Participant 2 shared that it is important to not be superficial in providing real-world applications in the classroom. “If you do it superficially, students still only see the math parts of the problem; they don’t realize how they can use the math they already know and apply it to the problem.”

**Connecting to other mathematics strands.**

Interview participants also shared their belief that connecting new material to other mathematics strands is important. Participant 6 stated that it is imperative that students understand that math is just math, and Participant 12 noted that the students should be ultimately informed that each concept they learn should be filed under math rather than to a specific strand. Participant 1 stated that integrated mathematics educators need to be developing mathematicians and not simply algebra or geometry students, because students need to be able to make sense of all components of mathematics, not just some components.

Participant 2 noted that it is rare that students begin a new concept or one that does not develop from their prior learning. Participant 14 stated that it is a point of emphasis to connect every new concept to something students already know; “I like to focus on the ideals from each of the previous courses and build off the students’ understanding from those concepts towards mastery of new content.”

Participant 7 stated that it is imperative that efforts are made to ensure multiple strands of mathematics are utilized in every lesson in some manner. Participant 6 stated each of the strands are just math, and the more the students simply perform mathematics, the more the strands marry together in their minds, bettering their overall understanding; students must use all their content knowledge to solve problems because math is not disjointed.
Participant 12 discussed the importance of incorporating algebra into a geometric concept and vice versa. The participant stated that the students need to know that no math is off limits when solving problems. Participant 12 stated that it is easy for teachers to incorporate algebra into geometry lessons, but not as easy to incorporate geometry into algebra. The participant mentioned the importance of this incorporation.

**Discovery Learning and Tasks.**

Five of the interview participants noted their use of tasks or discovery learning opportunities in their integrated mathematics instruction. Participant 7 stated that tasks are effective for providing relevancy for the students, because many tasks tag onto a real-world context; tasks also help with engagement and provide the capability for multiple entry points into a problem.

According to Participant 14, students enjoy working tasks and discovery learning activities. Participant 12 noted that the students enjoy completing these tasks because they are just “playing” with the mathematics. Participant 7 stated that this also allows students of all levels to grow their understanding; the students work collectively or on their own and build responsibility for their own learning because they are not learning passively. Participant 14 mentioned a similar ideal; the students enjoy tasks and discovery learning because they are not passively learning. “They are using the calculator, manipulating, discussing with fellow students, and finding values. They are engaged in the learning and are able to develop their own understanding that I can refine later.”

Participant 7 shared that tasks and discovery learning afford opportunities for students to develop their own understanding of concepts rather than what the teacher specifically tells them; doing so helps them remember and apply the concepts and skills more accurately.
Participant 2 stated that students who engage in the material before lectures or assignments are more apt to be subsequently engaged. The example provided was a writing assignment on logarithms, where students learned how logarithms are used in the real world. The discovery learning activity led to students asking specific questions about logarithmic graphs and equations, which led to better discussions and heightened student understanding of the content, according to Participant 2.

Participant 7 detailed that discovery learning activities allow students to work with mathematics concepts they understand and work with the tools they have in order to better make connections between new material, learned material, and real-world concepts that may be incorporated.

Participant 14 shared that the use of tasks and discovery learning promote productive struggle, where students are challenged and work through the challenges. Participant 1 noted that students learn most when they are challenged to think; tasks, according to Participant 1, force students to think about all mathematics, not just single strands, and build their overall understanding of the mathematics.

**Analysis of Observations of Participant Classrooms**

The final aspect of data collection and analysis came from participant observations. The four participants observed were chosen from a group of participants that indicated their willingness to contribute to the study further. These four participants represent each of the four learning academies of the participating school and each of the three integrated mathematics courses. The participating educators are listed in Table 4.12 below.
<table>
<thead>
<tr>
<th>Participant</th>
<th>Academy</th>
<th>Observed Subject</th>
</tr>
</thead>
<tbody>
<tr>
<td>P5</td>
<td>Freshman Academy</td>
<td>Integrated Math 1</td>
</tr>
<tr>
<td>P8</td>
<td>STEM</td>
<td>Integrated Math 3</td>
</tr>
<tr>
<td>P11</td>
<td>Humanities</td>
<td>Integrated Math 2</td>
</tr>
<tr>
<td>P15</td>
<td>MBA</td>
<td>Honors Integrated Math 1</td>
</tr>
</tbody>
</table>

Participant observations were conducted to help show the subtleties of teacher pedagogy and best practices. The observations were framed to identify the practices and strategies employed by the participant that enabled students to make connections among the different strands of mathematics. In this manner, participants showed their perceptions and efficacies of which strategies and practices worked in conjunction with their teaching philosophy regarding enhanced student understanding.

