HIGH SCHOOL MATHEMATICS TEACHERS' PERCEPTIONS OF MATHEMATICS

EDUCATION IN NORTHWEST FLORIDA

by

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ABSTRACT

In the United States, high school students have performed lower in mathematics than all the industrialized countries since the First International Study was administered in 1964. Studies revealed that a large number of high school graduates are not proficient in mathematics and are not ready for college mathematics or the workforce. This qualitative research intended to answer the question of why the U.S. high school students underperform in mathematics through teacher perceptions on the current curriculum and methods of instruction used in high school mathematics classes. The question was answered by exploring the perceptions of 12 high school mathematics teachers in northwest Florida through a survey of 16 open-ended questions and a focus group discussion that guided the research. Furthermore, the survey and focus group data were triangulated with teacher artifacts that included lesson plans. This resulted in an aggregate of 15 themes that included time, professional development, gap in the students' knowledge, student encouragement, application to real world, resources, rigor, student encouragement, teacher collaboration, student ownership, standardized testing, traditional teaching, too many topics, two-tracks courses, practice and mental math, and student collaboration.

The findings of this research support the need to provide teachers with more time to teach, plan, and collaborate. Teachers also need more support from the educational leaders to provide professional development that will help teachers apply real-world, collaborative learning, and move away from the current traditional teaching that most of the participating teachers in this study prefer.

DEDICATION

This work is dedicated to my wonderful family. I have a very big family, and they have all been extremely supportive. My three children, Ahmad (age 10), Jana (age 8), and Omar (age 6) would always tell me to work on my doctoral degree because they knew how much I wanted to successfully complete it. They would actually get happy when they observe me working on it and tried not to interrupt my learning at that time. My husband has been extremely supportive from day one. My parents, brothers, and sisters have always been so proud of me and helped me throughout my journey, especially my sister, Sowsan, who is a great writer and provided me with feedback on my writing. I love learning, and this was an extremely valuable experience. I sincerely thank my family for making it possible for me. I love you all so much.

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Introduction

Educational research encompasses investigation to resolve issues of practice in education and to bring forth improvements (Lingard & Gale, 2010). One area of educational research that deserves further inquiry involves United States students' academic mathematics performance, especially at the high school level. A large number of students who successfully complete high school do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century (McCormick & Lucas, 2011). Furthermore, the high school students in the United States underperform in mathematics compared to other nations, which may affect their chances of finding a job that requires mathematics skills in this age of globalization. In a report by the Organization for Economic Cooperation and Development (2009), the United States ranked 25th out of 30 in mathematics scores among the industrialized nations. The ranking of American high school students in mathematics has maintained a status quo since the first international study was done in 1964 by the First International Mathematics Study until the 2009 international assessment (Vernille, 2012).

Figure 1 shows that the United States performed worse than the top-scoring countries, as well as similar post-industrial countries, in Program for International Assessment (PISA) 2009 math area (Economic Policy Institute, 2013). In the 2013 report by the Organization for Economic Cooperation and Development (2013a), the United States' ranking dropped to 36 in mathematics scores generated from the 2012 PISA. The reports of international studies on mathematics education also indicate that the ranking of American students decreases with higher grade levels, in which the high school students received the lowest ranking from among the elementary, middle, and high school students in the United States (Vernille, 2012).

TABLE 1

Expand this chart

Overall average national scale scores, reading and math, for U.S. and six comparison countries, PISA 2009

	Top scoring				Similar post-industrial				U.S.	U.S. versus:	
	Canada	Finland	Korea	Average*	France	Germany	U.K.	Average*		Top-scoring average	Similar post-industrial average
Reading	524	536	539	533	496	497	494	496	500	-33	+4
Math	527	541	546	538	497	513	492	501	487	-50	-13

* Simple (unweighted) average of three countries

Source: Authors' analysis of OECD Program for International Student Assessment (PISA) (2010a)

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Figure 1. Overall average national score scale in reading and math for PISA 2009. Source: (Carnoy, M., & Rothstein, R., 2013).

National and international studies reveal that high school seniors in the United States do not demonstrate mathematics proficiency, which affects their mathematics performance in college and beyond (National Center for Educational Statistics, 2006, 2013b). Since the First International Mathematics Study in 1964, much research and many debates have taken place to help reform mathematics education. However, the research and debates have not been successful in pointing out the specific problems in high school mathematics classes and finding effective solutions to those problems (Organization for Economic, 2009). In fact, the ranking of high school students in mathematics has dropped in the past five years with respect to other nations (Organization for Economic Cooperation and Development, 2013a). This qualitative case study investigated teacher perceptions of the current mathematics curriculum and methods of instruction used in high school math classes.

Chapter 1 provides a background of the problems that exist in high school mathematics classes. Following the background, the problem statement and purpose of the study are discussed. Then the significance of the problem to the field of education and to the educational leader is addressed. An explanation for a qualitative case study is presented in the nature of the study. A research question is identified and followed by the theoretical framework. Chapter 1 concludes with the definition of terms, assumptions, scope, limitations, and delimitations of the study.

Background of the Problem

The results of national and international studies reveal that high school seniors in the United States do not demonstrate mathematics proficiency, which affects their mathematics performance in college and beyond (National Center for Education Statistics, 2006, 2013a, 2013b). A large number of students who successfully complete high school do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century (McCormick & Lucas, 2011). Many students who graduate high school in the United States require remediation when they enter college, which affects their ability to complete a degree (King & Jones, 2012).

In 2005, more than 75 % of high school seniors scored below proficient in mathematics in the National Assessment of Education (NAEP), which is considered the only national test that shows what students really know (Perie, Grigg, & Dion, 2005; National Center for Educational Statistics, 2014). The 2009 NAEP mathematics assessments for seniors showed very similar results to the 2005 average scale scores (National Center for Educational Statistics, 2013a). The 2012 PISA revealed worse results, in which the ranking of the United States high school students dropped from 25 in 2009 to 36 in 2012 (Organization for Economic Cooperation and Development, 2013a).

The qualitative study was designed to explore why United States high school students underperform in mathematics through teacher perceptions of the curriculum and instruction. Researchers have shown that the mathematics curriculum is recurring throughout grade levels (National Mathematics Advisory Panel, 2008). Repeating the same material every year does not allow time for the teachers to integrate more complex mathematical problems that simulate critical thinking (Corbishley & Truxaw, 2010). The majority of time spent in mathematical classes is on repetitive measures and drills rather than on solving real problems, which can lead to higher forms of mathematical thinking (Corbishley & Truxaw, 2010).

In the United States, curriculum and standards vary greatly from state to state (American Federation of Teachers & National Center for Improving Science Education, 1997). Unlike many countries around the world, the individual states in America, not the national government, have the responsibility for providing students with an education. Thus, state standards are often unclear and lacking in rigor and uniformity (Johnson, Dupuis, Gollnick, Hall, & Musial, 2008). According to the Council of Chief State School Officers (CCSSO) and the National Governors Association (NGA) Center for Best Practices (2010), each state has its own procedure for developing and applying its standards (NGA & CCSSO, 2010). "The gap in what students are expected to know in each state varies so greatly that the difference in student expectations between the states with the most rigorous assessments and those with the least stringent is twice the size of the national black-white achievement gap," (American Institutes for Research, 2010, para. 1).

In 2010, the CCSSO and the NGA Center for Best Practices (NGA Center) led the effort to develop a common core of standards for states to ensure all students in the country are prepared for success (NGA & CCSSO, 2010). The Common Core standards were internationally benched with fewer topics to master in depth and designed to be much more rigorous requiring higher order thinking skills (Hall, 2014). However, the majority of school leaders are not prepared to implement the Common Core standards in schools because of a lack of budget and overall shift in instruction, which demands new goals for learning mathematics (Maxwell, 2014). The implementation of Common Core will require professional development for teachers and a change in the curriculum, instruction, resources, and technology, which can be very costly (Hall, 2014). The Common Core standards also have many critics across the country. In the state of Florida, Governor Rick Scott ordered public hearings on Common Core and proposed changes calling them Florida Standards (Postal, 2014).

Another challenge in teaching mathematics to high school students is the method of instruction. Teachers must use various teaching styles in order to reach all students effectively (UNESCO, 2004). The two most common mathematics teaching methods are either traditional or constructivist methods (Pai-lin et al., 2001). There are strong supporters and opponents of the traditional and constructivist methods that provide strengths and weaknesses in both methods (Matthews, 2000).

The majority of mathematics classrooms across the country follow a traditional way of teaching, which is teacher-centered (Kohn, 1999; Cisco, 2009). Teachers lecture for most of the class period while the students listen and take notes, which can be a reason why students become bored and lose interest in learning mathematics (Kohn, 1999). Allowing students to relate the mathematics covered in class to real-life gives meaning to mathematical operations, enhances students' learning, and provides a positive attitude (Charles, 1999; Cisco, 2009). With this concept, the current study will include the teachers' perspective on how real-world applications and projects can enhance the mathematics instruction and generate more interest in learning mathematics.

Research findings have shown that constructivist practices in mathematics education can have a positive effect on student achievement (Cisco, 2009; National Council of Teachers of Mathematics, 2000). Therefore, some schools have initiated professional-development programs to support teachers in shifting their teaching methods from traditional to constructivist (Pitsoe & Maila, 2012). While many researchers wrote about the benefits of constructivism, Schmidt (2003) conducted research on the effectiveness of the professional development and concluded that constructivist practices did not affect the students' achievement. The teachers' perspectives on the current teaching methods can help stakeholders better understand the problems that exist in mathematics education and make improvements.

Another challenge teachers face in the 21st century is that they must be able to teach and meet the needs of a diverse group of students in inclusive classrooms. Teachers are seeing an increase in racial, ethnical, and cultural diversity. There are cultural differences in learning, which include learning styles, communication styles, and language differences (Aldridge & Goldman, 2007). In inclusive classrooms, teachers must also meet the needs of disabled students. With such diversity in the classroom, teachers must differentiate to accommodate all students. Differentiation is teaching to the diverse needs of all the students by adjusting the curriculum and teaching strategies, rather than teaching to the average of the class (Batts & Lewis, 2005). In the United States, the population of diverse groups is expected to comprise more than 40% by 2020 and 50% by 2040 (Aldridge & Goldman, 2007).

The intention of this research study was to explore teacher perceptions on the current curriculum and methods of instruction used in math class. The teachers' knowledge of mathematics and their beliefs about teaching and learning impact their classroom practices (Williams, 2008). Teachers were asked to provide their insight on how to reform and improve the mathematics education at the high school level. This perception is important because it may reveal ways to increase student achievement in mathematics, which will benefit them throughout their lives.

Mathematics is necessary for entry into many different college majors (Conley, 2005). It is also important in many career choices in which mathematical skills and abilities are often tested and used to judge the qualifications of job applicants (Duranczyk & Higbee, 2006). Students who have received a strong mathematics background in high school are more likely to earn in the top quartile of income from employment (National Mathematics Advisory Panel, 2008). Therefore, it is essential to find solutions to the problems that exist in the high school mathematics classes to increase the students' achievement beyond high school.

Statement of the Problem

National and international studies reveal that high school seniors in the United States do not demonstrate mathematics proficiency (National Center for Educational Statistics, 2006, 2013b). The problem is that the United States has a large number of students who successfully complete high school but do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century (McCormick & Lucas, 2011).

This qualitative exploratory case research study explored reasons why high school students in the United States are not ready for college mathematics through the perceptions of 12 high school mathematics teachers in a school district in northwest Florida. This study is important because having strong mathematics skills in high school will advance students throughout college and in the workplace (Achieve, 2011a).

Purpose of the Study

The purpose of this qualitative exploratory case study was to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. The perceptions of teachers included problems that exist in the curriculum and more effective ways to teach mathematics.

Qualitative data collection enables neutral exploratory methods with open-ended questions through interviews, which do not limit participants' views (Creswell, 2007). A case study was appropriate for this research because it focused on a particular phenomenon or situation, provided a description of it, and used qualitative research to discover new meaning to improve the situation (Shank, 2006). This study included teacher perceptions through open-ended surveys, focus group, and lesson plans to explore the current mathematics education that high school students are receiving in the mathematics classrooms. The teachers described the current curriculum and methods of instruction used in the classrooms and provided changes that may help students advance.

The sample of the population of this study was 12 high school teachers from the Panhandle in Florida, also known as northwest Florida. The teachers were asked to share their insight on the current mathematics curriculum and methods of instruction used in the classrooms to find the perceived reasons behind the students' poor performance. The teachers were asked to express their views about high school mathematics education; in particular, they were asked to describe the contributing factors for students' lack of math readiness in college and the workplace. The researcher also met with a focus group of four from the participating teachers and collected artifacts about the curriculum requirements to further support the outcome of the study.

Significance of the Study

A large number of students who graduate from high school are not ready for college and the labor force of the 21st century (McCormick & Lucas, 2011). Having strong mathematics skills allows students to compete internationally and advance them throughout college and in the workplace (Achieve, 2011a). The PISA (2007) and Organization for Economic Cooperation and Development (2009) have conducted studies on high school students from around the world and provided evidence that a problem in mathematics education exists in the United States. The mathematics skills of high school students in the nation are below average compared to other nations (Mathematics Achievement Partnership, 2001; Organization for Economic Cooperation and Development, 2013a). Although the United States is a superpower and spending more on education that any country in the world, the students in the United States rank below average in mathematics compared to other developed nations (Organization for Economic Cooperation and Development, 2009).

This study is important for students, parents, teachers, administrators, and stakeholders in the field of education in the United States. It provides school leaders and teachers with information that identifies problems with the curriculum and instruction in high school mathematics classes and how to resolve these problems. This information will help these stakeholders understand the reasons why the uppermost achieving states in the country are still significantly lower in student mathematics proficiency than the uppermost achieving countries (Phillips, 2007).

As high school students in the United States continue to face difficulties in mathematics and rank below average compared to other nations, mathematics education has proven to be stressful for both teachers and students (Moursund, 2011). Teachers are required by the state or district to teach specific topics, but the curriculum might not be interesting to students. Research shows that many students find mathematics boring and difficult (Onion, 2004). According to Kohn (1999), the curriculum lacks the emphasis of understanding, critical thinking, and real world experience. Students need a more challenging curriculum and more engaging forms of instruction that are motivating for them (Petkov & Rogers, 2011). Teacher perspectives on how to improve mathematics education in high schools may help U.S. students succeed in college and the workforce as well as become internationally competitive in mathematics. It will also reveal ways to motivate students to learn the subject of mathematics, which is necessary to understand other important fields of study such as science, technology, engineering, and economics.

The growing complexity of student needs, joined with legal mandates such as No Child Left Behind (2001) and Individuals with Disabilities Education (2004), put new demands on educators (Johnson, Dupuis, Gollnick, Hall, & Musial, 2008). In addition, the placement of students with disabilities in regular education classes will continue to occur and possibly increase (Johnson, Dupuis, Gollnick, Hall, & Musial, 2008). This inclusion may make it more difficult for teachers to complete the assigned curriculum and ensure that every student learns the material well (Bondurant, 2004). Forlin (2001) found that teachers felt a high level of anxiety because they will be held responsible for the educational results of students with disabilities. The teachers were also concerned that by devoting more time tackling the needs of students with disabilities, they will have less time to spend with the students without disabilities, which will make it difficult to maintain effective teaching for all students in the class (Forlin, 2001).

There is a not enough research on effective mathematics reform that benefits the students and teachers (Vernille, 2012). With the limited existing research, the mathematics curriculum remains in status quo (Vernille, 2012). This case study includes teacher perspectives on (a) how to close the gap that exists between the current mathematics education in high school and the topics and methods that will be of interest for students in the 21st century and (b) how to help students be successful in college and beyond. It provides teachers, administrators, curriculum developers, and statewide leaders with valuable information on how to improve the current practice and methodology of teaching mathematics and provide students with a more practical knowledge of mathematics.

Effective reform in mathematics education is needed to help American students advance. Students are now competing on a global level and need strong mathematics skills to better understand other subjects such as science, engineering, technology, and economics. Improving students' mathematics skills in high school will help them throughout college and beyond (Achieve, 2011a). The teacher perceptions provided solutions to the problems that are causing U.S. high school students to struggle with college mathematics and included more effective ways to educate students and provide them with the necessary skills to compete globally. It is very important to find the problems that may cause U.S. students to be unprepared for college mathematics to find the best way to educate students and provide them with the skills to succeed beyond high school. Answering the research question of why the U.S. students underperform in mathematics may be a start to effective reform in mathematics education. This reform may benefit high school mathematics teachers around the nation. It may also help novice teachers learn what educational techniques work well in the high school mathematics classes and what has failed the students. The answer to the research question may help teachers provide better instruction for the students to increase their achievement rate.

Significance to Leadership

This study will benefit leaders in the field by providing new knowledge about the current curriculum and instruction that will help leaders improve the mathematics education in their schools. It will include suggestions based on the perspectives of the high school teachers in the study that may also help the leaders make positive change. National surveys revealed that high school graduation rates have dropped close to 10 percent in the past quarter century (Kirsch et al., 2007). The surveys also showed that a large number of the country's adults do not have the essential reading and mathematics skills they need (Kirsch et al., 2007). This study may provide school leaders with an insight to students' needs, which may improve the mathematical skills of the students.

The research can also help school leaders comply with the No Child Left Behind (NCLB) mandates to increase the student proficiency in mathematics. Governmental mandates, such as NCLB, create more pressure on educators to keep children globally competitive. NCLB requires schools to assess and report proficiency in mathematics for every child, including those with disabilities (U.S. Department of Education, 2002).