Analysis of the participant observation data combined with their survey responses detailed multiple parallels and similarities with the participant interviews. The analysis of the data revealed the observed participants utilized pedagogy and practices from the same four main themes from the interviews: culture of collaboration, multiple solution pathways, deliberate connections to other mathematics strands, and the use of tasks and discovery learning activities. Each participant’s observation data are detailed below with discussions of their survey responses and analysis theme.

**Participant 5 observation**

Participant 5 utilized scaffolding for a majority of the lesson. The teacher began the lesson with rote memorization of formulas for parallel and perpendicular lines but subsequently
progressed into more higher-order thinking when discussing the implications of these types of lines regarding quadrilaterals. The instruction utilized numerous “I do, we do, and you do” portions that enabled students to show Participant 5 his/her understanding of the material.

Participant 5 grouped students in pairs and gave them a card with a quadrilateral to discuss their understanding of how parallel and perpendicular lines are utilized in the properties of their specific quadrilateral. Students discussed each kind of quadrilateral.

The essential question of the lesson, as evident on the expo board, was “how do the equations and properties of parallel and perpendicular lines influence quadrilaterals?” The deliberate tying in of quadrilateral properties alongside parallel and perpendicular lines required the students to understand the properties of quadrilaterals and how the slopes of the sides of the quadrilateral fulfilled the needs of each type of quadrilateral. Thus, concepts and skills from algebra and geometry were required for solving the problems within the lesson.

Participant 5’s survey data revealed question and answer segments as a practice that the participant believed is integral for student understanding. The participant noted that “understand the basics” is a key motivator for his/her teaching style, which aligns with the use of scaffolding and small group discussions.

**Participant 8 observation**

Participant 8 noted, in the survey responses, that students will understand mathematics processes at any level if they are able to make numeric, algebraic, and graphical connections. The observed lesson showed that Participant 8 allows the students to utilize their calculators, partners, and groups to help solve problems. The students were given a task that had multiple cubic functions and asked to find the solutions. This task required students to be able to utilize algebraic and graphical understanding to solve.
Participant 8 initially allowed students to work individually on the task, but then asked students to pair up and discuss their methods for solving. The students discussed how they solved each cubic function for the roots. The students discussed which root they began the problem by finding, then how they found the remaining roots. Some students began the problems with graphing, thus multiple solution pathways were found and were discussed within the groups. The students were observed taking notes and noticing their different methods of solving.

After allowing time for students to discuss their findings, Participant 8 highlighted one problem and three different students’ work. The teacher used the graphing calculator emulator on the SmartBoard to show the possible zeros of the function, then utilized the document camera and the papers of the three students. Participant 8 demonstrated to the other students that it did not matter which graphed zero was used, the other two could be found – highlighting multiple solution pathways.

**Participant 11 observation**

During the observation, Participant 11 taught a lesson on factoring quadratics. The lesson focused upon the procedures for solving and factoring the quadratic functions. The learning target for the lesson was listed as “students will use multiple tools to solve quadratic equations.” Throughout the lesson, the participant utilized multiple questions and the students worked individually for a substantial time. Then, the students were grouped for more exercises. When in partners, the students would show work by alternating steps. The collaborative effort was evident in this “round robin” exercise. Multiple students were observed helping and encouraging their counterparts. It was evident that the participant had created good norms for collaboration and the culture for collaboration was successful.
Participant 11 stated, in the survey, an adherence to the workshop method where students work on their problems and advocate for themselves. The culture created by the participant was also evident in this regard. One pair of students were working the “round robin” problems among themselves until they encountered a problem they did not understand. Subsequently, they absorbed another pair, made a group of four, and continued the “round robin” exercise. The students asked the others for help and then helped one another through their problems.