The growing challenges of student needs, in addition to legal mandates such as NCLB and The Individuals with Disabilities Education Act (IDEA), have put further difficulties on educators (Johnson et al., 2008). In addition, the placement of students with disabilities in regular education classes will continue to occur and possibly increase (Johnson, Dupuis, Gollnick, Hall, & Musial, 2008). This may make it more difficult for teachers to complete the assigned curriculum and ensure that every student learns the material well. When the NCLB Act was passed in 2001, teachers felt a high level of anxiety because they would be held responsible for the educational outcomes of students with disabilities (Forlin, 2001). The teachers were also concerned that by spending more time tackling the needs of students with disabilities, they would have less time to spend with the students without disabilities, which will make it difficult to maintain efficient teaching for all the students in the class (Forlin, 2001). The feeling of apprehension towards inclusion continued among teachers, specifically novice teachers. More than a decade later, Wiggins (2012) concluded that teachers with experience teaching in inclusion classrooms had a more favorable attitude towards inclusion than those who had not taught in inclusion classrooms.

Educational leaders with a large number of special education students face exceptional challenges in fulfilling the Adequate Yearly Progress (AYP) requirements of NCLB (Johnson, Dupuis, Gollnick, Hall, & Musial, 2008). Under NCLB, all public schools must make AYP and have 100% of the students achieving proficiency by the year 2014 (Center on Education Policy, 2012). However, a report by the Center of Education Policy

(2012) revealed that half of the nation's public schools did not make AYP in 2011, which is an increase from 39% in 2010 and the highest percentage since NCLB. The State of Florida had the highest percentage of public schools not making AYP in 2011, which was about 91% (Center of Education Policy, 2012).

Educational leaders may benefit from research-based strategies to better serve the needs of students and help them become proficient in mathematics. Educational leaders have the opportunity to share with their teachers the information gathered from this study, which may help them improve the achievement of all their students. Educational leaders can present the information during the professional training sessions or staff meetings and discuss how they can benefit from the information in this study.

Nature of the Study

A qualitative research method was used to explore why high school students in the U.S. are not ready for college mathematics and the workforce and how to increase student achievement in mathematics. Qualitative research is suitable when the researcher is concerned about exploring a situation in order to better comprehend the situation (Creswell, 2008). A quantitative research design was not appropriate for this research because the presence of a cause-and-effect relationship between the variables was not known, and there were no numerical calculations (Christensen, Johnson, & Turner, 2011). Shank (2006) stated, "The goal of analysis in quantitative research is twofold: to describe things according to pre-established measurement criteria, and to test predictions based on theory," (p. 16). The objective of quantitative designs is to classify and investigate reoccurring independent variables to determine their effect on dependent variables (Creswell, 2008). The research study did not involve independent and dependent variables. It focused on the teacher perceptions, which cannot be measured quantitatively. "In addition, quantitative research questions are oriented toward verification or prediction. Qualitative research questions, on the other hand, lead us in the direction of gaining a deeper understanding," (Shank, 2006, p. 103).

The qualitative method examines specific non-numerical data, insights, and lived experiences to gain a deeper understanding of a situation (Neuman, 2006). Qualitative data collection allows unbiased analytical procedures with open-ended questions that do not limit participants' notions, decreasing researcher bias (Creswell, 2008). It was appropriate for this research because it depended on the collection of qualitative data though open-ended surveys and a focus group interview of participating teachers. Qualitative research includes information about the person's views and feelings on a particular subject and allows the researcher to collect information from the participant's standpoint (Creswell, 2008). Leedy and Ormrod (2010) stated that qualitative research happens in a natural setting and uses numerous interactive methods. The current study was designed to explore the experiences and outcomes of U.S. high school students in mathematics classrooms by interacting with the teachers of those students.

The research design was a qualitative exploratory case study to determine the factors that contribute to the United States high school students not having the mathematics skills needed to be successful in college and beyond through the teachers' perspectives. A qualitative, exploratory case study is the suited method to explore the perspectives and experiences of the participants (Creswell, 2008). Yin (2009) stated that a case study is used to contribute to the knowledge of an individual, group, or organization and a related phenomenon. Qualitative case studies are being used in educational research to describe situations in schools and to make conclusions by generalizing the findings (Kyburz-Graber, 2004). A case study methodology is the most appropriate to seek teachers' perceptions through open-ended questions, observations, and interviews (Leedy & Ormrod, 2010). Yin (2009) stated that an interview is one of the most important sources of case study information.

An ethnographical approach is not appropriate for this study because it would necessitate presenting teacher perceptions over a limited period of time. In ethnographical studies, researchers participate over an extended period of time in the lives of the people they are studying to see the world from a cultural perspective (Shank. 2006). The phenomenological study is also not appropriate because it seeks to uncover insights of experiences in particular settings that depend almost exclusively on lengthy interviews of over an hour (Leedy & Ormrod, 2010). The interview of the focus group for this study was exactly an hour in length.

A case study design is appropriate when examining for particular samples from a subgroup of the population of interest (Neuman, 2006). This study included examples from high school mathematics teachers about problems that exist in the educational system. A case study is also suitable for learning more about a situation with little known information (Leedy & Ormrod, 2010). There is a lack of information about the problems that exist in the high school mathematics classes and possible solutions (Rasmussen et al., 2011). Leedy (1997) stated that existing problems or circumstances that need improvement are best unveiled through the use of a case study. The problem in this case study was that there is a large number of students who successfully complete high school but do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century

(McCormick & Lucas, 2011). It is important to better understand this problem to provide suggestions for improvement of the current curriculum and methods of instruction.

The sample of the population of this study was 12 high school mathematics teachers of northwest Florida. This research included an exploratory case study. The case study explored the teacher perceptions about the problems that may exist in the high school mathematics curriculum and instruction. The case study proposed explanations of why high school students enter college without the necessary mathematical skills to succeed in college and beyond. This may help educators make changes that may improve the current curriculum and instruction.

The data collection included the researcher as the instrument interviewing the teachers to explore perceptions of why the students in the United States perform lower than other developed nations in mathematics. To support triangulation and gather more information about the high school mathematics curriculum and instructional methods, the researcher gathered participating teachers for a focus group, collected curriculum requirement artifacts, and included scholarly resources from online libraries, such as the University of Phoenix online library and ERIC (Educational Resources Information Center by the U.S. Department of Educational). Keywords that were used in the search include: mathematics, education, reform, high school, students, teachers.

Data analysis included qualitative coding, which is an integral part of data analysis (Yin, 2009). Coding allows the researcher to categorize data. During the first phase of open coding, the data is examined for themes that may emerge (Neuman, 2003). The second phase of data coding is axial coding. During this phase of coding the data is reexamined and organized according to the code labels (Neuman, 2003). NVivo, a computerized qualitative research tool, was used to organize the data, help code, and categorize the large amounts of narrative text. NVivo 9 was used to sort the data according to codes.

The data was presented in terms of themes related to the narratives. It included quotes from the participants, which drove the themes. The data was taken from Chapter 4.

Research Question

This qualitative research intended to answer the question of why the U.S. high school students underperform in mathematics through teacher perceptions on the current curriculum and methods of instruction used in high school mathematics class. The question was answered by exploring the perceptions of high school mathematics teachers through a survey of the 16 open-ended questions (see Appendix C) and focus group questions (see Appendix D) that guided the research. Participants were encouraged to expand on their answers. The general population group of the qualitative exploratory case study was 12 high school mathematics teachers from northwest Florida. In addition, the researcher invited four participating teachers for a focus group and used that information, along with the curriculum requirements and literature review, to validate the results.

It is very important to find the problems that may cause U.S. students to be unprepared for college mathematics to find the best way to educate students and provide them with the skills to succeed beyond high school. The answer to the question may also provide teachers with effective instructional methods that can help their students advance. Answering the above question may be a start to effective reform in mathematics education. This reform may benefit high school mathematics teachers around the nation. It may also help novice teachers learn what educational techniques work well in the high school mathematics classes and what has failed the students.

Effective reform in mathematics education is needed to help American students advance. Students are now competing on a global level and need strong mathematics skills to better understand other subjects such as science, engineering, technology, and economics. Improving students' mathematics skills in high school will help them throughout college and beyond (Achieve, 2011b).

Theoretical Framework

Learning theories have greatly contributed to the understanding of human development, which will help contribute to the understanding of learning mathematics. Curriculum theories have greatly contributed to the development of the mathematics curriculum and the education of students in the United States. This research focused on different curriculum and learning theories that are used in the class to identify their effectiveness in mathematics instruction. Posner (2004) stated five theoretical perspectives that the curriculum can take on, which include traditionalist, experiential, structure of disciplines, behavioral, and constructivist. Educational theorists recommended many theories on how children learn and react to teaching strategies that include behaviorist, constructivist, and social cognition (Marquette University, 2005).

Traditional mathematics instruction was influenced by B.F. Skinner, who believed that the foundation for student learning followed the approach of memorization, drills, and recitation as the foundation for traditional teaching methods (Skinner, 2002). These behaviorist theories have dominated American education for many decades (Gredler, 2009). Early on in school, students master the skills of learning their numbers by repeatedly writing them and memorizing arithmetic fact. Learning from a behaviorist viewpoint is represented by means of continuing behavior change (The Pennsylvania State University, 2007). The behavioral theory indicates learning as a change in behavior due to the environment. Behavioral theories focus on the belief that a subject can be conditioned to change or grasp a desired behavior (Gredler, 2009). Behavioral changes are decided by the effects of a person's reactions to stimuli (Posner, 2004). The most identifiable information involved in the behaviorist approach was the introduction of classical conditioning.

The classical conditioning theory developed by Ivan Pavlov (1849–1936) is based on the assumption of observable behavior, which is found in many species and explains how people develop involuntary responses to particular stimuli (Kretchmar, 2008). Building upon Pavlov's work, John B. Watson (1878–1958) was the first to introduce behaviorist principles. Similarly, B. F. Skinner (1904–1990) developed the operant conditioning theory based on the assumption that learning is a behavioral change and occurs as a result of the organism operating on its environment (Kretchmar, 2008). Other behavioral theorists include Edward L. Thorndike (1878–1958) who developed the law of effect theory and Albert Bandura (1925– present) who developed the social cognitive theory.

The behaviorist theory has influence on the current curricula because of its focus on development through change in behavior that is based on objective observations and measurements (Martinez, 2010). The theory ensures learners will behave the same way when the same situation occurs (Nagowah & Nagowah, 2009). One of the weaknesses of the behaviorist theory is that it only focuses on behavioral change and ignores other processes, such as mental, which also has an effect on learning. Another weakness is that the concepts of knowledge, goals, and memory are not directly observable (Martinez, 2010). Therefore, the constructivist theory has become more popular in teaching mathematics.

The constructivist theory is growing in popularity because of its many benefits to learning. The constructivist theory focuses on the learner constructing knowledge by experiences. Pitt and Kirkwood (2010) stated that learning mathematics should be established based upon the prior knowledge and experience of the student. Major proponents of the Constructivist Theory include Jean Piaget, Jerome Bruner, Maria Montessori, John Dewey, Ernst von Glasersfield, and Seymour Papert.

Jean Piaget (1896–1980) and Jerome Bruner (1915–present) provided demonstrations of constructivism in school-aged children as they progress from concrete to abstract levels (Chung, 2004). Bruner's theoretical framework is based on the theme that learners construct new ideas or concepts based upon existing knowledge. This particular type of theory has been favored amongst brain-based educators for many years because the teaching is focused on the meaning and understanding of the desired material (Winters, 2004).

Tenets of the constructivist theory for course design are that students come with a worldview which acts as a filter to all their experiences and observations (Bruner, 1960). Other tenets include relating the curriculum to real life and looking at the big idea. This allows students to see the relevance of what they are learning and become more interested in understanding the idea. Teachers who use the Constructivist Theory recognize how this motivates students and ensure that a project or lesson in the curriculum can relate to students' daily lives (Scherer, 1999). Students can be given problems to explore freely and create their own solutions (Van den Brink, 2000). Learners actively create, interpret, and organize knowledge in their own way (Gordon, 2009). After much research, Pitt and Kirkwood (2010) recommended that teachers use the constructivist method for teaching mathematics.

However, one of the weaknesses of the constructivist theory is that the method places particular burdens on the teachers (Gredler, 2009). The teacher must first learn how to deal with the variety of ways students can actively learn in order to successfully help the students.

Social settings may also provide opportunities for students to work cooperatively to solve problems that no student could have solved alone. Cooperative learning activities provide motivational advantages because they react directly to students' needs as well as prospective learning benefits that will help them achieve goals and be successful (Brophy, 2004). Educators have advocated the use of cooperative learning in the mathematics curriculum and instruction (National Mathematics Advisory Panel, 2008). There has been an increased use of cooperative learning groups in the teaching and learning of mathematics (National Mathematics Advisory Panel, 2008). When educators collaborate in an effort to improve the education for all students, they may be contributing to a better future for the students. The teachers and leaders must engage in collective inquiry into the best practices about teaching and learning (DuFour & Eaker, 2008).

The experiential theory was developed by Carl Rogers (1902–1987) based on the assumption that learning is experiential (Schunk, 2008). In *Freedom to Learn*, Rogers (1969) concentrated on the individual participation of the learner and the self-initiated aspiration to understand and make meaning of experiences. David Kolb (1984), a well-known experiential learning proponent, identified John Dewey, Kurt Lewin, and Jean Piaget as the "foremost intellectual ancestors of experiential learning theory" (p. 15). John Dewey argued in *Experience and Education* (1938) that "amid all uncertainties there is one permanent frame of reference: namely, the organic connection between education and personal experience" (p.

25). The work of John Dewey (1859–1952) that learning arises directly from experience has been valued as an important foundation in formal educational setting.

The historical roots of experiential education can be trailed to the Enlightenment in Europe during the 17th and 18th centuries when philosophers of the time highlighted the significance of both mind and sense impressions (Posner, 2004). The 20th-century development of experiential education was to make the curriculum extremely broad since everything that happens to students influences their lives (Posner, 2004).

Experiential learning is interactive learning that requires students to be actively involved in the learning process and not passively acquire knowledge (McCarthy, 2010). Proponents of experiential learning believe that including it in the curriculum encourages greater interest in the content, develops deep learning gratification, increases understanding of the subject, boosts the desire of lifelong learning, and improves critical thinking skills of the students (McCarthy, 2010). Research data showed that if mathematics concepts are instructed using real-world situations, which the students can experience, their performance on evaluations will improve (National Mathematics Advisory Panel, 2008).

The sociocultural theory of Lev Vygotsky (1896–1934) focuses on the importance of society and culture for children's development and has roots in Vygotsky's theory of cognitive development (Ormrod, 2008). Complementing Vygotsky's view is Albert Bandura's social learning theory. Bandura's social cognitive theory combines behaviorism and cognitive theories of learning in which the key element is that people learn by observing the behavior of others (Ormrod, 2008). The theory assumes a three-way interlocking relationship between behavior, the environment, and personal events to explain learning (Gredler, 2009).

Definition of Terms

Adequate Yearly Progress (AYP). A measure established under the No Child Left Behind Act by which schools and districts must demonstrate that their students are improving annually in academic achievement (McNeal, 2008).

Common Core. National standards that provide a consistent and clear understanding of what students are expected to learn at every level in elementary, middle, and high school (Common Core, 2012).

Elementary and Secondary Education Act. Public Law 89–10, of 1965, which addressed issues of equal educational opportunity and was the beginning of substantial reform efforts in the succeeding years (Zascavage, 2010).

Individuals with Disabilities Education Act (IDEA). A national act passed in 1990 and reauthorized in 1997 and 2004 to defend the rights of pupils with disabilities by guaranteeing that they obtain a free appropriate public education (FAPE), regardless of ability (National Resource Center on ADIHD, 2012).

No Child Left Behind (NCLB). Federal legislation, which is latest reauthorization of the Elementary and Secondary Education Act of 1965, designed to reform kindergarten through 12th-grade education based on standards (Tosolt, 2011).

Assumptions

One of the assumptions of this research was that teacher perceptions on curriculum and instruction may help improve the educational system. Since the teachers deliver the curriculum and instruction to the students, it was assumed that they will be the most knowledgeable to answer the research question of why the U.S. underperform in high school mathematics. It was also assumed that the teachers' responses will provide valuable information for stakeholders and may bring about positive change to the curriculum and instruction used in high school mathematics classes in the country. Teachers provided information about the rigor of the curriculum and how students respond to different instructional methods. It was assumed that the standards the classes are using are the Florida State Standards, which follow the No Child Left Behind Act. Since this is what Florida public schools must follow, it was assumed that all the high school mathematics teachers were following the same standards.

Another assumption was that the teachers would provide honest responses because they want the best interest of the students. The face-to-face focus group interview allowed teachers to be more open, in which they were encouraged to expand on their answers. It was assumed that this would encourage them to be more open and respond with honesty. It was also assumed that the participants would provide sufficient information to add value to the research by providing in-depth answers. The study also assumed that the participants would be guaranteed that their concealment and confidentially will be protected. The participants were also informed of privacy and confidentially of their responses. This study also assumed that the teachers have a good understanding of the curriculum, learning theories, and college requirements for mathematics courses. A final assumption was that the research is expected to provide neutrality through maintaining integrity of the information presented.

Scope, Limitations, Delimitations

The scope of this study was limited to the high school mathematics teachers in northwest Florida. Creswell (2007) noted possible limitations of data collection including participants failing to answer all questions and the selection of inappropriate populations or site. This case study involved 12 individuals, which does not represent the general population in the country. Therefore, the findings can only approximate the actual experiences, perceptions, and views of the participants on that specific day. Since this study only included the perceptions of high school mathematics teachers in northwest Florida schools, it may not be the same perception of all the teachers in the United States. However, the school district chosen for the study was representative of the surrounding school districts in student demographics. Its average scores on the state standardized tests were very similar to the averages of the whole state.

There was also a limitation of time and money. It would be time consuming and very expensive to conduct this study throughout the United States. There were also limitations in the design because there was no experimental design. This case study was limited to description without conclusions about cause-and-effect relationships because there will be no laboratory research conducted. Therefore, one cannot make casual conclusions. Qualitative case study research is subjective due to the process of interpreting the perceptions of the individuals, which may limit the findings. However, this study included teacher open-ended survey, a focus group interview, and artifacts to support the findings.

The study focused on the perception of high school mathematics teachers in northwest Florida. Therefore, the participation in this research was delimited to teachers who only teach high school mathematics in public schools and confined to northwest Florida. The study was also delimited to participating teachers who were actively teaching high school mathematics courses at the time of the study. Another delimitation was the collection method, which included open-ended surveys and a focus study group. In addition, the focus of the research was delimited to the high school mathematics teacher's perception and experience and did not include the student or parent perceptions.

Summary

Improvement of education has always been and will continue to be a priority for educators. One of the major areas that needs improvement in the educational field is the mathematics curriculum and instruction at the high school level. A large number of students who successfully complete high school are not ready for college and the labor force of the 21st century (McCormick & Lucas, 2011). The students in the United States have consistently scored below average in mathematics compared to the developing countries. The 21st century demands more mathematics knowledge from a society that leans more heavily on science and technology (Stanic & Kilpatrick, 2004). However, over the past sixty years, the percentage of new college graduates who major in math-intensive subjects has declined (Vigdor, 2012). Teacher perceptions about the current curriculum and instruction provided insight about ways to improve student achievement in mathematics.

Chapter 1 contained an introduction and background of the study as well as the problem and purpose statements. It provided a description of the qualitative method used to address the problems in high school mathematics education. It also included the significance of the study, as well as the scope and limitations. Chapter 2 will provide information about previous research on the curriculum and teaching practices used in high school mathematics classes. Chapter 2 will also address the history of mathematics education in high school and the learning theories used.

Chapter 2

Review of Literature

The focus of this qualitative case study was to explore the perceptions of high school mathematics teachers to the current curriculum and instruction used in class. This study helps educators understand the reasons why U.S. high school students are not ready for college and the highest achieving states within the United States are still significantly below the highest achieving countries (Phillips, 2007). The purpose of Chapter 2 is to review literature that provides a background to the study of high school mathematics education in the United States.

There are various problems in high school mathematics education that can explain why a large number of high school students enter college without the necessary skills for success in college mathematics and beyond. One problem can be that the curriculum and approach of teaching have not changed for decades, and today's students might not find the traditional mathematics style motivating (Merseth, 1993). Since the turn of the 20th century, the mathematics curriculum for the majority of high schools has focused on arithmetic, algebra, and geometry (Stanic & Kilpatrick, 2004). While other countries teach these skills in middle school and introduce more advanced topics in high school, most students in the United States learn them in high school (Merseth, 1993).

There have been minor changes in the high school mathematics curriculum since the 20th century but no major successful reform (Merseth, 1993; Stanic & Kilpatrick, 2004; Vigdor, 2012). Between 1972 and 2011, the average math Scholastic Assessment Test (SAT) score of college-bound high school seniors barely changed, nor did the proportion of college graduates majoring in a mathematically intensive subject (Vigdor, 2012).

Furthermore, the performance of the United States students on the Programme for International Student Assessment (PISA) has slipped over the past decade (Vigdor, 2012).

This literature review functions as a technique to investigate previous studies and current research on students' performance in high school mathematics classes, as well as provide ways to improve the curriculum and instructional methods used. It includes a historical overview of the mathematics curriculum in the United States, the international assessments of high school mathematics students, reform needed in the curriculum and instruction used in these classes, and the gap that exists between these mathematics classes and students' needs.

Title Searches, Articles, Research Documents, and Journals Researched

The fundamental questions for this study are: What are the teachers' perceptions on the current curriculum and methods of instruction used in high school mathematics class? What changes in the current curriculum and instructional methods of teaching mathematics need to be reformed to enhance learning and help students advance?

This study is focused on U.S. high school students' achievement in mathematics and the reasons why a large number of students who successfully complete high school are not well prepared for college and the workforce. The following key words and terms were used to research the problem and purpose: *teacher perception, high school mathematics, high school mathematics instructional methods, high school mathematics curriculum, high school mathematics reform, history of high school mathematics education, technology in high school mathematics classes, college and career readiness, and high school mathematics education problems.* These words were essential in the search for this literature review. The searching began with peer-reviewed journals from major research databases: ERIC, EBSCOhost, ProQuest, and Digital Dissertations.

The search involved gathering articles from textbooks, peer-reviewed publications, government reports, and a variety of organizational web sites such as Trends in International Mathematics and Science Study (TIMSS), National Center for Educational Statistics (NCES), Achieve, Business Higher Education Forum, and Florida Department of Education.

Historical Overview

The subject of mathematics was first introduced in schools after 1700 in response to popular demand (Stanic & Kilpatrick, 2004). In the mid-1700s, the colleges began to require arithmetic for admission (Stanic & Kilpatrick, 2004). In the 18th century, the mathematics curriculum began to include algebra, geometry, trigonometry, and some calculus (Stanic & Kilpatrick, 2004). As colleges continued to raise their admissions requirements, algebra was required for college entrance in 1820, followed by geometry several decades later (Stanic & Kilpatrick, 2004).

Extensive federal funding for research and training in mathematics began in the 1950s, which was labeled as The Golden Age in the field of mathematics education (Stanic & Kilpatrick, 2004). After the Soviet Union's accomplishments in outer space in the late 1950s, the central government launched a number of curriculum development projects intended to improve science and mathematics education (Stanic & Kilpatrick, 2004). Concerns that the United States was dropping behind in the areas of math and science activated major nationwide reforms that brought about the New Math of the 1960s and 1970s (Burris, 2005). The emphasis of New Math was on properties, proof, and abstraction (Burris, 2005). However, it created more math confusion than it eliminated and failed to meet the challenge of improving mathematics education (Burris, 2005). Therefore, in the late 1970s and early 1980s, the curriculum went back to the basics, which highlighted arithmetic computation, rote memorization, and basic arithmetic facts (Burris, 2005). Today, many high schools also teach calculus to its advanced students, and some students can receive college credits for calculus as part of the College Board's Advanced Placement program (Stanic & Kilpatrick, 2004).

In 2010, the Council of Chief State School Officers (CCSSO) and the National Governors Association Center for Best Practices (NGA Center) led the effort to develop a common core of standards for states to ensure all students in the country are prepared for success (NGA & CCSSO, 2010). These Common Core Standards are part of a state-led effort that states may choose to adopt and have no affiliation with the federal government (NGA & CCSSO, 2010). The Common Core State Standards are based on sound research about what it takes for high school graduates to be ready for college and careers built on the finest state and international standards (Achieve, 2011a). There are currently 45 states and three territories that voted to adopt the Common Core Standards, including the State of Florida (Common Core, 2012). However, after much criticism on Common Core, the Governor of Florida, Rick Scott, ordered public hearings on Common Core and proposed changes calling them Florida Standards (Postal, 2014).

The Common Core standards are not fully implemented across the states. Therefore, there is currently no research on the effect these standards will have on the educational system. They need to be fully implemented to provide more accurate results on the effect that the Common Core Standards will have on student achievement. The State of Florida was expecting to fully implement the Common Core Standards in the year 2015 but that changed after the Governor of Florida changed the Common Core Standards to Florida Standards in 2014 (Florida Department of Education, 2011; Postal 2014).

Historical Influence on Curriculum

In 1635, the First Latin Grammar School opened in Boston for the sons of certain classes destined for leadership positions in churches, states, and courts (Sass, 2011). The dominant belief on educating children was mostly for religious reasons. However, the arrival of people from different countries and religions led this notion to fail. People wanted to learn in languages other than English and this conflicted with the ministry, which imposed spiritual views through public education (Thattai, 2011).

In the middle and late 1800s, the curriculum was a matter of evolving subject matter. Some reform ideas concerning pedagogical principles emerged mainly as a result of European influence. The national system of formal education in the United States began to develop in the 19th century. The field of curriculum was born in 1918 with Franklin Bobbitt's small book entitled simply *Curriculum* and quickly became an area of study that assessed and sorted out choices and procedures (Wiles & Bondi, 2007). Ralph Tyler was another powerful curriculum leader in the first half of the 20th century who was credited with framing questions that led to a cycle of development which begins with an analysis, proceeds to a design stage, undergoes implementation, and then is evaluated for effectiveness (Wiles & Bondi, 2007).

Philosophical influences on curriculum. Philosophy is central to curriculum. Wiles and Bondi (2007) state that at the heart of purposeful activity in curriculum development is an educational philosophy. The philosophy of a school and its leaders influence the goals, content, and organization of its curriculum (Ornstein & Hunkins, 2009).

Philosophy provides educators, especially curriculum designers, with a framework for organizing schools and classrooms (Ornstein & Hunkins, 2009).

The philosophical influences on curriculum started with John Locke (1632–1790) whose views about the mind and learning significantly influenced American education (Posner, 2004). Locke argued that learning arises directly from experience. Benjamin Franklin (1706–1790) formed the American Philosophical Society, which helped carry ideas of the European Enlightenment, including ones of John Locke, to colonial America. Jean-Jacques Rousseau (1712–1778) also influenced contemporary philosophers and educational reformer John Dewey with his ideas on the significance of early childhood. Influenced by Dewey, Ralph Tyler placed more importance on philosophy than on other criteria for developing educational purposes.

Psychological influences on curriculum. Theories within the psychology field also influence curriculum development (The Commonwealth of Learning, 2000). Psychology provides a basis for understanding the teaching and learning process, which are both essential to the curriculum (Ornstein & Hunkins, 2009). Comprehending the psychology behind learning theories applied in curriculum development maximizes learning with substance, distribution, collaborating activities, and experiences (The Commonwealth of Learning, 2000).

Learning theories such as the classical conditioning theory developed by Ivan Pavlov (1849–1936) is based on the assumption of observable behavior, which explains how people develop involuntary responses to particular stimuli (Kretchmar, 2008). Building upon Pavlov's work, John B. Watson (1878–1958) was the first to introduce behaviorist principles. Similarly, B. F. Skinner (1904–1990) developed the operant conditioning theory based on the assumption that learning is a behavioral change and occurs as a result of the organism operating on its environment (Kretchmar, 2008). Other behavioral theorists include Edward L. Thorndike (1878–1958) who developed the law of effect theory and Albert Bandura (1925–present) who developed the social cognitive theory. Abraham Maslow's book *Motivation and Personality*, published in 1954 introduced the hierarchy of needs. These needs have obvious implications for teaching and learning. The teacher's and curriculum maker's role in this scheme is to view the student as a whole person. The student is to be positive, purposeful, active, and involved in life experiences.

Social influences on the curriculum. Understanding social foundations of curriculum is essential because such foundations have had major influences on schools and curriculum decisions. Hollis Caswell wrote of the socializing function of the schooling experience. The constructivist theory encourages social settings that may also provide opportunities for students to work cooperatively to solve problems that they may not be able to solve alone. Jean Piaget (1896–1980) and Jerome Bruner (1915–present) provided expressions of constructivism in school-aged children as they progress from actual to theoretical levels (Chung, 2004).

Experiential learning is also interactive learning that requires students to be actively involved in the learning process instead and not passively acquiring knowledge (McCarthy, 2010). The experiential theory was developed by Carl Rogers (1902–1987) based on the assumption that learning is experiential (Schunk, 2008). John Dewey (1938) argued in *Experience and Education* that "amid all uncertainties there is one permanent frame of reference: namely, the organic connection between education and personal experience" (p. 25).

Technological influences on the curriculum. The advancements in technology and learning methods have brought about much change for the better in public education. Technology began to play an important role in school in 1957 after Russia sent up their Sputnik space vehicle to demonstrate their lead in technology. In 1984, the Apple Macintosh computer was developed in which computer-based tutorials and learning games were created by commercial software manufacturers (Murdock, 2008). Since the mid-1980s, importance in computer use in United States public schools has been rising. The nation has spent over $38 billion to bring technology and Internet access to schools (Benton Foundation, 2002). The computer technology of the 21st century influences curriculum development at every level of learning (The Commonwealth of Learning, 2000). Nationwide, 24 states have online education programs. In 1997, Florida established the first statewide, Internet-based public high school. In 2008, the Florida Virtual School (FLVS) had more than 60,000 middle and high school students enrolled (Virtual Learning Academy, 2008). The use of technology influences educational goals and learning experiences among students.

Political and economic influences on the curriculum. Political influences on the curriculum start with the economic influence, funding (The Commonwealth of Learning, 2000). All aspects of curriculum depend on local, state, and national funding. In 1965, the historic Elementary and Secondary Education Act provided federal funds to help low-income students, which initiated Title I. More recently in 2001, the No Child Left Behind Act (NCLB) was approved by Congress, which mandates high-stakes testing and requires adequate yearly progress (AYP). The American Reinvestment and Recovery Act of 2009 signed by President Obama provided more than 90 billion dollars for education, including Race to the Top initiatives to induce reform in K–12 education.

Theoretical Framework

Learning and curriculum theories have greatly contributed to the development of the mathematics curriculum and the education of students in the United States. The behavioral theory indicates learning as a change in behavior due to the environment. The classical conditioning theory developed by Ivan Pavlov (1849 –1936) is based on the assumption of observable behavior, which is found in many species and explains how people develop involuntary responses to particular stimuli (Kretchmar, 2008). The constructivist theory focuses on the learner constructing knowledge by experiences. Experiential learning is interactive learning that requires students to actively be involved in the learning process and not passively acquire knowledge (McCarthy, 2010). The sociocultural theory of Lev Vygotsky (1896–1934) focused on the importance of society and culture for children's development and has roots in Vygotsky's theory of cognitive development (Ormrod, 2008). Bandura's social cognitive theory combines behaviorism and cognitive theories of learning in which the key element is that people learn by observing the behavior of others (Ormrod, 2008).

Cognitive information processing and brain-based learning theories have had a positive effect on education. The way the brain works has an important effect on what kinds of learning activities are most effective. Learning involves multiple parts of the brain where new information gets stored in different parts. It is important for educators to learn how students process information and learn in order to provide better instruction. Understanding brain development and instruments of learning have considerable implications for education (Fischer & Immordino-Yang, 2008). Cognitive information processing and brain-based learning theories help educators understand how students learn, and therefore provide better instruction.

Cognitive Information Processing Theories

Cognitive information processing theories emphasize on concentration, insight, translating, storage, and retrieval of knowledge (Schunk, 2008). It is very important for educators to understand how students process information and then remember it. Individuals remember information by the way they organize, perceive, comprehend, and store it (Lockhart, 2011). Schunk (2008) stated, "Information processing approaches have been applied to learning, memory, problem solving, visual and auditory perception, cognitive development, and artificial intelligence" (p. 131).

One of the benefits of information processing is to understand how information flows within the memory system. The cognitive processes of sensation, perception, attention, learning, remembering, and knowing define how information flows (Martinez, 2010). Cognitive information processing takes into account the manner, in which individuals remember and store information (Lockhart, 2011). This usually involves connecting new knowledge to prior knowledge. The cognitive information processing theory gives a lot of attention to instructional practices, curriculum guided decisions, and remembering content. The method of gathering information focuses on sensory, short-term, and long-term memory (Lockhart, 2011).

Stages of information processing. The cognitive information processing theory looks at the role of three stages of memory in retrieving information and then transferring it to store in memory to recall when needed. The three main stages of information processing are sensory memory, short-term memory, and long-term memory. The sensory memory holds all stimuli from the environment and this lasts in the minds for just a few seconds (Losabia, 2010). Short-term memory permits the learner to store and to comprehend small amounts of information. The duration of information in the short-term memory depends on how we organize, practice, and repeat the information (Losabia, 2010). This repetition can help the information move to the long-term memory. If the information is efficiently linked to previous knowledge, it is stored in long-term memory.

Strategies for processing information. Marzano (2009) stated that scaffolding is the keystone for students to process information. Another effective strategy in processing information is chunking. The grouping of information into meaningful units works well for all kinds of information (Martinez, 2010). Gestalt psychology has an important historical influence on cognitive information processing (Schunk, 2008).

Brain-based Learning Theories

Brain-based learning involves how educators explore the connection between brain function and educational practices. Many educators are particularly interested in brain research because they believe that it may provide ways to make education more suited for the children to learn (Schunk, 2011). Brain-based learning is a broad approach to instruction using current research from neuroscience (Wilson, 2011). Brain-based education emphasizes how the brain learns naturally and helps explain recurring learning behaviors (Wilson, 2011). There are many educational practices whose positive effects on learning are supported by both learning and brain research, such as multiple intelligences and problem-based learning.

Multiple intelligences. In 1983, Harvard psychologist, Howard Gardner, discussed the areas of multiple intelligence, in his book *Frames of Mind: The Theory of Multiple Intelligences*. Gardner (1993) discussed eight major intelligences that include verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical, rhythmical, naturalist/environmental, interpersonal, and intrapersonal. His book laid the foundation for differentiated instruction and served as a primary driving force for it (Gardner, 1993).