**Participant 15 observation**

Participant 15 taught a lesson on the angles created by intersecting lines and transversals. Within this lesson, the students completed a task where they discovered the meaning of vertical angles, showed supplementary angle theorem, and the angles created by parallel lines and transversals. In the task, students were assigned to use rulers and protractors to create numerous intersecting lines. The students would then measure each group of lines with the protractor to find if there were any similarities among their intersecting lines. Participant 15 used the document camera to display examples of the students’ work and show that the angles across from one another were always congruent in this situation.

Participant 15 noted the use of tasks in the instruction as integral to student understanding. The task in this observation required students to perform a simple task in order to discover the meaning of vertical angles. The task progressed and students were asked to create specific angle measurements and then to create parallel lines cut by a transversal. Participant 15 utilized scaffolding questions to show the different angle pairs in the situation were congruent.

Participant 15 finished the lesson by introducing algebraic concepts and skills to the task. The students were grouped into threes and provided one large set of parallel lines cut by transversal. One angle had a measurement and others had variables. The problem asked the
students to solve for all angles. This activity reintroduced solving linear equations and married an algebraic skill with geometric concepts of lines and angles. The groups of three also allowed students to work and learn with their peers.

Study Findings

Upon completion of each data type, data analysis commenced. The data were coded through open, axial, and selective coding to derive meaning from the survey responses, interviews, and observations. From the data collected and analysis of that data, themes and findings were categorized to best convey teacher and educator perceptions of best practices and effective pedagogy for integrated mathematics instruction. The study first employed open coding to determine concepts and connections among survey responses, which allowed raw data to be grouped into related responses by connectedness to effective pedagogy and best practices. Comparisons among data and the categories found within the open coding phase highlighted the axial coding aspect of analysis. Within this phase, similarities were found within participant responses; selective coding was utilized to determine which categories and themes best answered the two research questions and represented the strategies and practices for implementation in integrated mathematics instruction. Tables 4.13 and 4.14 illustrate the levels of coding utilized in this study.

Due to the interrelated nature of the research questions posited, the findings were presented by data sources. Triangulation of data sources through the analysis of themes via coding presented a cohesive, coherent answer to the individual research questions:

Research Question One

How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery? Educators perceived that a deliberate devotion to “the
why” and connections to the real-world and other mathematics strands and evoking a Culture of Collaboration help students realize the interconnected nature of mathematics topics in the integrated mathematics curriculum.

**Research Question Two**

What practices help students make connections among strands of mathematics within the integrated mathematics curriculum? Utilizing tasks and projects, highlighting multiple solution pathways, and building a culture of collaboration are practices that help students make connections among strands of mathematics.
Table 4.13
Data Sorted in Levels of Coding for Research Question One: How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery?

<table>
<thead>
<tr>
<th>Raw Data</th>
<th>Open Coding</th>
<th>Axial Coding</th>
<th>Selective Coding</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Students need to connect each lesson to a bigger picture they find value in”</td>
<td>Need to know “Why” they need to know concepts</td>
<td>The “Why”, connecting to real-world context and other mathematics strands</td>
<td>Educators perceived that a deliberate devotion to “the why” and connections to the real-world and other mathematics strands and evoking a Culture of Collaboration help students realize the interconnected nature of mathematics topics in the integrated mathematics curriculum.</td>
</tr>
<tr>
<td>33% of participants stated the “Why” of the lesson, or connecting real-world context and other mathematics strands is integral</td>
<td>Real-world contexts give reason to lesson</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“When they apply math to meaningful real-world applications it gives significance to the process”</td>
<td>Real-world problems use all Math</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Linking detailed lessons to a larger project or real-world project the different strands can be brought in as needed”</td>
<td>Connecting math strands helps develop mathematicians</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“The why provides context, and if you can get them to buy-in for the why, you can get them to be successful.”</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>40% of participants utilize group and partner discussions and discovery</td>
<td>Students relate to and learn from each other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“encouraging students to talk out loud about their process”</td>
<td>Help each other through misconceptions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Productive Struggle</td>
<td>Help catch and fix mistakes productively</td>
<td></td>
<td></td>
</tr>
<tr>
<td>students must not be daunted by mistakes in the classroom; mistakes are not permanent</td>
<td>Mistakes are not final</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Students discuss any mistakes and lead each other to fix mistakes and help understand content”</td>
<td>Learn best from one another</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Math Family”</td>
<td>Math conversations spark thought and other ways to solve</td>
<td></td>
<td></td>
</tr>
<tr>
<td>“Students knew we all depended on each other”</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