Problem-based learning. Problem-based learning is substantiated by brain research and engages students in learning while they work in groups (Schunk, 2008). Problem-based learning requires students to think creatively and apply their knowledge in unique ways. When students work together to solve problems, they become more motivated and learn from one another.

For many years, traditional methods of teaching were the norm in the public school setting (Nesmith, 2008). In the traditional classroom, the teacher provides clear, step-by-step instructions on how to solve problems, while students observe and listen (Nesmith, 2008). The majority of time spent in traditional classes is with the teacher lecturing, the students answering questions and working independently, and assessments based on standard pencil and paper testing (Mathnasium, 2012). Evidence suggested that many high school teachers still teach in a repetition lecture style that emphasizes on the teacher delivering information to unmotivated, uninvolved students (White-Clark et al., 2008). The traditional method of teaching mathematics is the behaviorist approach, which emphasizes the students' observable behaviors (Nesmith, 2008).

The direct opposite of this behaviorist approach is constructivism in which teachers request students to approach a new task with prior knowledge and construct their own meaning by assimilating new information (Nesmith, 2008). Constructivist learning emerged as an important approach to teaching based on the cognitive theory (Nesmith, 2008). In the

1980s, the National Council of Teachers of Mathematics began publishing articles on the need to reform the mathematics curriculum, which included *Principles and Standards for School Mathematics* (Nesmith, 2008). This article was revised in 2000 and continues to guide reform in mathematics education (Nesmith, 2008). The reform focused on the constructivist method to improve learning (Nesmith, 2008). Constructivism has been found to be essential in generating greater success in mathematics classrooms and enhancing student learning (White-Clark et al., 2008). Some researchers support using constructivist theory to teach math because students are given the opportunity to construct mathematics knowledge through exploring, reasoning, and problem solving (McKinney & Frazier, 2008). The constructivist approach to teaching math is hands-on and student-centered and enables students to make connections with prior knowledge and personal experiences (McKinney & Frazier, 2008). The constructivist approach includes cooperative learning, hands-on activities, technology, critical thinking, and manipulatives (White-Clark et al., 2008). There has been an emphasis from educators that mathematical knowledge should be taught by problem-solving, hands-on activities, and interactive learning experiences (Wang, 2009).

Educators have also tried to improve the instruction by applying real-world contexts. The experiential learning is used to actively involve students in the learning process, such as real-world experiments, rather than passively acquiring knowledge (McCarthy, 2010). Studies have indicated that if mathematical ideas are taught using real-world contexts, then the students' performance on assessments involving similar real-world problems is improved (National Mathematics Advisory Panel, 2008). In 2006, President George W. Bush issued an order to create a National Mathematics Advisory Panel to advise him and the Secretary of

Education on the best use of scientifically based research on the teaching and learning of mathematics (Kilpatrick, 2009).

Another theory that is becoming popular in mathematics classes is cooperative learning. According to the National Mathematics Advisory Panel (2008), there is an increased use of cooperative learning in mathematics education. The usage of such learning strategies has been encouraged in state curricular frameworks and instructional guidelines (National Mathematics Advisory Panel, 2008).

Cooperative Learning

Cooperative learning is an effective learning strategy but can be challenging to assess. Assessment is a major factor of education reform in the 21st century that is intended to improve student performance. Johnson, Musial, Hall, Gollnick, and Dupuis (2008) define "cooperative learning, in which students are expected to work together to accomplish tasks and are held accountable for both individual and group achievement" (p. 417). There is a convincing belief that cooperation in groups, with the goals of learning, enhances both learning and social skills (Slavin, 1995). Studies show that cooperative learning helps students develop interpersonal skills (Slavin, 1995).

High School Mathematics Curriculum

History of High School Mathematics Curriculum

Mathematics became a professional field of study in America at the turn of the 20th century, in which arithmetic, algebra, geometry, trigonometry, and calculus became part of the curriculum (Stanic & Kilpatrick, 2004). This is still the same curriculum and order used in schools today. The subjects and curriculum have changed very little since the original curriculum was put in place (Stanic & Kilpatrick, 2004).

The mathematics classes of arithmetic, algebra, geometric, trigonometry, and calculus are all taught as separate courses and exclusive of each other (Stanic & Kilpatrick, 2004). In the beginning of the 20th century, there were educators who tried to correlate these subjects together and with subjects such as physics and biology (Stanic & Kilpatrick, 2004). However, these subjects are still taught independently.

Algebra. Algebra is considered to be a main concern for student achievement because it is necessary to later achievement in more advanced mathematics course work (Evan et al., 2006). Algebra I provides the foundation essential for students to complete a comprehensive set of mathematics topics throughout high school and college (Achieve, 2010). Studies show that high school students who have successfully fulfilled Algebra II are two times more likely to finish college than those who do not take Algebra II (Evan et al., 2006). The Educational Longitudinal Study of 2002–2004, included a group of 11,909 high school seniors who completed at least one course beyond Algebra. The study revealed that students who completed one course beyond Algebra 2 had more than double the odds of completing their baccalaureate degree (Sciarra, 2010).

Precalculus and Calculus. Data from the Education Longitudinal Study of 2002 revealed that students who reach the most advanced courses such as precalculus and calculus before leaving high school are more likely to learn the most advanced skills and concepts (Bozick & Ingels, 2008). Students who take advanced courses are less likely to take intermediate courses in college (Bozick & Ingels, 2008). Much research revealed that increasing the number of students taking advanced math courses will lead to an increase in the number of students entering college, completing bachelor's degrees, and going on to careers that earn high wages (Kelley-Kemple et al., 2011). However, proficiency scores showed that by the end of high school, only 38% of the students had mastered intermediate mathematics skills (Bozick & Ingels, 2008). Only 4% of the students had mastered advanced skills and concepts (Bozick & Ingels, 2008).

Differences between U.S. Curricula and Top Performing Countries

One of the main distinctions between the curriculum in top performing countries and those in the United States is in the amount of mathematical ideas or topics taught at each grade level (National Mathematics Advisory Panel, 2008). The U.S. curriculum includes many more topics at each grade level, with each topic limitedly covered, whereas top performing countries provide students with greater depth to each topic (National Mathematics Advisory Panel, 2008). The highest ranking country in mathematics is Singapore, which established course standards intended to advance skills in a limited amount of significant mathematical subjects (National Mathematics Advisory Panel, 2008). Another difference in curriculum is that the U.S. presents many topics already presented at earlier grades in the higher grade levels, whereas the top performing countries move on to more advanced topics once they completely cover a topic in depth (National Mathematics Advisory Panel, 2008).

A third major difference between the curriculum in highest accomplishing countries and those in the United States is in the expectations for learning. Teachers in the majority of high schools in the United States teach each mathematic subject separately in the sequence of Algebra I, Geometry, and Algebra II (National Mathematics Advisory Panel, 2008). However, most of the high achieving nations in the TIMSS study do not follow this single-subject format (National Mathematics Advisory Panel, 2008). They have blocks for each subject that extend for months in order for students to understand the topic very well and avoid the need to revisit the same material over several years (National Mathematics Advisory Panel, 2008).

To help improve the mathematics education for students in the United States, it may be helpful to learn how the top nations educate their children and prepare them for the workforce. The country of Finland tops the international rankings in various research reports (Abdul, 2013). Researchers have shown that the quality of educators in Finland is what makes its educational system so successful. All educators have a master's degree (Gillies, 2013). It is extremely competitive to find a teaching job in Finland that only about 10 percent of applicants are accepted (Gillies, 2013). The whole culture of education is Finland is different than in the United States, in which teachers are accorded as much respect as the Finnish doctors and the wages are considered high (Gillies, 2013). In the United States, the salary gap between teachers and doctors is huge, and teachers' salaries are considered low compared to the amount of work teachers put in and the critical role they play in child development.

The Finnish model is different than many countries, including the United States, because it focuses on equality not competition in education (Gillies, 2013). The Finnish school system is designed to reduce social inequalities (Gillies, 2013). Therefore, the Finnish officials do not believe that a single top-down approach to education is effective; they instead allow schools and teachers to choose how they want to utilize their time and resources (Gillies, 2013). Cooper, Fusarelli, and Randall (2004) agreed that further regulations will not create better teachers or better education. Finland eliminates standardized tests and prefers to give the teachers the authority to design their own forms of assessment (Gillies, 2013). The country only has one matriculation exam that high school students take to qualify for postsecondary studies, which is very different than in the Unites States, which has standardized testing starting in elementary school. In the State of Florida, students who fail the standardized test can fail the whole school year. Florida assigns grades to schools based on the standardized tests. This is the opposite of what the Finnish officials believe, and they have proven to be more successful in their approach and educational model creating some of the best students in the world (Gillies, 2013).

With their top scores in the world, one might think that Finnish students spend more time learning, but the opposite is true. Finns spend the least amount of time in the classroom, with just 640 hours a year between the ages of 9 and 11, as opposed to the average of the industrialized nations that spend 810 hours and the United States that spends over 1000 hours a year (Gillies, 2013). Furthermore, the Finns assign less homework and strongly encourage extracurricular activities (Gillies, 2013).

High School Mathematics Instructional Methods

Learning and teaching mathematics has become one of the greatest failures in schools (Stanic & Kilpatrick, 2004). Larson and Howley (2006) stated that most principals do not engage in conversations about the nature of learning mathematics or about new approaches to mathematics pedagogy. Students are more motivated to learn new mathematical concepts if the instructional approach teachers implement in the class is engaging to students (White-Clark et al., 2008). Many high school students feel disengaged from their math instruction and see it as irrelevant to their lives (White-Clark et al., 2008). This can impact students' levels of interest and mathematics achievement (White-Clark et al., 2008). Today, differentiation, technology, instructional software, calculators, books, and formative assessments are used for instructional purposes.

Differentiation

Students in classrooms worldwide have many diverse instructional needs, including different abilities, interests, learning styles, and cultural backgrounds (Chamberlin, 2011). According to Johnson et al. (2008), one of the biggest challenges educators will endure is how to deal with societal change as classrooms become more diverse. Teachers need to present the content in a way that all students can understand and learn. Differentiated instruction is the best educational practice for teachers to apply in a classroom with diversity and multiple readiness levels (Lawrence-Brown, 2004). Differentiated instruction benefits all students, from gifted to those with significant disabilities in the same classroom.

Differentiated instruction is a process in which teachers are constantly changing their teaching methods, learning activities, and assessments to meet the diverse needs of students (Chamberlin, 2011). It is teaching to the diverse needs of all students by adjusting the curriculum and teaching strategies, rather than teaching to the average of the class, which may be too difficult or easy for some students (Batts & Lewis, 2005). Differentiated instruction is supported by both theoretical literature and empirical research (Chamberlin, 2011). Chamberlin (2011) conducted research on the incorporation of differentiated instruction in the mathematics content course to address the diverse needs. Research revealed that differentiated instruction supports the diverse needs of students (Chamberlin, 2011). According to Little (2009), effective mathematics instruction for students, both with and without learning disabilities, should include differentiated instruction. Chamberlin and Powers (2010) also found positive effects on mathematics learning because of differentiated instruction.

Through differentiated instruction, teachers create different levels of expectations for tasks, in which students can complete alone, in flexible groups, or together as a class. Differentiated instruction is an instructional philosophy that respects and celebrates the varied ways in which individuals learn (Loeser, 2008). The teacher responds to the learners' needs and presents respectful and appropriate learning tasks based upon readiness, interests, and learning styles.

Philosophy of differentiated instruction. Teachers need to encourage students to learn in the way that works best for them. This means not all students need to be on the same page at the same time. Teachers can use Bloom's taxonomy of cognitive educational outcomes to design projects that meet the different levels of students in the class (Cox, 2008). Benjamin Bloom identified three types of learning, which include knowledge, skills, and attitude.

History of differentiated instruction. The foundation for differentiated instruction comes from research, theories, and experience. As classrooms in the United States became more diverse, teaching to the average of the class leaves certain students behind and others unchallenged. After years of exploring different techniques for teaching and studying the brain, research suggested that the best practice of teaching diverse students in the same classroom is through differentiated instruction (Loeser, 2008).

In 1983, Harvard psychologist, Howard Gardner, discussed the areas of multiple intelligence in his book *Frames of Mind: The Theory of Multiple Intelligences*. His book laid the foundation for differentiated instruction. Differentiation has also been extremely helpful for students with disabilities, specifically after the Individuals with Disabilities Education Act of 1997, which necessitated that all students be given the opportunity to become involved with the general education curriculum, regardless of their abilities. Since then, a great deal of research has been done on differentiation.

Research supported differentiation. Differentiated instruction embraced years of research to find the best ways to provide instruction in classrooms (Loeser, 2008). In 1999, Carol Ann Tomlinson, Professor of Educational Leadership, wrote *The Differentiated Classroom*. Her research confirmed that students flourish more when they are taught based on their own readiness levels and interests, as is done in differentiation classes (Tomlinson, 1999). Dr. Tomlinson is now a renowned leader in the area of differentiated instruction, having written 13 books and numerous articles on differentiated instruction.

Need for differentiation in classroom. Differentiation became a trend in the 21st century when educators realized that a one size fits all class could not tackle the increasing diversity that exists throughout the nation or appropriately move each child through his or her own personal zone of proximal development (Vygotsky, 1978). Students in general education classrooms, in which there is a wide range of readiness levels, are not homogeneous. However, traditional classroom practices dominate.

Traditional versus differentiated classrooms. In traditional classrooms, teachers normally teach to the average of the class (Tomlinson, 2001). Teachers teach the way they were taught, paying little attention to individual differences. In differentiated classrooms, all students are active, engaged, challenged, interested, and respected (Tomlinson, 2001). Differentiation is a tool that values differences and pays attention to individuals, small groups, and the class as a whole (Tomlinson, 2001).

Benefits of differentiated instruction. Differentiated instruction is important for students at all levels in which there is an appropriate balance of challenge and success for all.

With support from the teacher, differentiated instruction helps all students who are exceptional to receive an excellent education in the same classroom (Lawrence-Brown, 2004). Differentiated instruction benefits students with a wide range of abilities, learning styles, and cultural backgrounds (Lawrence-Brown, 2004). All students gain from the availability of a variety of methods and appropriate balance of challenges for students at every level (Lawrence-Brown, 2004).

Differentiated instruction is accommodating students in any classroom but is necessary for inclusive classrooms (Scigliano & Hipsky, 2010). When special needs students are placed in inclusive settings, they have greater opportunities for normalization; at the same time, students without disabilities gain skills and insights that are beneficial for them, such as developing increased tolerance and appreciating human differences (Aldridge & Goldman, 2007).

How differentiation works. Differentiated instruction supports the classroom as a society in which students are nourished as individual learners (Lawrence-Brown, 2004). Differentiated instruction provides flexibility in content and practice based on student readiness, abilities, and learning styles. Teachers must connect subject matter with students' interests, previous knowledge, and experiences (Lawrence-Brown, 2004). Teachers need to incorporate multiple intelligences in the curriculum. An important strategy for maximizing attainment of the curriculum is for teachers to provide additional supports for struggling students and more challenging tasks for gifted students.

Teacher training. The first step in teaching students in a differentiated manner is to train the teachers how to educate differentially (Hedrick, 2005). Hedrick (2005) believes that teachers need to comprehend the theory of differentiation, as well as the connected observations and developmental skills, before they begin the process of differentiation. They also should demonstrate how to develop an understanding related to the needs of different learners. Teachers may take differentiation workshops that provide information about different learner styles, specific differentiation activities, and most important the differentiated curriculum.

Multiple intelligences. Gardner (1993) discussed eight major intelligences that including verbal/linguistic, logical/mathematical, visual/spatial, bodily/kinesthetic, musical, rhythmical, naturalist/environmental, interpersonal, and intrapersonal. A teacher can assess the students' multiple intelligence using several factors that include observation, interviews, and multiple intelligence surveys.

Inclusion**.** Inclusion was designed to bring special education services into the general classroom and has been a major topic in the 21st century. The underlying philosophy that embraces inclusion of students into regular education is based on welcoming all neighborhood students into the community school (Aldridge & Goldman, 2007). Inclusion forced teachers and researchers to explore ways to teach students with different abilities in the same class. Researcher Lawrence-Brown (2004) stated that differentiated instruction is critical for teachers in inclusive classrooms.

Rimpola (2011) studied high school mathematics inclusion classes and found that they help provide all students the access to rigorous curriculum because of the teacher support structures and adaptive shifts in instructional practices between the co-teachers. Co-teachers in a class are usually having general and special education teachers to deliver the instructions in the inclusive classroom (Murawski, 2009). Because of recent legislation, including No Child Left Behind and IDEA, as well as the current inclusion trend for placement of students with mild disabilities, many students with specific learning disabilities will be taking algebra and geometry courses in the general education rather than special education classroom (Steele, 2010). This placement will help learning disability students take a college preparatory curriculum and have the pre-requisite skills for college level mathematics (Steele, 2010). To assist high school students with learning disabilities so that they can be successful in their algebra and geometry classes, the special education and mathematics teachers need to collaborate on the planning, assessing, teaching, and determining modifications (Steele, 2010).

The reauthorization of IDEA required districts to put students with disabilities in the least restrictive environment (LRE) by allowing them to participate fully in rigorous academics and assessments (Murawski, 2009). The No Child Left Behind Act of 2001 also changes some of the legal requirements to increase the academic achievement of all students by delivering a rigorous mathematics instruction, which is necessary for all students to succeed in the workforce (Rimpola, 2011). This need brought about the development of inclusive classrooms to help all students advance (Murawski, 2009). Co-teachers can work together to plan engaging lessons and interact with students to encourage their participation in the lesson (Schunk, 2008).

Technology

Technology has a significant place in the field of education and deeply affects many disciplines (Ozgen & Bindak, 2012). One of the principles that the National Council of Teachers of Mathematics determined for school mathematics in the year 2000 for improving learning is technology, pointing out that it is essential in mathematics learning and instruction (Ozgen & Bindak, 2012). Technology was also important in mathematics learning where the principles of the constructivist learning approach were adopted (Ozgen & Bindak, 2012). In addition, differentiated instruction, with the use of technology, offers teachers the opportunity to connect with students in various modalities, while also varying the rate of instruction, complexity levels, and teaching strategies to engage and challenge students (Stanford, Crowe, & Flice, 2010). Technology allows teachers and students to interact in a manner that was not previously possible (Beeland, 2011).

Technology is most influential when integrated with curriculum and assessment (Center for Applied Research in Educational Technology, 2012). Integration of technology with curriculum and professional growth increases student achievement (Center for Applied Research in Educational Technology, 2012). It can also help students compete on a global level. A number of developing nations are increasing programs to help teachers and students become proficient in using computers and communication tools (Manzo, 2009). Nations like China and India are more focused than the U.S. on developing students' technical skills (Manzo, 2009).

Science, technology, engineering, mathematics (STEM). STEM is becoming very popular in the new global economy and seen as a vital step towards taking part in careers of the future (Scott, 2009). According to the President's Council of Advisors on Science and Technology (2010), STEM education will determine whether the United States will remain a leader among nations and will help produce the workforce needed to compete in a global marketplace with more scientists, technologists, engineers, and mathematicians. However, high school students in the United States not only lack proficiency in mathematics but also a lack of interest in STEM fields (The President's Council of Advisors on Science and

Technology, 2010). For this reason, the President's 2014 Budget invests $3.1 billion in programs across the Federal government on STEM (White House, 2003).

Instructional software. Research has shown that classes that use instructional software have a more positive effect on students' achievement in mathematics than classes that do not incorporate such technologies (National Mathematics Advisory Panel, 2008). The studies conducted revealed that technology-based drill and exercises can advance students in specific areas of mathematics and can support the development of particular mathematical concepts, applications, and problem solving (National Mathematics Advisory Panel, 2008). Computer delivered instructional software has the potential to motivate students (Luterback & Cole, 2008). Many schools have begun using interactive computer assisted instruction within the classes to assist students in mastering skills and concepts (Traynor, 2009). Teaching computer programming to students can also support the development of particular mathematical concepts, applications, and problem solving (National Mathematics Advisory Panel, 2008).

Calculators. There have been mixed feelings about calculators. Some educators worried that students would not be able to retain their knowledge of simple arithmetic if they learned to use a calculator before fully understanding basic mathematical concepts (Banks, 2011). Other teachers saw calculators as a chance to increase student motivation to learn as reasons to utilize these new devices (Banks, 2011). Calculators are now used on standardized tests, such as SAT, ACT, and the National Assessment of Educational Progress.

The National Mathematics Advisory Panel (2008) found that a great use of calculators in class can delay fluency in computation that students need throughout life. However, Banks (2011) explored the history of calculator usage in mathematics classrooms in the United States since 1975 with a focus on the attitudes of parents, educators, and national organizations. The study revealed that all the groups agree that the calculator increases motivation and the desire for students to learn.

Differentiation and technology. Technology has been very helpful in a differentiated curriculum in which students can use the Internet to conduct research on topics that interest them. The use of technology in differentiated instruction offers teachers the opportunity to connect with students in various modalities, while varying the rate of instruction, complexity levels, and teaching strategies to engage and challenge students (Stanford, Crowe, & Flice, 2010).

Textbooks

Mathematics books in many high performing nations are much smaller than the mathematics books used in the United States, which are often 700–1,000 pages (National Mathematics Advisory Panel, 2008). School mathematics books with excessive length can be a factor of students' lack of retention due to the large amount of information presented to them (National Mathematics Advisory Panel, 2008). Unlike other countries, the U.S. mathematics textbooks include many photographs, stories, and content that does not relate to mathematics (National Mathematics Advisory Panel, 2008).

Formative Assessment

The National Mathematics Advisory Panel (2008) found that the average gain in learning provided by teachers' use of formative assessments is marginally significant and that use of formative assessments benefited students at all ability levels. Teachers who use formative assessments on a regular basis show an increase in their students' learning (The National Mathematics Advisory Panel, 2008). Formative assessments in mathematics can aid teachers in classifying specific instructional needs that will benefit all the students (The National Mathematics Advisory Panel, 2008). The National Mathematics Advisory Panel (2008) found that if mathematical ideas are taught using real-world contexts, then student performance on assessments involving similar problems is improved.

Assessments that provide students with descriptive feedback help students improve; whereas, the judgmental feedback in the form of letter grades can sometimes have a negative effect on learning (Reeves, 2007). Classroom assessments provide individual assistance that can help all the students. Formative assessments are very different from large-scale assessments. Large-scale assessments are designed to rank the order of schools and students for reasons of accountability. Most of these assessments take place at the end of the school year when it is too late for the teacher to help the students. Formative assessment helps the teachers determine the next steps during the learning process as the instruction approaches the summative assessment of student learning (Garrison & Ehringhaus, 2007). Formative assessment is part of the instructional process that provides the information needed to adjust teaching and learning while they are happening (DuFour & Eaker, 2008). Formative assessment allows students to be evaluated on a continuous basis in all areas of instruction including observations, questioning, peer assessment, presentations, and reflection.

International Assessment on High School Math Students

The Program of International Students Assessment (2007) and Organization for Economic Cooperation and Development (2009, 2013a) have conducted studies on high school students from around the world, which provide evidence that a problem in mathematics education exists in the United States. International assessments on high school mathematics students reveal that the students in the U.S. are ranked below average compared to other civilized countries (National Mathematics Advisory Panel, 2008; Organization for Economic Cooperation and Development, 2013a). The international test data and analysis helped Americans learn about the strengths and shortcomings of the education systems in other countries (Cavanagh, 2009). Educators, policymakers, and researchers in the United States studied the teaching methods, curricula, and academic programs of high-performing countries for lessons that can be applied to American schools (Cavanagh, 2009). Differences between the mathematics education in the U.S. and other countries are presented in this chapter under the curriculum section. This section contains the international assessments of the Trends in International Mathematics and Science Study (TIMSS) exam and the Program for International Student Assessment (PISA) mathematics test to provide information about how the United States students' knowledge of mathematical concepts compares to other nations.

The Trends in International Mathematics and Science Study (TIMSS)

The Trends in International Mathematics and Science Study (TIMSS) exam is administered on a regular basis to students in many countries throughout the world in a number of grade levels and content areas (Evan et al., 2006). The Trends in International Mathematics and Science Study (TIMSS) data is a source for assessing the student outcomes of United States students compared to the performance of students in a variety of countries throughout the world (Evan et al., 2006). This study heightened the importance of educational excellence in mathematics (Schmidt et al., 1999).

Schmidt et al. (1999) issued a series of reports following the 1995 international math and science assessments that were strongly critical of U.S. mathematics practices. The TIMSS revealed that U.S. student performance substantially lags behind many of our international peers (Evan et al., 2006). The data also revealed that performance of U.S. students declines the longer students stay in our K–12 system; so by the time students reach 12th grade, the scores fall near the bottom (Evan et al., 2006). The top U.S. students who were enrolled in Advanced Placement Calculus were only average compared to the other nations (Evan et al., 2006).

The Third International Mathematics and Science Study of 1995 study showed that U.S. 12th-graders scored below 14 of 21 participating countries (Martin & Mullis, 2005). The U.S. scored in the middle ranking of 41 countries, only significantly higher than countries like Cyprus and Lithuania (Schmidt et al., 1999). Asian countries and Belgium were significantly higher than the U.S. in their overall performance (Schmidt et al., 1999).

The 2007 and 2011 Trends in International Mathematics and Science Study (TIMSS)

The results of the 2007 Trends in International Mathematics and Science Study (TIMSS) indicated that American students were underachieving in mathematics and compared unfavorably with students in other countries (Visone, 2010). Even though the United States is the richest nation in the world and spends the most on education, students scored behind several other countries with fewer resources (Visone, 2010). In 2011, more than 60 countries with almost 500,000 students, including the United States, participated in TIMSS, with more than 20,000 students in more than 1,000 schools across the United States (National Center of Statistics, 2012). There was no measurable difference between the U.S. average mathematics score in 2007 and in 2011 (National Center of Statistics, 2012).

The 2007 Program for International Student Assessment (PISA)

Hanushek et al. (2010) discussed the performance of U.S. math students in relation to other countries using the Program for International Student Assessment (PISA) mathematics test. In the 2007 Program for International Student Assessment (PISA), U.S. high school students ranked 25th out of 30 developed nations in math literacy and problem solving (Baldi et al., 2007). The state of Massachusetts had the highest performance in the country, but the Massachusetts students still trails that of 14 countries. The authors also examined how well U.S. schools perform at producing high-achieving math students by comparing the percentage of U.S. students in the graduating class of 2009 to percentages of high achievers in 56 other countries. Countries with students who perform at higher levels in mathematics showed larger rates of increase in economic productivity than countries with lower-performing students (Hanushek et al., 2010). Hanushek et al. (2010) state that mathematics skills predict better future earnings and other economic outcomes than other skills learned in high school.

The 2012 Program for International Assessment (PISA)

In the 2013 report by the Organization for Economic Cooperation and Development (2013a), the United States' ranking dropped to 36 in mathematics scores generated from the 2012 Program for International Assessment (PISA). According to the PISA 2012 report published by the Organization for Economic Cooperation and Development (2013b), key findings include that:

1. The United States performed below average in mathematics.
2. The scores for the top performer, Shangai-China, indicate that their students are over two years ahead of the top performing U.S. state of Massachusetts.
3. While the U.S. spends the most per student, it did not reflect better performance.
4. The United States performed at the same level as Slovak Republic, which spends less than half the amount of money the U.S. spends per student.

5. United States students showed weakness in performing mathematics tasks with higher cognitive demands, such as mathematically solving real world problems.

Reform in High School Mathematics Education

The international assessments of high school students suggest that reform is needed in mathematics curriculum and instruction in U.S. schools (Corbishley & Truxaw, 2010). Reform in schooling may be whatsoever provides systematic change in educational views and practices in a society (Edyburn, 2008). There has been constant talk about reform in school mathematics curriculum, but little has been done (Stanic & Kilpatrick, 2004).

One of the National Education Goals set by the Clinton Administration was for U.S. students to be ranked first in the world in mathematics by the year 2000 (Bellomo & Strapp, 2008). The National Assessment of Educational Progress (NAEP) given to high school seniors in 2000 confirm that too few students are taking higher-level mathematics classes (Bellomo & Strapp, 2008). According to the NAEP Assessments, 44% of high school students never advanced beyond Algebra II (Bellomo & Strapp, 2008). The 2000 NAEP Mathematics Assessment revealed that only 17% of 12th graders performed at or above proficiency (Bellomo & Strapp, 2008). The Committee on the Undergraduate Programme in Mathematics (CUPM) found that the percentage of students intending to major in mathematics steadily declined from 1975 (1.5%) to 2000 (0.7%) (Bellomo & Strapp, 2008).

Most mathematics reformers believe the solution is to bring more advanced mathematics in the lower grades, while others believe that students should discover as many mathematics principles as possible (Stanic & Kilpatrick, 2004). Studies also revealed that senior year mathematics homework, in which students completed out of school, was extremely important in preparing students for college (Zelkowski, 2011). Students who spend more time on mathematics homework have a greater chance of earning a bachelor's degree (Zelkowski, 2011).

Efforts to reform the mathematics curriculum indicate that the teacher is the key to change (Kilpatrick, 2009). It is important for teachers to analyze and discuss the proposed changes in the mathematics curriculum (Kilpatrick, 2009). This study was designed to shed more light to the problems that exist in high school mathematics classes and an effective reform to improve student achievement by using the teachers' perceptions, who may provide the key to positive change. Professional development may be helpful for teachers to enhance math curriculum and instruction by collaborating with other colleagues.

Professional Development

The culture of traditional schools is transforming to a professional learning community where educators work collaboratively in an ongoing processes of inquiry and research to achieve higher learning of the students (DuFour & Eaker, 2008). Traditional schools have not been successful in providing excellent instruction for all students in the United States. Researchers have shown that professional learning communities (PLCs) improve the schools for both student and adult learning (DuFour & Eaker, 2008). Schools that transform to professional learning communities provide higher learning for students and more satisfaction and fulfillment for teachers.

Professional development activities. DuFour and Eaker, along with some of the most influential people in education provide insights to improving schools and implementing activities that will benefit both students and instructors. They use research, practices, and study of organizational development, change processes, leadership, and successful practices outside of education to provide the best techniques and activities to transform schools to professional learning communities.

Create a clear vision. The first and foremost activity is to create a clear and compelling vision. According to Baker (1991), educational leaders can articulate a meaningful vision of the school where students are engaged in thoughtful work if it has a disciplined system where all students are organized as high-performance workers.

***Communicate clear goals*.** Clear goals guide the ongoing work of educators (DuFour & Eaker, 2008). The leader must communicate the goals to the staff and constantly work with them to meet the goals. When the staff clearly understands the goals, they are more motivated to take action, especially if the leader provides them with ongoing feedback (DuFour & Eaker, 2008). People enjoy their job more when they know they are contributing to the achievement of the goals and making a positive difference in the lives of others. For goals to have a positive impact on the organization, they must be specific and direct. School leaders of the high school should constantly remind the teachers that the goal is to improve students' understanding of mathematics and increase student achievement. According to DuFour & Eaker (2008), schools with leaders who support the staff and provide them with information about improving the educational experience in the classroom are more successful.

***Create a collaborative culture with a focus on learning*.** "If shared purpose, vision, collective commitments, and goals constitute the foundation of a PLC, then the collaborative team is the fundamental building block of the organization" (DuFour & Eaker, 2008, p. 15). When teachers work together, they can share their knowledge and experience that benefits the rest. The educational leader must also collaborate with the teachers to provide more information and coaching on how to provide the best instructions for students. Teachers and leaders can engage in collective inquiry into the best practices about teaching and learning (DuFour & Eaker, 2008).

Provide teachers with relevant and timely information. Teachers need information about effective techniques of teaching. They also need to receive frequent and timely information regarding the achievement of their students. Data alone does not improve the teaching or increase student learning (DuFour & Eaker, 2008).

Utilize ongoing assessments. Teachers must monitor learning on a timely basis. The educational organization must provide interventions for students who are struggling and enrich the learning for students who already mastered the material (DuFour & Eaker, 2008). According to DuFour and Eaker (2008), one of the most powerful strategies for a school to become a professional learning community is for teachers to create high-quality assessments. Formative assessment is extremely important for the teaching and learning process. Formative assessments should start from the first day of school and are ongoing.

College and Career Readiness

It is important to close the gaps between mathematics education and students' needs because students' success in mathematics education gives them more college and career options and increases prospects for future income (National Mathematics Advisory Panel, 2008). At a time when the world is driven by technology, students need to study more advanced mathematics to improve their critical thinking and problem-solving skills (Bellomo & Strapp, 2008). For the past 25 years, the high school mathematics education has been documented to be essential in advancing student's academic achievement and college readiness (Zelkowski, 2011). Statistics revealed that many high school math courses are not rigorous enough to prepare students adequately for college-level work (Achieve, 2010). Research studies reveal that students who pursued mathematics majors in college complained about the inadequate mathematics preparation in high school (Bellomo & Strapp, 2008). Improving mathematics education in high school will also improve the students' learning experience in college.

Research has shown that students who study math at least though Algebra II in high school are more likely to earn a bachelor’s degree (Achieve, 2011b). Colleges offered an average of 2.5 remedial courses in mathematics, mostly to students who did not have Algebra in high school (Business Higher Education Forum, 2005). These courses may limit a student’s ability to graduate college in a timely manner (Business Higher Education Forum, 2005).

Daun-Barnett and St. John (2012) found that constraining the high school curriculum in terms of course requirements and mandatory exit exams affects three educational outcomes: test scores on SAT math, high school completion, and college continuation rates. They collected data from all 50 states from 1990 to 2008. Mathematics curriculum and exit exams may prevent some students from completing high school on time. The authors suggested that providing school funding could help improve high school graduation rates and test scores.

Improving students' mathematics skills can also help them throughout their lives. According to Phillips (2007), 78% of adults cannot explain how to compute the interest paid on a loan and 71% cannot calculate miles per gallon on a trip. Also, the U.S. needs to prepare students for careers in science, technology, engineering, and mathematics (STEM) that will help them in a technologically sophisticated and global environment. Students who have received a strong mathematics background in high school are more likely to earn in the top quartile of income from employment (National Mathematics Advisory Panel, 2008). Studies showed that the annual earnings of students who had taken calculus in high school were about 65 percent higher than the earnings of students who had only completed basic math (Achieve, 2011b).

The goal of the Common Core State Standards (CCSS) was designed to help close this gap and ensure all students advance to the college and career-ready level by the end of high school (Achieve, 2010). The Common Core Standards in Mathematics reflect the need for all students to take at least three years of rigorous mathematics through what is currently found in an Algebra II class (Achieve, 2010). Research from Achieve (2010) suggested that for high school graduates to be prepared for success in college and the workforce, they need to take four years of challenging mathematics, including content at least through Algebra II.