33% of participants stated the “Why” of the lesson, or connecting real-world context and other mathematics strands is integral. The “Why”, connecting to real-world context and other mathematics strands helps develop mathematicians. Educators perceived that a deliberate devotion to “the why” and connections to the real-world and other mathematics strands and evoking a Culture of Collaboration help students realize the interconnected nature of mathematics topics in the integrated mathematics curriculum.
Table 4.14
Data Sorted in Levels of Coding for Research Question Two: What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

<table>
<thead>
<tr>
<th>Raw Data</th>
<th>Open Coding</th>
<th>Axial Coding</th>
<th>Selective Coding</th>
</tr>
</thead>
</table>

- 40% noted discovery learning and project-based learning are key practices
- "exploration helps them pull from skills they have already learned to help discover new content knowledge"
- effective for providing relevancy for the students, because many tasks tag onto a real-world context
- "Projects that apply the skills learned"
- "Tasks require students to use all kinds of mathematical knowledge"
- "Presenting work in front of the class"
- "presenting information differently for students"
- Students were observed searching and learning from each other with multiple solution pathways
- "document camera provides great environment for students to share different solution pathways and make connections between approaches"
- "Share Pair"
- "Partner work and think time"
- "Sage and Scribe"
- "Build off each other’s strengths"
- "Students help one another in their understanding"
- using Kagan strategies prompts students to talk about mathematics, which makes it more likely the lesson will be meaningful

- Discovery learning and projects make students use prior knowledge
- Construct new knowledge from previous learning
- Students need to utilize all math skills
- Real-world problems use all strands

- Tasks and Projects

- Students see how a peer works the problem and can emulate
- Learn in different ways, think in different ways, likely answer in different ways
- Highlight different approaches to same solution

- Multiple Solution Pathways

- Students work through together and learn together
- Pushes lower student and higher student masters through teaching
- Student skills vary, utilize your strengths and your partners
- Kagan strategies promote group thought

Utilizing tasks and projects, highlighting multiple solution pathways, and building a culture of collaboration are practices that help students make connections among strands of mathematics.
Summary

Chapter 4 provides an analysis of the data collection process and the data collected. The purpose of the study was to find methods and strategies to help students make connections between mathematics concepts and among the different strands of mathematics. The study also researched teacher efficacies and perceptions of the pedagogy and best practices that promote student success within the integrated mathematics classroom. Data collection and analysis of the data enabled the study to answer the following research questions:

1. How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery?

2. What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

Data were collected from participant surveys, interviews, and observations. The data collected were analyzed and coded, and four common themes became apparent. In analyzing participant responses and data, the themes pertaining to the pedagogy and best practices for instruction were to create a culture of collaboration, encourage and celebrate multiple solution pathways, make deliberate connections to real-world concepts, other mathematics strands, the why of the lesson, and the use of tasks and discovery learning activities. In the final chapter, the qualitative research findings, conclusions, and implications are discussed and recommendations for future research are presented.
CHAPTER 5: CONCLUSIONS, IMPLICATIONS, AND RECOMMENDATIONS

Summary of Study

This qualitative study identified the practices and pedagogy perceived by teachers to be most effective in helping students make connections among mathematics strands in the integrated mathematics curriculum. The study emphasized best practices and pedagogical strategies because of their significant impact and effectiveness on student achievement.

The integrated mathematics curriculum requires teachers, administrators, and district-level mathematics coaches to research, identify, and implement practices and pedagogical strategies appropriate for helping students make sense of mathematics as a whole. With the new research and set of practices, educators are called to modify their teaching strategies and change which practices are utilized in their instruction to help students make and understand connections between the real-world and different strands of mathematics.

This qualitative study is comprised of educator and administrator survey and interview responses. Educator observations were utilized to provide triangulation of which practices and pedagogical strategies were effective for the participating educators’ classrooms and students. A total of 15 educators, administrators, and math coaches participated in the survey. Fourteen of these participants were integrated mathematics educators. A survey question gauged willingness to continue participation in the study, with 10 participants choosing to continue. Semi-structured interviews were conducted with six of these willing participants to further understand their perceptions of effective pedagogy and best practices within their integrated mathematics classroom instruction. The remaining four participants were observed to provide visual evidence of the practices and strategies perceived to be most effective for helping students make connections.
The purpose of this study was to find which methods and practices current and former integrated mathematics teachers are utilizing in order to maximize student understanding of mathematics and the connections among strands of mathematics. The study sought to help future integrated mathematics teachers modify their instruction in order to best aid their students by providing successful pedagogical strategies and best practices, as perceived by educators of integrated mathematics courses.

**Research Questions**

This qualitative study of teacher perceptions was guided by two research questions:

1. How does the perceived connectedness of topics within the integrated curriculum affect teacher pedagogy and content delivery?
2. What practices help students make connections among strands of mathematics within the integrated mathematics curriculum?

**Discussion**

The research questions were answered in this study through a comprehensive analysis of data collected from the participant surveys, educator interviews, and observations. To provide credibility for the study, triangulation, member checks, and peer debriefing were utilized throughout. The utilization of survey responses, interviews, and observations from the participants provided triangulation of data to answer the research questions. Detailed notes and transcripts were recorded during the participant interviews and observations to aid in collection and analysis of the data and to provide participants opportunity for member checks. All data found were coded using open coding, axial coding, and selective coding to find similarities, categories, and answers to the study’s research questions. The following sections discuss the
findings of the study derived from the data analysis and coding process, with regard to each of the research questions.

**Research Question One**

Throughout the study, participants were able to determine their perceptions of effective pedagogy and delivery strategies for helping students connect mathematics in their instruction. The survey responses, interview comments, and observed strategies of the participating educators induced two main themes: students need deliberate connections to the “why,” the real-world, and other mathematics strands within the lesson; and educators should evoke a culture of collaboration. The educators in this study perceived that a deliberate devotion to the “why” and connections to the real-world and other mathematics strands and evoking a culture of collaboration help students realize the interconnected nature of mathematics topics in the integrated mathematics curriculum.

**Deliberate Connections.**

One of the main themes perpetuating through participant survey and interview responses was the notion of deliberate connections to other aspects of learning. These connections were referenced toward the “why” of the lesson, toward real-world contexts and concepts, and toward concepts and skills from other mathematics strands. Connecting the current lesson with the “why,” the real-world, or other mathematics strands helps establish relevancy for the students. The students need to find relevance in the mathematics in order for their learning to be meaningful and for prolonged understanding of the concepts.

Students need to know the “why” of the lesson to fully support the learning process. Participant 14 noted the importance of educators establishing the why and providing relevancy for their students, stating that the why provides context for student learning and can aid in
student engagement and buy-in, which leads to increased student understanding. Participant 12 mentioned in the interview process that the “why” of the lesson can be derived numerous places, specifically mentioning real-world concepts and prior learning in other mathematics strands. Participant 1 stated that when students “apply math to meaningful real-world applications it gives significance to the process.” Also, Participant 3 stated, “Linking detailed lessons to a real-world project, different strands can be brought in as needed.” Real-world mathematics is not entirely one strand of mathematics, and students should know and understand that they will need to bring a full repertoire of skills and conceptual knowledge to solve the real-world mathematics in the classroom.

Thirty-three percent of surveyed participants stated that the “why” of the lesson or connecting real-world context and other mathematics strands is integral for helping students understand the connected nature of integrated mathematics. Educators can provide these connections for their students or provide paths for them to discover them on their own, but being deliberate in these connections is perceived to be integral in promoting success in the integrated mathematics curriculum.