Conclusion

The results of the National Assessment of Educational Progress (NAEP), also known as National Report Card, indicated that only 23% of students are proficient in mathematics at Grade 12 (National Mathematics Advisory Panel, 2008). In addition, the performance of U.S. students in college and on international assessments is concerning, since the U.S. students are outperformed by a large number of nations (Business Higher Education Forum, 2005). While every student's future depends on high-level competence in mathematics, the vast majority of U.S. students, including the highest performing students, are falling well below expected levels of performance (Evan et al., 2006). America's leadership in innovation and economic prominence relies on the strong foundation of mathematics (Business Higher Education Forum, 2005).

Summary

The problem in this study is that a large number of students who graduate from high school are not ready for college and the labor force of the 21st century (McCormick & Lucas, 2011). The fact that U.S. students enter college not ready for college mathematics is very concerning. In addition, the poor academic performance of U.S. high school students in mathematics has been a concern of educators for decades. There is a need to develop more efficient and effective mathematic curriculum and instruction (Witzel & Riccomini, 2007). Chapter 2 included a review of the literature that supports the study of finding the issues in high school mathematics education and possible solutions. After a brief overview of how the literature review documents were researched and found, the chapter started with a historical overview of mathematics education in the United States, which dates back to the year 1635, when the first school opened in Boston, Massachusetts, until the present time.

Chapter 2 also contained a theoretical framework that focuses on traditional and constructivist methods of teaching. The normal method of teaching mathematics for many years has been the traditional method (Nesmith, 2008). However, the constructivist approach has become essential in generating greater success in mathematics classrooms (White-Clark et al., 2008). This chapter also included a discussion of the change in the mathematics curriculum. The mathematics curriculum has undergone little change since it became a professional field of study in the 20th century (Stanic & Kilpatrick, 2004). Algebra is considered the most important subject in the curriculum because it improves student achievement throughout high school and college (Evan et al., 2006). To improve students' learning, it is also important for teachers to use effective instructional methods of teaching. The chapter includes evidence of the positive affect that instructional tools such as technology, instructional software, calculators, books, formative assessments, differentiation, and inclusive classes have on student learning.

This chapter contained a summary of the international assessments used to evaluate students' understanding of mathematical concepts from around the globe. These assessments revealed that students in the U.S. are ranked below average compared to other civilized countries (National Mathematics Advisory Panel, 2008). Assessments studied in this research are the Trends in International Mathematics and Science Study (TIMSS) exam and the Program for International Student Assessment (PISA) mathematics test. These assessments suggested that reform is needed in mathematics curriculum and instruction in U.S. schools (Corbishley & Truxaw, 2010).

Finally, Chapter 2 contained a discussion about college and career readiness and how to close the gaps that exist between mathematics education in America and the students' needs. One of the effective ways to close this gap is to have students study more advanced mathematics that will improve their critical thinking and problem-solving skills (Bellomo & Strapp, 2008). Chapter 3 will provide a description of the methodology that will be used to conduct the research for the study.

Chapter 3

Methodology

The purpose of this qualitative exploratory case study was to explore why a large number of high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. This study provides details about the curriculum and instructional strategies that are used in high school mathematics classes today. This information was necessary to provide an understanding of why high school students in the United States are behind other civilized nations around the world in mathematics. Teachers were asked to share their views on the curriculum and methods of instruction used in the mathematics classes. Finding the problems helped bring forth solutions, which may increase the students' achievement in mathematics.

Several attempts have been made to improve the curriculum and instruction in high school mathematics classes over the years. The literature review documented the history of high school mathematics curriculum, instructional methods used in classes, and reform in high school mathematics education. This research provides educational leaders with new knowledge on the current curriculum and instruction that may help the leaders improve the mathematics education in their schools. Scientific studies have shown that traditional methods for high school mathematics instruction are ineffective and lack mathematics reasoning and problem solving skills (Grossman, 2007). However, the teaching of mathematics continues to resemble the traditional teaching seen for many decades (Beswick, 2006). Poor education in high school mathematics classes may delay a student from entering college or graduating on time and may render a student to be less prepared for the workforce (Grossman, 2007). This chapter describes the research design and methodological approach to the study. The research questions and procedures are outlined. The methods used for research design, data collection, data analysis, and validation are presented.

Research Method

A qualitative research method was used to explore why a large number of high school students in the U.S. are not ready for college mathematics and how to increase student achievement in mathematics. Qualitative research methods provide in-depth descriptions that provide a deeper understanding of how participants perceive a situation (Finn & Kohler, 2010). Qualitative research is appropriate when the researcher is interested in exploring a situation to gain a deeper understanding of the situation (Creswell, 2008).

Qualitative data collection included open-ended questions that do not restrict participants' views (Creswell, 2007). The use of open-ended questions ensured an opportunity for participants to respond in their own words to facilitate the acquisition of meaningful interpretations that address the situation in this study (Fontana & Frey, 2005; Yin, 2009). This study included the views from high school mathematics teachers to explore the current mathematics education that the students are receiving. The teachers described the current curriculum and methods of instruction used in the classrooms and suggested possible changes that may help students advance. A case study is appropriate for this research because it focuses on a particular phenomenon or situation, provides a description of it, and uses qualitative research to discover new meaning that may improve the situation (Shank, 2006). The situation under study is why students in the United States underperform in high school mathematics education and possible solutions to this problem. Yin (2009) stated that the case study is used to contribute to the knowledge of an individual, group, or organization and a related situation.

Design Appropriateness

The research design was an exploratory case study to explore the teacher perceptions of the current curriculum and methods of instruction to better understand why U.S. students underperform in mathematics. A qualitative, exploratory case study was the suited method to understand the perspectives and experiences of the participants (Creswell, 2008). Qualitative case studies are increasingly being used in educational research to describe context-specific educational situations and to draw conclusions by generalizing the findings (Kyburz-Graber, 2004). Leedy and Ormrod (2010) stated that a case study methodology is the most appropriate to seek teachers' perceptions through open-ended questions and interviews. Stake (2005) stated that the face-to-face interviews and a focus group provide an opportunity to hear and understand first-person narratives of the teachers' experiences. The surveys, along with the focus group interview, were used to answer the research question of why U.S. high school students underperform in mathematics.

A quantitative research design was not appropriate for this research because the presence of a cause-and-effect relationship between the variables was not known, and there were no numerical calculations (Christensen, Johnson, & Turner, 2011). The objective of quantitative designs is to classify and investigate reoccurring independent variables to determine their effect on dependent variables (Creswell, 2008). This research study did not involve independent and dependent variables. It focused on the teacher perceptions, which cannot be measured quantitatively. The qualitative method examined specific non-numerical data, insights, and lived experiences to gain a deeper understanding of a situation (Neuman, 2006). It was appropriate for this research because it depended on the collection of qualitative data though surveys and focus study interview.

An ethnographical approach was not appropriate for this study because it would necessitate presenting teacher perceptions over a limited period of time. In ethnographical studies, researchers participate over an extended period of time in the lives of the people they are studying to see the world from a cultural perspective (Shank. 2006). The phenomenological study was also not appropriate because it seeks to uncover insights of experiences in particular settings that depend almost exclusively on lengthy interviews of over an hour (Leedy & Ormrod, 2010). The surveys for this study were around half an hour in length, and the focus study was 60 minutes. The data collected from the surveys and focus group allowed the researcher to gain an in-depth understanding of why United States high school students underperform in mathematics. Since the study was intended to explore real-life experiences of these teachers, the exploratory case study is the most suitable design for this research (Yin, 2009).

Population and Sample

The sample of the population of this study was 12 high school mathematics teachers of northwest Florida. The study was limited to the high school mathematics teachers because the purpose of the study was to explore the perceptions of high school mathematics teachers regarding the problems that exist in the curriculum and share the effective strategies they use to teach mathematics. The criterion for selecting the teachers was that they must be certified public high school mathematics teachers. The sample size of 12 teachers allowed for an in-depth study of the teachers' perceptions (Fontana & Frey, 2005).

The sample was obtained from the district's faculty website. Each public school in the district has a website with a faculty tab, which includes all the mathematics high school teachers. Those teachers were all contacted via email and interoffice courier. The first 12 teachers who responded back and were willing to consent served as the sample of this study.

The research method was qualitative with an exploratory case study design. A qualitative exploratory case study was appropriate to explore the perceptions of the high school teachers regarding the students' poor performance in mathematics and ways to improve student achievement. The teachers were asked to share their insights on the current mathematics curriculum and methods of instruction used in classrooms and to find the perceived reasons behind the students' poor performance. The teachers were also asked to communicate their concerns regarding high school mathematics curriculum and instruction that may be the cause why students are not ready for college mathematics upon graduation and suggest a better approach to teaching mathematics in the 21st century. The participation in the study was voluntary and posed no risk or harm to the study subjects.

Qualitative research generally involves small numbers and a population that does not need to represent the larger population (Stake, 2005). Qualitative research is very time consuming, so analyzing a large sample can often be impractical (Crouch & McKenzie, 2006). A reasonable number to complete this study was 12 high school mathematics teachers from different public schools in northwest Florida. The teachers were diverse in age, experience, and years of teaching. In addition, open-ended responses are often problematic when dealing with a large number of participants; therefore, qualitative studies tend to be small (The Research & Planning Group, 2011). Each teacher in this study responded to 16 open-ended questions about high school mathematics education. After all the data was collected and organized, it was analyzed through data coding phases (Neuman, 2003). NVivo 10 sorted the data according to codes.

As the researcher was collecting data, the researcher kept track of the themes to assess data saturation and ensure that no new information was presented as the data collection ends with the last participant. NVivo 10 calculated the percentage of coverage for each theme to rank the themes in order. This included the coverage in both the surveys and focus study.

Informed Consent

A Premises, Recruitment and Name (PRN) Use Permission letter was sent to the Superintendent of the public high schools in northwest Florida and signed (see Appendix A). Initially, 12 mathematics teachers from different high schools in the district were contacted via email and courier mail. Courier mail is the inter office mail. The researcher of the study is a school employee at the district and is able to send and receive letters to all school district employees using the courier. Therefore, the delivery of the Informed Consent was through the district courier and email. The teachers were informed in an email when the Informed Consent was delivered though the courier. Once courier mail reached a school, it was placed in the teachers' mailboxes. After the teachers signed the consent form, they used the courier to return the informed consent forms back to the researcher. The courier usually delivers the mail within 24 hours or less.

The teachers were provided with both information about the study and an Informed Consent Form. When the research had 12 teachers interested in participating in the study, the research did not contact any more teachers to participate in the study. According to Creswell (2005), the researcher should select individuals who have interest in learning and understanding the central phenomenon. Participants need to be assured that their information will be valued and kept confidential (Leedy & Ormrod, 2005). The Informed Consent Form (see Appendix B) indicated that participation will be voluntary and that participants could discontinue their participation at any point during the study. The Informed Consent Form was used to inform participants of the purpose of the study and describe the survey and focus study process.

Risk and Benefit

The Informed Consent specified to the participants that there is no risk for participating in this research in any way. The Informed Consent Form included the possible benefit from being part of this study. A possible benefit of this study is that it may allow educators to explore innovative methods that the teachers in the study use to assist students in meeting or exceeding the state standards. This study is important for students, parents, teachers, administrators, and everyone who cares about the education of the students in United States. It provides school leaders and teachers with information that identifies problems with the curriculum and instruction in high school mathematics classes and how to resolve those problems.

Privacy and Confidentiality

The Informed Consent informed the participants that the results of the research study may be published but their identities will remain confidential and their names will not be made known to any outside party. Pseudonyms were used instead of the participants' name to ensure confidentiality. Personal information and the school names for the study were coded to ensure compliance with and respect for confidentiality.

The participants were informed that the data will be secured in a fireproof locked storage for three years. The focus group discussion was video recorded and downloaded onto a personal computer and saved on a USB, which is securely stored. The answers were transcribed for data analysis. No personal identification was included in the transcripts, only the assigned pseudonym for each study participant. Participants were advised that if at any point they requested it, the videotaping or equipment would be turned off. They may also choose to withdraw from the study at any time.

Information about Participation in the Study

The Informed Consent included the purpose of the study, as well as how long the participation would be, which would include a survey of 16 questions that should take no more than 30 minutes and voluntary participation in a focus group. The participants were informed about the confidentiality of their participation. They were also informed how to withdraw at any time. The participants read and signed the consent letter. The participants' signature on the informed consent form confirmed that the participants agreed to be part of the study and acknowledged the protection of their rights (Creswell, 2005).

Data Collection

Qualitative data collection consists of collecting data using general questions to permit the participant to generate responses (Creswell, 2005). The exploratory case study research design is appropriate to the research method because the design allows the researcher to use in-depth interviews (Neuman, 2003). The qualitative data that was collected included open-ended surveys, focus group interactions, and examination of artifacts of teaching representing teacher planning methods.

Surveys

The open-ended surveys served as the primary method of data collection to understand the teacher perceptions about why a large number of students in the United States are not ready for college mathematics and the workforce. Qualitative survey research is often used as a way of collecting verbatim statements from participants (The Research & Planning Group, 2011). "Written open-ended surveys allow respondents to offer a responses within their own unique context, and the value of the information provided can be extremely high," (The Research & Planning Group, 2011, para. 6). The surveys were completed by the 12 participating teachers and were returned to the researcher via email and courier. The answers were transcribed for data analysis.

Focus Group

The study also included a focus group of volunteers from the participating teachers to enhance responses from the open-ended surveys. The focus group provided an opportunity to gather more information, confirmation, and clarification from the interviews (Fontana & Frey, 2005). This confirmation affirmed the validity and reliability of the research (Fontana & Frey, 2005). The focus group included four volunteer participants of the 12 teachers who completed the survey for the study.

Face-to-face interviewing during the focus group study is used in qualitative research through the use of open-ended questions to obtain the experiences and opinions of the participants, while providing a mechanism for expanding (Creswell, 2008). The participants, who were high school mathematics teachers, were encouraged to expound upon their survey responses with greater depth and clarity. The questions were focused on how the curriculum and instruction in the class affects the students' learning and the ways to improve the learning. The focus study was video recorded by the researcher.

Video Recording

A video recorder was used to ensure all relevant information was documented and presented accurately as raw data. The teachers were recorded during the times of the focus group discussions. Recordings were used to ensure proper transcribing of participants and coding for responses. The focus group recording, which was 60 minutes, included four focus group questions (see Appendix D). The participants all signed the Media Release Form (see Appendix F) before video recording began. Before the focus group discussion, the teachers were informed about the consent form granting permission to record the focus study. The video recorder started at the beginning of the focus group study to capture all the answers, comments, and discussions that take place. The data was coded to ensure confidentiality. The video recording was completed using a Sony digital high definition (HD) video camera recorder.

Artifacts

The artifacts that were collected included lesson plans, curriculum requirements, and supplemental data supporting instructional techniques to provide further information about the curriculum and instructional methods used in classrooms. Lesson planning documents were appropriate for data collection because they provided an understanding of what the teachers plan to teach and how (Neuman, 2003; Yin, 2009). The artifacts were collected to triangulate the data, gain a better understanding of the teachers' perceptions, and identify possible issues that contribute to why the students in the United States underperform in mathematics.

Triangulation

Triangulation of data was used for data collection and data analysis (Creswell, 2005). Yin (2009) stated that a case study relies on multiple sources of evidence, in which the data is triangulated to increase the validity. Open ended surveys, focus group study notes, and artifacts related to the curriculum and instructional methods were the three major sources of data collection. The use of a focus group as a form of triangulation was used to support this research (Fontana & Frey, 2005; Stake, 2005; Yin, 2009). The results collected from the surveys, focus group, and artifacts were all compared to see if similar results are found. The three forms of data collection were triangulated during the data analysis phase to identify patterns, themes, and phrases. The triangulation of data collection increases reliability in a case study (Yin, 2009).

Triangulation provides an opportunity for comparing and crosschecking findings (Hastings, 2010). Triangulation was used to cross verify the same information from the different types of data sources, which included surveys, focus group, and teachers' artifacts. NVivo was used to find data sets that complement one another. Data from the interviews, focus group notes, and teachers' artifacts were compared to one another to develop multiple perspectives and achieve triangulation.

Instrument

The data collection included the researcher as the instrument interviewing, observing the focus group, and collecting artifacts from the teachers to explore perceptions of why the students in the United States perform lower than other developed nations in mathematics. Yin (2009) stated that in a qualitative research study, the instrument in a case study is the researcher. The researcher in this qualitative exploratory case study asked the teachers open-ended questions through the surveys, observed the focus group and recorded the data, and collected artifacts that helped solve the research question and increase validity. Another instrument was a Sony digital high definition (HD) video camera recorder, which was used to record the face-to-face focus group discussion. NVivo software was downloaded from the

University of Phoenix website to assist with the coding of the data collected from the surveys and focus group study.

Validity

Validity is a key concept in conducting research (Shank, 2006). Research validity is the way researchers conceptualize the correlations between the outcomes and ensure the research findings and interpretations are accurate (Creswell, 2008). Validity of qualitative research can be complex since qualitative research takes on many forms (Shank, 2006). One of most popular validations in qualitative research is triangulation (Shank, 2006). Triangulation is when a researcher uses different resources to ensure validity, such as different methods, different researchers, and different sources of data (Shank, 2006). Using a triangulation of multiple sources and connections to research questions established with a chain of supportive evidence that increase validity (Yin, 2009). Yin (2009) also stated that the use of multiple sources enhances the reliability of the design. This study included data collection from multiple sources to increase consistency, which included surveys, focus group interactions, and high school mathematics lesson plans in northwest Florida to explore teacher perceptions of the curriculum and instructional methods used in the classrooms. The focus group also provided an opportunity to confirm the information from the surveys, which affirmed the validity and reliability of the research (Fontana & Frey, 2005).

Internal Validity

Internal validity is challenging in qualitative research when using a non-experimental design. This qualitative research did not contain variables like quantitative research has. While there are no casual relations in this qualitative study, pattern matching from the data analysis in this study strengthens internal validity. Yin (2009) indicated that one of the most desirable techniques in case study analysis is to use pattern matching.

External Validity

External validity refers to the ability of the research to be repeated (Creswell, 2007). Neuman (2005) stated that for scientific research to hold value, it should be generalized or applied to other people or settings. To reduce the threat of external validity, the researcher should include a diverse group of participants in the study (Creswell, 2007). This study included teachers from different high school grade levels, as well as different schools in northwest Florida. Creswell (2007) stated that external validity is enhanced when the information documented reflects real life experiences that are common to participants in the general population. Because this study included the lived teaching experiences described by high school mathematics teachers, the findings might possess external validity to a certain extent. However, since this case study is exploratory and not causal or experimental, then internal and external validity will not be a concern (Neuman, 2003; Yin, 2009).

Data Analysis

The research included a case study database to collect and organize the data. Qualitative data analysis was conducted through data coding phases (Neuman, 2003). Qualitative coding is an integral part of data analysis to the overall efficacy of the case study (Yin, 2009). Coding allows the researcher to categorize data. During the first phase of open coding, the data was examined for themes that emerge (Neuman, 2003). The second phase of data coding was axial coding. During this phase of coding the data was reexamined and organized according to the code labels (Neuman, 2003).

NVivo, a computerized qualitative research tool, organized the data, helped code, and categorized the large amounts of narrative text. NVivo sorted the data according to codes. First, the researcher carefully read the surveys, focus study discussions, and artifacts collected to identify and highlight common themes. Then a set of codes was selected from the common themes to use with the NVivo software. In addition, all the material collected from the surveys and focus group was imported to NVivo. Then, the sources were coded to gather the material into themes. These themes were organized in folders in NVivo. NVivo allows the user to run queries to uncover trends and see how ideas are related (QSR International, 2011). NVivo 10, which was used, also allows visualization techniques to help see the patterns and connections in the imported data (QSR International, 2011). NVivo 10 allows the user to view the percentage of coverage for each theme. The percentage of coverage was used to rank the themes that emerged in the study.

Summary

Chapter 3 contained a description of the research methodology and design appropriate for the study. A qualitative case study design captured the perceptions of high school mathematics teachers in northwest Florida. Chapter 4 includes the data analysis and results from the data collected.

Chapter 4

Results

The purpose of this qualitative case study was to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. Chapter 1 included problems that exist in teaching high school mathematics. A large number of students who successfully complete high school do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century (McCormick & Lucas, 2011). Chapter 2 presented an extensive literature review of the historical influences on curriculum, theoretical framework, mathematics instructional methods, and international assessments on high school math students. Chapter 3 described the qualitative research methodology, appropriateness of the case study design, population, data collection, and validity. The qualitative data that was collected included open-ended surveys, focus group interactions, and teacher artifacts.

Chapter 4 provides the data demographics, response from the surveys, and response from the focus study. It also includes the data analysis and a summary of the findings. The first part is the data collection, which includes the data demographics of the teachers in this study. The second part of this section presents the findings and analysis of each theme.

Participants

The participants of this study included 12 high school mathematics teachers from northwest Florida. The researcher is an administrator in northwest Florida and has access to the courier system for communication, as well as all the educators' email addresses. The researcher first contacted the high school math teachers via email explaining the study. Appendix E contains the Subject Recruitment and Selection Message. The participants who agreed were then provided with the Informed Consent Form to sign (Appendix B). The participants were also informed about the focus group participation and provided with the focus group questions in Appendix D. The focus group study was completed after all the surveys were received from the 12 teachers. All 12 teachers were contacted about the focus study. Four teachers, or one-third, responded and participated in the focus group study.

The survey starts with three demographic data questions that include the age of the teacher, years of teaching high school math, and math classes taught by the teachers. Figure 2 includes the age groups of the 12 teachers.

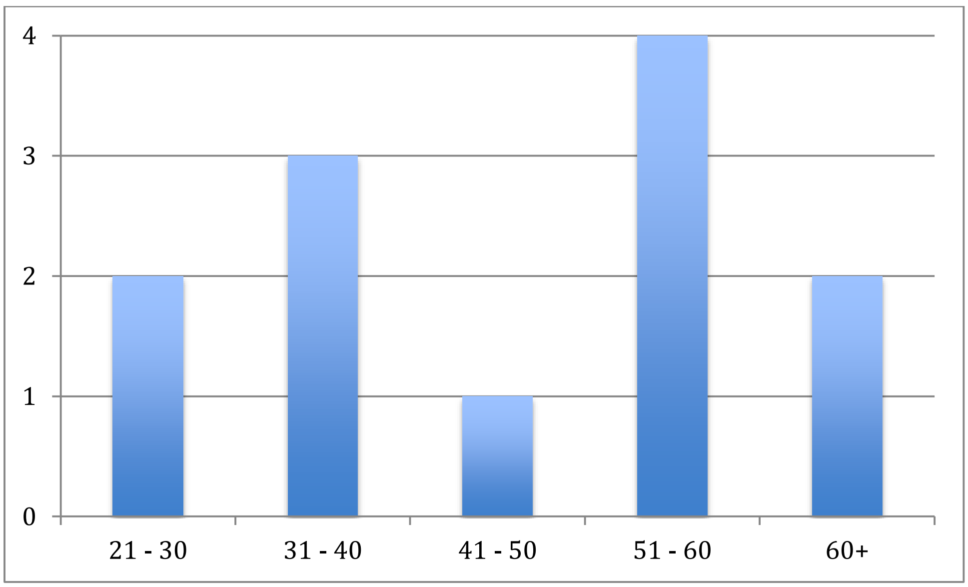

Figure 2. Age of teachers.

Two teachers (16.7%) were between 21 to 30, three teachers (25%) were between 31 to 40, one teacher (8.3%) was from 41–50, four teachers (33.3%) were from 51–60, and two teachers (16.7%) were over 60 years old. The teachers had between 3 and 32 years of experience as shown in Table 1. Table 1 also shows the mathematics courses taught by each teacher.

Table 1

Demographics of Participants

Participant Number	Years in Teaching	High School Mathematics Courses Taught by Teacher
P1B	4 years	Algebra 2, Geometry, Liberal Arts Mathematics, Algebra 2 honors, Geometry
P2A	3 years	Algebra 1 A, Algebra 1 B
P3G	25 years	Algebra 1
P4L	18 years	Uniform Geometry, Geometry, Honors Geometry, Algebra I A, Algebra I B, Algebra I, Algebra II, Pre-AICE Math II
P5S	32 years	Algebra I A, Algebra I B, Algebra I, Honors Geometry, Geometry, Algebra II, Liberal Arts Math, Remediation for FCAT, Basic Math, Dual Enrolled Intermediate Algebra, DE Pre-Calculus, DE Trigonometry, DE Calculus I, AP Calculus, AICE Math I, AICE Math Statistics, AICE Math II, AICE Mechanics, DE College Algebra
P6W	6 years	Algebra I, Algebra II, Geometry
P7B	5 years	Algebra I, Algebra II, Liberal Arts 2, Integrated Math 1, Honors Algebra I, Intensive Math
P8K	17 years	Algebra I, Geometry, Algebra II, Pre-Calculus, Trigonometry
P9G	10 years	Algebra 1, Geometry, Algebra 2
P10O	26 years	Mathematics with biological sciences
P11R	10 years	Algebra 1
P12S	15 years	Algebra 1, Algebra 2, Trig, Geometry, Pre-Calculus, Calculus

Data Collection Procedures

This qualitative research intended to answer the question of why U.S. high school students underperform in mathematics through teacher perceptions on the current curriculum and methods of instruction used in high school mathematics classes. The question was answered by exploring the perceptions of high school mathematics teachers through a survey of 16 open-ended questions (see Appendix C) and focus group questions (see Appendix D) that guided the research.

The data for this study was collected through surveys and a focus study group from among the teachers who participated in the survey. The first three questions were demographic questions about the teachers' age, years of teaching, and high school courses taught. Then there were 16 open-ended questions related to high school mathematics curriculum and instruction. Following the survey was a focus study of 60 minutes with four voluntary participants from the sample.

The qualitative case study focused on open-ended questions the high school mathematics teachers answered in both the survey and the focus study. The focus of the questions was on the problems that exist with high school mathematics curriculum and instruction. The questions also provided the teachers with the opportunity to share their beliefs, attitudes, practices, suggestions, and recommendations to bringing forth improvement in high school mathematics education.

Analysis of Themes

Fifteen themes emerged during the data analysis of the teachers' responses that were collected from the surveys and during the focus group study. All the participants (100%) agreed that the majority of high school students are not proficient in mathematics when they graduate. The most common themes that emerged were: gap in the students' knowledge that creates different levels in the same class, student encouragement, professional development, application to real world, resources, rigor, student encouragement, teacher collaboration, student ownership, standardized testing, traditional teaching, too many topics, two-tracks courses, time, practice and mental math, and student collaboration.

Table 2 shows the coverage percentage of each theme, which is how much of the source content is coded at this node. Time appears to be the biggest challenge for teachers, which they discussed the most and attributed to the reason why students are not proficient in math when they graduate high school.

Table 2

Percentage of Coverage for Themes

Themes	Percentage of Coverage
Time	15.96
Professional Development	12.67
Two-tracks courses	11.07
Knowledge gap among students	6.93
Student collaboration	6.68
Student encouragement	5.68
Standardized testing	5.52
Resources	5.49
Rigor	4.66
Practice and mental math	4.36
Student ownership	4.34
Application to real world	4.29
Traditional teaching	3.14
Teacher collaboration	2.24
Too many topics	1.53

Theme One: Time

The theme of time was discussed extensively by the participating teachers and had the largest percentage of coverage in the surveys and focus group study. Teachers definitely want more time. Time to plan. Time to teach. Time to collaborate. Participant P5S talked about the seven 45-minute periods students get in high school, which provides very little time each day for students to practice and have a deeper learning of the subject. Participant P6W stated that teachers also struggle with time because they have to do duties other than plan and teach, such as the Individual Professional Development Plan (IPDP), which can be time consuming. Participant P9G commented on how standardized testing also takes up too much instructional time, not to mention preparing students for the test. For these teachers, the worst part about testing is the time it takes from instruction. Participant P6W gave an example of how her Geometry (Honors) students will miss six days of instruction for Discovery Education Testing, about five days for AICE testing, a day for history, math, Biology EOC. and whatever else, which is around 14 days of missed instruction. To excel in math, students need to practice and practice needs time. Participant P9G also complained that there is no time for students to think critically because there are too many topics to cover in a short amount of time, so there is no time to go in depth with one topic.

In Florida, the standards keep changing. Right now, Florida is following FSA (Florida Standards Assessment), derived from Common Core. Participant P9G expressed concern that there is no time to learn the new standards teachers must teach.

Theme Two: Professional Development

The second most common theme discussed by the participants was professional development. Thirty-three percent (33%) of the teachers agreed that the professional development they received is very helpful, and they used the information they learned in the classroom. Fifty-eight percent (58%) of the teachers thought that the professional development they received was fairly helpful, but they did not always use everything from professional development. Eight percent (8%) of the teachers thought the professional development was not helpful, and they did not use any of the information inside the classroom. Participant P1B stated that the reason for not using the information from the professional development sessions is due to lack of time. This participant prefers to finish the course rather than trying to work in the new strategy.

Participants P1B, P6W, P7B, P8K, P9G, and P11R (50%) expressed that classroom management professional development gives them ideas to minimize disruptive behavior and was the most beneficial. Participants P1B, P7B, and P11R (25%) stated that Kagan professional development was very useful for them, and they had actually tried the tools in the classroom. Kagan professional development provides teachers with classroom management tools and resources that allow students to collaborate and teachers to differentiate instruction (Kagan Publishing, 2014). Participant P6W commented, "Classroom management gives me new ideas to minimize bad behavior. Math professional development shows new ways to teach certain objectives."

Only two teachers (16.6%) commented specifically on the math professional development. Participant P6W stated, "Math professional development shows new ways to teach certain objectives." Participant P7B stated, "These professional development opportunities have given new questioning techniques to me, which keeps me from becoming a stale teacher which no students will listen to." Participant P12S did not find the professional development on the curriculum helpful stating, "I have not been in a math PD that taught me anything new about teaching math." Participant P5S stated, "The recent Common Core professional development has had no effect on my teaching."

Theme Three: Two-Track Courses

The third major theme discussed by the participants and most common solution proposed by the teachers was two-track courses. Participants P1B, P3G, P6W, P7B, and P11R (42%) stated that by offering students two-track courses, the students who plan to go to college would be more prepared, and all the students would be better prepared for the workforce. Other teachers may support this view but did not state it as their prime solution to help high school students advance in math.

Participant 9G stated, "What's wrong with having two different tracks? Why does every kid have to go to college? Why can't it be a consumer math for the students who want to work right after high school? I think we're forcing them to go to the college track and not every students is at that level." Participant P1B agreed saying, "College doesn't mean a bachelor's degree anymore. College can be a trainer certificate and even most of those programs need mathematics, but students don't see that because they are focused on the career." Participant P3G added to the conversation saying, "I think it's a county and state wide issue because some states have a vocational track and a college track, and the kids are able to leave the school and go to the vocational school on campus half the day to do half academics and half vocational."

Seventy five percent (75%) of the focus group participants stated that schools should offer two-track courses and that preparing every student for college mathematics is not realistic. These teachers agreed that the Florida Department of Education should allow students to take other math classes in high school that will prepare students who are not planning to go to college for other career tracks, such as manual labor jobs. According to these teachers, different tracks of learning for high school students will really prepare them for the jobs they are interested in or are able to perform. Participant P7B provided an example of students who are interested in construction (different than engineering) should have a class full of skills necessary for the construction world, and students interested in becoming electricians should be learning mathematics that would be used in that field.

Participant P1B stated, "I think for a lot of students, college is not a reward. When we tell them college is coming and you need to be ready, that's not something that matters to them. If we tell them, if you're in this track, you could graduate with a thousand hours for your technical certificate. That's a reward for them. They will have a motivation." For this participant and the supporters of two-track courses, the State is setting some students up for failure because they want every student to go to college even when the students do not want to go or have the abilities necessary for success in college. However, these participants believe that some students can be very successful in other careers that do not require college. These participating teachers do not think it is fair for students to drop out of high school or continue to fail a course or two in math. Instead, they believe that the State should provide students who are not interested in going to college with technical schools to gain skills they need for life. Participant P11R stated, "We are trying to focus every student to go to college. We need to have more technical options open for students." The teachers who support two-track courses believe that the technical option will not only benefit the students who choose that route, but also benefit the students who plan to go to college because the mixing of non-college bound students is holding back the college bound students. When those students have goals set and are working towards those goals, they are more likely to succeed, according to the participating teachers.

Participant P3G expressed that the career track was available at the time the participant was a student, and the students who took that career track were very successful. The option is no longer available to students. The teachers who supported two-track courses believe that removing this option has greatly hurt students. No participating teacher spoke against two-track courses.

Theme Four: Knowledge Gap Among Students

The fourth most common theme was the gap in the students' knowledge that created different levels in the same class. For the majority of the participating teachers (75%), one of the biggest areas that caused high school students to graduate without mastery of math content is because they are trying to close this gap. Seventy-five percent (75%) of the focus study participants agreed that if they had students at the same level in mathematics, they could focus on what the group of students needs to know and what is missing. Participant P1B stated, "I would love to teach a class of 25 level one students cause I know exactly what the expectations are and what I need to fix. The issues become when I have very low students and very high students." Participant P3G strongly agreed and said, "All level 1 is easy to teach them because you can focus on what they need to know and what's missing. You can bring those students up to speed. It's very hard to do that when you have higher students because when you go down to level 1, you lose the higher level students. They are bored. They are not going to come to class. They will just tune out. So you really can't do that." However, Participant P2A disagreed saying:

> I respectfully disagree because number one: I'm on a different mindset because I was trained that you teach standards; you don't teach a book. And you bring in material. And we were trained that you always go back and do professional development. In this county, you can take Beacon courses for free. You don't have to pay a dime for any of it. There are strategies, differentiated instruction. In Discovery Education, I create probes and you can tweak a problem and make it go up a level. With the DOK, these classes we go to. With my students, they don't think about a grade, they think about their level because it's the effort they put forth. If you are at a level two and

> you put effort, it's ok. It's amazing what's free with CPALM. Even in the summer, they offer classes. Even when I was home with my children, I made the time because it's where your priorities are, but I always knew when I went to the teaching profession, it's going to change. Technology is not going to go away. It's not going to go back to the old way and if I'm going to be an effective teacher, I have to keep up with it. I learned all these different strategies and it doesn't take much. It doesn't take much to get these kids to do it. You just offer them some candy. It is amazing what they would do for a candy and students buy into it. The free material that is given to us is amazing, but we have to apply it. I use what I learn.