**Culture of Collaboration.**

Most participants in this study mentioned their utilization of collaboration to help students understand and make connections among mathematics strands. The survey responses included 40% of participants utilized group and partner discussions to help students better understand mathematics in the classroom. These instances of collaborative learning are an integral part of student learning in participating educators’ classrooms because they believe students learn well from one another. During the interview, Participant 6 stated that students have a wealth of knowledge themselves and that their learning should not solely come from the
teacher; therefore, teachers should be adept at providing opportunities and avenues for their students to work alongside one another and discuss their learning in order to promote the making of connections among mathematics strands.

A culture of collaboration also propels students to overcome misconceptions and mistakes. Participant 2 stated that collaborative learning opportunities for students allow for mistakes to be productive, because the students learn from their peers and overcome the misconceptions. The students in Participant 11’s class were comfortable in their shortcomings and were unphased when asking other groups for help in solving problems. They understood that a mistake and not understanding is not final, and they collaborated to further each member’s understanding of the concept.

Utilizing grouping in such a manner was a prevalent response in the study surveys and interviews. Each of the observed participants also utilized collaboration to help students make the connections from their current learning to other strands of mathematics. The students were able to use math conversations to spark thought and find other ways to solve the problem or task at hand. The idea of creating a “culture of collaboration” is imperative for helping students understand mathematics.

Research Question Two

The second research question of the study sought best practices that educators can utilize to help students make connections among mathematics strands. Participants were asked variants of this question on the survey and within the interviews and observed participants displayed their perceived beliefs on best practices, and three themes emerged in the response analysis: effective integrated mathematics instruction should utilize tasks and projects, highlight and celebrate multiple solution pathways, and teachers should utilize a plethora of practices within a culture of
collaboration. Utilizing tasks and projects, highlighting multiple solution pathways, and building a culture of collaboration are practices that help students make connections among strands of mathematics.

**Tasks and Projects.**

Tasks, projects, and discovery learning were practices that 40% of the participants specifically mentioned in the survey aspect of the study. These participants noted that tasks and projects provide an element of exploration of the mathematics, and Participant 13 stated “exploration helps [students] pull from skills they have already learned to help discover new content knowledge.” Exploration within tasks and projects help students use their prior knowledge and construct their own meaning of newer concepts.

Tasks and projects are not confined to one strand of mathematics. Participant 15 noted in the survey that tasks and projects “require students to use all kinds of mathematical knowledge.” Students can utilize the mathematics they understand to make sense of the current problem. Tasks often require productive struggle. Participant 14 stated that productive struggle challenges students to think deeper about the problem and challenge themselves to work through the difficulty. This productive struggle instills grit into the students and helps them to understand they can overcome the challenges since they have overcome and solve the tasks.

Tasks and projects often utilize a real-world context, as Participant 7 stated in the interview. The math connects to an area that could pique the interest of the students and provide relevancy and a desire to learn or utilize the concepts and skills necessary in the task.

Students enjoy working on tasks and learning through discovery because they are just playing with the mathematics, as Participant 12 stated. The students are not passively learning material; they are interacting with the mathematics and molding their understanding by the
moment. Beal (2000) noted that teachers need to provide opportunities for the students to play with the mathematics so that they are actively learning and constructing their own understanding (Holden & Lias, 2009).

**Multiple Solution Pathways.**

The second main theme that helps answer research question two involves the highlighting and celebrating multiple solution pathways. Integrated mathematics teachers should encourage students to work mathematics problems, tasks, or projects in their own manner. Participant 6 stated that students need to know that mathematics does not follow one set procedure; therefore, educators need to encourage the finding of different pathways to correct solutions.

There are numerous practices that encourage and enable the presentation of multiple solution pathways. Participant 2 mentioned hovering over students enables educators to notice students using different methods to solve the same problems. Participant 2 further stated that educators should ask these students to present their work to the class in order to celebrate the finding of multiple solution pathways. Participant 6 stated that celebrating multiple solution pathways helps build mathematicians that think outside the box, which is a highly desired outcome for students.

Teachers should promote confidence in their students through multiple solution pathways. Having students present work in front of the classroom, according to Participant 2, helps build confidence in their abilities each time they present. Utilizing the document camera is one practice that enables educators to highlight these different approaches to the same problem, and students are afforded opportunities to see how a peer works the problem so that they can emulate that procedure.
**Culture of Collaboration.**

Building a culture of collaboration is another practice that helps students make connections among strands of mathematics. Providing opportunities for students to collaborate on problems, tasks, or projects allows them to discuss the mathematics among themselves. Participant 1 stated in the survey that students, when in group discussions, can build off each other’s strengths in order to solve the problems or tasks. A task or project could require skills and concepts from multiple mathematics strands. Each member of a group or partnership has certain strengths that they could use to help their peers better understand the mathematics in the task. Group learning practices, according to Participant 15, allow students to help one another in their understanding. Students are also able to learn from one another or solidify their understanding through teaching their peers.

Within this theme of culture of collaboration are multiple practices for educators to help students make connections among the strands of mathematics. Among the practices mentioned were “share-pair,” “sage and scribe,” and Kagan strategies. The Kagan strategies help prompt students to talk about the mathematics in the problem, tasks, or lesson, which makes it more likely the lesson will be meaningful to the individual student. Using the Kagan strategies is an effective practice because Kagan strategies promote group thought and discussion about the entire problem and how the problem can be viewed with regard to geometry, algebra, or any other mathematics strand.

**Implications**

The findings in this study indicated the pedagogy, content delivery strategies, and best practices that integrated mathematics educators use to help students realize and make connections among the many strands of mathematics. The participating educators and
administrators believed these strategies and practices are effective in building mathematicians that understand and utilize their knowledge of concepts within different strands of mathematics to solve all sorts of mathematics problems, tasks, or projects. From these findings, implications regarding the teaching of the integrated mathematics curriculum can be formulated. Educators should understand and utilize the collective understanding of their students to further the understanding of their peers. The teacher should not be the only beacon of mathematics knowledge within the classroom, and the students should be comfortable learning from and teaching one another. Further, the educators in this study provided practices and strategies to help students make and utilize connections within their integrated mathematics instruction. The practices and pedagogical strategies stated in this study have been perceived as effective in the integrated mathematics curriculum and future educators should implement them in their own instruction.

Limitations

The study was conducted within one school district in Southeast Tennessee. The participants of the study were employed by a single school with only one participant from the district level, limiting the sample population. A sample population from a different region or setting may produce different results. Teacher perceptions of successful pedagogy and best practices may differ if the study were conducted in a different setting or with a different sample size than the sample in this study.

Recommendations for Further Study

There are numerous areas that future studies would be recommended. This study was conducted in one school in Southeast Tennessee, limiting the scope of the perceptions presented by the educators, administrators, and math coaches who participated in the study. Future
research should include participants from differing regions and from schools that differ in demographic composition, as the educators and administrators of those schools are likely to present different viewpoints, practices, and pedagogy for their integrated mathematics instruction.

Further recommendations would include student input on which practices and strategies helped them better understand the mathematics concepts presented. Future studies should include participants from multiple levels of mathematics instruction, as elementary and middle school mathematics education is integrated in nature. Teacher perceptions of best practices and pedagogy may differ at these levels than what is presented at the high school level.

Summary

The purpose of this qualitative study was to find practices and methods that integrated mathematics educators perceive as effective in helping students make and utilize connections within their learning of mathematics. Through surveys, interviews, and observations, practices and pedagogical strategies were identified by educators and their opinions expressed as to the effectiveness of these practices and strategies in their integrated mathematics classrooms. Open, axial, and selective coding of the participant opinions and responses provided thematical evidence of best practices and pedagogical strategies perceived to be most effective for helping students make and understand the interconnected nature of mathematics. This study provided practices and strategies for implementation by future educators of the integrated mathematics curriculum. This information informed educators and administrators of the repertoire to help students grow into successful mathematicians.
References


Appendix A

Informed Consent Document

PROJECT TITLE
Teacher Perceptions of the Integrated Mathematics Curriculum and Successful Pedagogy and Best Practices for Implementation

INTRODUCTION
You are invited to join a research study that seeks successful pedagogy and practices that enable students in your integrated mathematics classes to be successful in making connections among the different strands of mathematics. Please consider participating in this study and furthering the literature regarding the educating of our students in mathematics. Participation is strictly voluntary in all phases of the study.

WHAT IS INVOLVED IN THE STUDY?
If you choose to participate in this study, you will be asked to complete a survey containing agree/disagree questions and open-ended questions concerning your teaching strategies and practices. The survey will take approximately 15 minutes. Further participation in the study will involve interviews with the researcher and observations of lessons. Again, those would only apply to you if you choose to continue to participate in the study.

You can end your participation in the study at any time, and you will not lose any benefits. The researcher may also choose to stop the study or remove you from the study at any time he judges it is in your best interest.

RISKS
There are no risks involving this study. The IRB (International Review Board) of Carson-Newman University has given permission for this study. Additionally, the school system involved has granted permission for the study to take place.

BENEFITS TO TAKING PART IN THE STUDY?
It is likely that you will benefit from participation in this research in the following manners: self-assessing your strategies and practices may help you better understand how to help your students; gain a better understanding of which strategies and practices help students grow as mathematicians in the integrated curriculum. The researcher cannot guarantee these benefits will apply to you personally, but all participants will likely benefit from the findings of the study at its conclusion.

CONFIDENTIALITY
The study will ensure confidentiality through anonymity in your responses, restrict unauthorized disclosure, tampering, or damage. Names will not be used at any point in the study and data files will be safely guarded and password encrypted.
INCENTIVES
No incentives will be used in this study

YOUR RIGHTS AS A RESEARCH PARTICIPANT?
Participation in this study is voluntary. You have the right not to participate at all or to leave the study at any time. Deciding not to participate or choosing to leave the study will not result in any penalty or loss of benefits to which you are entitled, and it will not harm your relationship with the researcher or anyone involved in the study.

CONTACTS FOR QUESTIONS OR PROBLEMS?
Call the researcher, Wes Anderson, at 423-895-2007 or by email at waanderson@cn.edu if you have questions about the study, any problems, or think that something unusual or unexpected is happening. The chair of this study may also be contacted:
Dr. Julia Price, Director of the Carson-Newman University Advanced Programs, jprice@cn.edu
Appendix B

The survey questions and format were as follows:

For questions 1-2, use a 1-5 rating scale with 1 being not at all familiar/comfortable and 5 being very familiar/comfortable.

1. How comfortable are you teaching each of the mathematics strands (algebra, geometry, probability and statistics, and trigonometry)?
2. How familiar are you with the main ideals and aspects of the integrated mathematics curriculum?

For questions 3-6, answer regarding how strongly you agree or disagree.

3. It is important to present mathematics concepts with regards to real world concepts.
4. It is important to emphasize making connections among the different mathematics strands in mathematics instruction.
5. Providing students with opportunities to discover mathematics concepts on their own/with peers helps solidify student understanding.
6. Our school and district provide sufficient and useful professional development on pedagogy and best practices for teaching integrated mathematics.

In your integrated mathematics classroom instruction, how often do you:

7. Teach concepts with regards to multiple mathematics strands.
8. Provide students with tasks that require knowledge and/or skills learned within other mathematics strands.

Open-ended response questions

9. What practices and pedagogy strategies are, in your opinion, integral to successful mathematics instruction?
10. How do the practices and strategies listed in question 9 help students make connections among the different strands of mathematics?

11. What strategies and practices have you used to promote student engagement in the integrated mathematics classroom?

12. In your integrated mathematics classes, how have you utilized technology to supplement instruction, help make connections among mathematics strands, or enhance student engagement?

13. How many years have you taught mathematics?

14. Which of the following courses have you taught?

15. This study of pedagogy and best practices for the integrated mathematics classroom will need to interview and observe integrated mathematics teachers. If you would be willing to volunteer for further participation in the survey, please provide your name in the following response box.