Participant P3G disagreed and replied, "I've done a lot of PD too, but half of the things I learned, I can't teach because there's a gap and the students are not motivated to learn math. They look at it like this is hard; I can't do it. You work with them all to teach them yes you can, you will be successful with one group but not all."

This topic of the gap among the students caused the most disagreement among the participants. Seventy-five (75%) of the participating teachers believe it is better to place students in math classes based on their level and abilities. They believe this will allow all the students to advance. Participant P12S believes that it is not possible to advance all the students if there's a gap. P12S stated, "In math, you need to advance all students and not all students in a class are on the same level, so it becomes impossible sometimes."

Implementation of Common Core leaves enormous gaps. When Florida voted to adopt the Common Core Standards, the teachers worried about closing the gap from the previous Florida Standards that were taught to the new Common Core Standards. While 92% of the participating teachers agree with the Common Core and its rigor, they do not agree with the implementation and cannot imagine how the students will succeed in the next three years of high school. The participating teachers agree that the Common Core has left enormous learning gaps, and teachers are trying to fill in the skills the students have not covered, as well as cover the new content. Some students need more review, while others need to be challenged more. At the same time, many students are missing the basic skills in math, which hinders their learning in upper level classes. Participant P12S stated, "If you have students who still can't add fractions, you can't ask them to factor variable equations. You need to review that skill first, but if you review that skill, the students who know it get bored. It would be great if you have students on the same level so you advance them quicker. I think Common Core is more rigorous than previous standards, but again, the problem comes with the gap that exists among students. We need to close it and it's tough when the classes has students with all levels."

Most participating teachers believe it will be years until the students come to high school math courses with the prerequisite necessary for the current math standards. Participant P4L stated, "I believe that the way Common Core has been implemented has left enormous learning gaps. We are trying to fill in the skills they have not covered, as well as the ones for our classes. It will be several years until our students come to us having lessons throughout their education."

Theme Five: Student Collaboration

The fifth major theme discussed by the participants and second most common solution proposed by the teachers was student collaboration. Participant P3G said, "Teachers should allow students to work in pairs or small groups for re-teaching or reinforcing ideas. High school students will succeed in college mathematics and the workforce if they are taught problem based learning, research, project design, inquiry, work based learning, cooperative learning, instructional technology, presentations, and exhibitions." Participant P2A said, "The workforce today is on groups, collaboration, thinking ability; that's the workforce. This group of students we have don't know how to work together. They don't know how to go and do things on their own independent, so when they get to college, they are not ready. They want the teacher to tell them everything. They want people to give them things. Before they leave school, we should get them college ready. We need to provide them with strategies they need for every day life. We as teachers need to teach those strategies so we don't set them up for failure."

Other teachers were torn on student collaboration but still saw it as valuable. Participant P9G stated:

> I found it different for the workplace and college. I feel like in a lot of classes, from elementary to high school, we all teach differently, and that's understood. But some classes focus more on the collaborative learning and groups, others do the traditional way, and then when they go to college, that's what they are going to have. Every college math class I ever had, the professor was on the board just writing. There was no group work going on; there was no collaboration. And so I'm kind of torn because research is saying you need to work in groups and feed off each other. This is the way they can actually process their learning, but then they get to college, and that's not how they learn. I feel like that contributes to their lack of success once they make it to college math because for the most part, they are used to working in teams, and when they get to college, that's not there anymore. But then as far as the workplace

goes, you are working as a team, so these classes where they are working in groups that is preparing them for the work place. The college classes, I don't know."

Although all the teachers agree that collaboration is valuable, few teachers were concerned about the time it takes students to complete their work. The teachers felt that they can cover more if they are in front of the board explaining the problems and solutions to the students, rather than letting them figure it out. Participating teacher P1B said, "If I need to go over a complex problem, that time doubles if I need to get student groups." Participant P1B also commented that the students prefer direct instruction rather than grouping, saying, "When I have to review for a test, I ask the students if they want to work in groups, individually, or have me work them out, and they just want me to work out the problems on the board for them. They say we'll get 15 problems on the board when you do them or 8 problems if we work them."

Theme Six: Student Encouragement

The sixth major theme discussed by the participants was student encouragement. Survey questions number 10 was: How do you think that teachers can be more proactive in helping high school students succeed in college mathematics and the workforce? One out of three of the participants (33%) stated that student encouragement will help high school students succeed. Participant P5S stated, "Teachers can demonstrate a love of and an appreciation for the power of mathematics. They can encourage students who need extra work to take advanced courses. They can show the students that they can learn math, even if it is hard." Participant P12S commented, "I encourage them while I walk around and check their work. It creates an active environment where the students are thinking and working the whole time. I like to see them do the thinking, rather than me on the board doing the work while they watch." Participant P8K also commented, "Teachers should encourage students continuously and give them positive remarks and avoid negative ones. Show the students that they care about them and their progress."

Theme Seven: Standardized Testing

The seventh theme was standardized testing, in which 100% of the comments were against the current state standardized assessment. Participant P9G said, "The biggest suggestion would be to not have as many standardized tests." Standardized testing is a big topic in schools, especially in Florida, where standardized tests are used to grade teachers and schools. School funding and the teachers' increase in salaries rely on the standardized testing. Therefore, standardized tests increase teacher pressure. Participating teacher P1B stated that the anxiety of these tests flows from the teacher to the students. P1B also stated, "I try to be positive everyday but when the test scores come out, you can see people worried around the school. It's not the teacher's fault. It's just that students are not prepared for this change and the gap is too big to close." Another participant, P4L said, "We are so focused on testing that learning true understanding is thrown aside."

All the participants (100%) stated that standardized testing is also time consuming. The standardized math test in Florida is scheduled for three days and takes around two hours with short breaks each day. This is taken from instructional time. In the participating teachers' classes, there is also time spent preparing for the test. Participant P1B said that the students are "being fed the information wanted for a test." Teachers were worried about whether they are covering all the material for the test. Participant P4L said, "High stakes testing begins at the start of the 4th nine week grading period. We are expected to have covered the required course material (meant for an entire school year) in three-fourths time.

It can cause some material that, while not EOC test, is essential to the course to be ignored." Participant P7B said, "High stakes testing such as Algebra 1 EOC sometimes causes teachers to cut out enrichment activities in order to cover all the skills that are to be tested. I feel like I am stressed sometimes just trying to cover everything. I also question whether I am doing the best job possible when I am feeling stressed." The teachers agreed that the focus on these assessments hurts students who should focus on deeper learning and creativity instead. Participant P11R commented, "It hurts students because we become too focused on assessments instead of creativity. I feel that I am in a rush to cram the rigorous Common Core standards in before the EOC." Participant 12S also commented, "High stake tests are very stressful. If we don't need to deal with those, then we can focus more on deeper learning and real-world projects, but it's really hard to focus on projects if you have to prepare students for the test, which has a lot of material that you have to squeeze in a short amount of time."

Theme Eight: Resources

The theme of resources emerged numerous times in the surveys and focus group study. Some teachers complained about the lack of resources, while others complained that the resources were not being applied appropriately. Some teachers said they do not have what they need to prepare the students for after high school, especially resources that help them apply real world situations. These teachers claimed to still have old textbooks. Participant P9G said, "If we had more to present to our students, that would make a big difference." Participant P9G also said, "The barrier lies with materials. If we were provided materials to use in teaching other than our outdated textbooks, it may help in closing the gap." However, some teachers believe that they are given many resources, but they do not use them because they do not have enough time or do not know how to use the resources. Participant P2A said, "The free material that is given to us is amazing, but we have to apply it."

Theme Nine: Rigor

One of the questions in the survey was about the rigor of the high school math courses; therefore, the theme of rigor was present in the survey. However, it was not mentioned in the focus study. The coverage of rigor was in the ninth place based on the percentage of coverage. The participating teachers noted that the rigor in high school math classes depends on the course, curriculum, and students. Participant P2A, who taught two high school classes last year said, "One was rigorous and one was not."

Rigor in Geometry. All the teachers (100%) who spoke about Geometry stated that the geometry courses have lots of rigor with the geometric proofs, which require a lot of thinking. Participant P9G stated, "I think that by far Geometry is more rigorous than Algebra both in the classroom and online."

Rigor in Common Core. Most teachers (83%) agreed that the curriculum is becoming more rigorous with Common Core and will prepare students for college math and the workforce. However, the participants stated that teachers are not ready for Common Core. Teachers must learn the new standards and how to teach them, but most of them claimed that they do not have time to do that. The teachers also agreed that Common Core is not for every student. Participant P7B stated, "As far as Common Core is concerned, I think it is fine for higher level students, but the lowest level students need something geared for them. I really don't think Common Core is going to help our lowest students prepare for the 'real' workforce." This teacher believes that the lower students should have the option to take vocational math classes. Most participating teachers (75%) of the focus study agreed with two-track math, rather than Common Core for all. With Common Core, there exists a big gap among students, and the classes have too many levels to accommodate all students.

Theme Ten: Practice and Mental Math

The tenth theme that emerged in the study was practice and mental math. Forty-two percent (42%) believe that the students are not getting enough practice and are not mentally able to calculate math problems. These teachers agreed that practice and mental math will help the students master new math skills. These participants blamed the low scores on the lack of practice and time students take to think critically and solve problems. As a result, the students are not able to solve simple problems mentally because they did not retain the information. Participant P12S said, "They don't practice enough. They need to solve more problems in school and at home. When they don't practice, they can't retain the information."

Some teachers blame the use of calculators on the students' lack of mental math and believe that this hinders the students' learning in upper level classes. Participant P1B said, "The current problem I see is that I have very few students who do not have any mental math skill whatsoever. We have bread a generation reliant on calculators and answer keys and things like that." Another participant, P7B, said, "In my opinion, the fact that calculators are allowed on the standardized tests in middle school, therefore not requiring students to master their basic facts before going in to high school mathematics courses, is a major reason for students not having the appropriate mathematics skills to succeed in college level mathematics courses. Mastery of these basic skills is a must for success in high level mathematics."

Theme Eleven: Student Ownership

The participating teachers spoke frequently about student ownership and how it contributes to the students' lack of mastery in high school mathematics classes. Student ownership was mentioned in both the surveys and focus study. Participant P1B said, " I believe that there's a large problem with student ownership. Most of the high school students I see already developed a dislike of math." Teachers expressed how some students come to school unprepared, unmotivated, and uninterested in learning. Participant P9G stated, "If it is something that does not provide instant gratification, they are not interested." This negative attitude towards learning makes it difficult for teachers who are trying to meet the needs of all students. In the survey, participant P4S, wrote, "It is difficult to challenge someone who refuses to be challenged. I believe that good teaching practices and teacher enthusiasm for the subject are good motivators. It is necessary to balance the desire to challenge students with the desire to help them succeed."

Theme Twelve: Application to Real World

All participating teachers (100%) agreed that applying mathematics to real world helps students retain the information, master the content, and be more prepared for college and the workforce. Participant P3T stated, "I include real-world applications in my instruction by integrating into my daily practice short, quick instructional activities that raise the level of thinking, application, and reflection. Students' understanding of content increase as they are given relevance activities and inquiry-based skills to make connections to everyday life." Geometry is the math subject that teachers find the easiest to implement in the real world. Participant P1B stated, "In Geometry, it's quite a bit easier to get real world because you can find situations or look at any type of construction, things like that and relate to the students. I n Algebra 2, the real world, you play a little bit more loosely. Maybe some graph analysis, cause effectiveness functions and some basic ideas, but most of the real world that Algebra 2 carries is a little more of a statistical side so you kind of brush against it. But, it's a lot of core learning really more so than direct application."

Many mathematics textbooks contain real-world application, especially the Common Core-aligned books. Participant P7B wrote, "Nearly every mathematics textbook provides problems with real-world applications (word problems). I try in many lessons to give students examples from my life where I have had to use math skills in order for them to relate to what I am teaching. The students seem to get more out of the lesson if they know how and where they might use the skills in their lives." However, not every teacher is applying real-world problems. Participant P3G stated, "Students find mathematics boring and difficult because math is not relevant to what is going on in the world. The real world application of mathematics is missing." Participant P7B stated, "Students can't make the connection between the math they are learning and the real world."

Theme Thirteen: Traditional Teaching

Fifty eight percent (58%) of the participating teachers favored traditional teaching and preferred the teacher-led, direct instruction strategy. Participant P11R stated, "Most of my work is independent work that is teacher lead. I think the practice my students receive helps build muscle memory." Participant P5S said, "With 45-minute periods, most all instruction is lecture because that is the best way to cover the material." This implies that time is a factor in using the traditional method of teaching. Participant P9G commented, "I prefer direct instruction. I have used cooperative learning in the past, but I feel it is more successful with middle school students. Direct instruction is important when teaching math because they need to be taught the process explicitly in order to ensure that the work is done correctly." Participant P11R also preferred traditional whole group instruction and stated, "I think this prepares students for upper classes, as most upper classes are not hands-on. Plus, it gives students more opportunity to practice."

Thirty percent (30%) of the teachers believed that the traditional teaching method is boring and does not prepare students for success. Participant P8K blamed other teachers saying, "The teacher may not be qualified to teach or their method of teaching is boring." Participant P3G stated, "Students enter college without the appropriate mathematics skills to succeed because traditional learning was teacher-directed and not based on a rigor/relevance framework."

Participant P9G expressed that the participant is torn between traditional and non-traditional instruction. This teacher stated:

> I feel like in a lot of classes, from elementary to high school, we all teach differently, and that's understood. But some classes focus more on the collaborative learning and groups, others do the traditional way, and then when they go to college, that's what they are going to have. Every college math class I ever had, the professor was on the board just writing. There was no group work going on; there was no collaboration. And so I'm kind of torn because research is saying you need to work in groups and feed off each other. This is the way they can actually process their learning, but then they get to college, and that's not how they learn. I feel like that contributes to their lack of success once they make it to college math because for the most part, they are used to working in teams, and when they get to college, that's not there anymore. But then as far as the workplace goes, you are working as a team, so these classes where

they are working in groups; that is preparing them for the work place. The college classes, I don't know.

Theme Fourteen: Teacher Collaboration

Question 11 of the survey asked the teachers: *Does your school support math teachers' collaboration? If so, how does this collaboration of the high school mathematics teachers benefit students? How often do these collaborations take place?* All the teachers responded to the question. Teacher collaboration did not come up at all in the focus study discussion by the teachers. The teachers were divided on how the collaboration of the high school mathematics teachers benefits students.

Thirty-three percent (33%) of the participating teachers found teacher collaboration helpful and meet at least once a week. Participant P4L said, "It allows us to bounce ideas and strategies around and ask for help." Participant P6W stated, "Our school provides us with a common planning time before school. We have subject area meetings once a week to discuss all sorts of things." Participant P9G commented, "At our school, the math department has common planning. We spend this time collaborating with each other to prepare for each unit. This collaboration keeps the courses that are being taught consistent throughout the campus."

Thirty-three percent (33%) of the participating teachers viewed their teacher collaboration as a growing process that is small and mostly at the teachers' level. These teachers meet only a few times a year. Participant P1B stated, "Our collaborations are currently in a growing process. We have department meetings. Most of collaboration comes on a teacher level. Most of us will find teachers who are also teaching the same course will kind of discuss how we are keeping to the lesson." Participant P3G stated, "We have some collaboration but not at the level that has changed students learning. Collaborations mostly take place during professional development workshop." Participant P7B commented, "I wouldn't say that this collaboration is helping the students directly, but rather they are reaping the benefits of teachers who are working together for the good of the students. We are finding that we may have to reteach certain material or that maybe we can skip other material because students know it well."

Twenty-five percent (25%) of the participants meet a maximum of once a month and prefer not to have what participant P5S call "forced collaboration" because they claim the teachers do not want to collaborate or share information. When asked by the researcher, "Does your school support math teachers' collaboration?" Participant P2A replied, "Yes, but teachers don't want to collaborate. They do not want to share." Participant P5S said, "The forced collaboration in the form of PLC's is now one more thing for teachers to do in their already packed day."

Theme Fifteen: Too Many Topics

The fifteenth theme of too many topics emerged in the focus study when the teachers were asked about the problems they see with the mathematics curriculum. Participant P9G said, "I think part of the problem is we are covering way too many topics, rather than specializing in just one area, rather than going really deep in Algebra. They go from Algebra to Geometry, which is totally different way of thinking, as well as different topics, then they throw them into Algebra 2, which they might not have had the basic skills in Algebra 1, so there's no way they're going to be successful in Algebra 2." Later on in the focus study, participant P9G added, "I think we are covering too much rather than going deep with a smaller set of concepts."

Summary

The data presented in Chapter 4 was created from responses of the open-ended surveys and from the focus group discussion. The research method for the qualitative case study was presented in Chapter 3 and provided the structure of the data analysis. The study focused on the problems that exist with the high school mathematics curriculum and instruction. It also asked the participating teachers about possible solutions. Fifteen themes emerged from the data collected. The most common themes that emerged are: gap in the students' knowledge that creates different levels in the same class, student encouragement, professional development, application to real world, resources, rigor, student encouragement, teacher collaboration, student ownership, standardized testing, traditional teaching, too many topics, two-tracks courses, time, practice and mental math, and student collaboration.

Chapter 5 includes a discussion of the results and the conclusion with implications for the leadership in high school mathematics education. Chapter 5 will detail lessons learned from the research leading to recommendations.

Chapter 5

Conclusion and Recommendations

Chapter 5 includes a discussion of the conclusions resulting from the analysis of the surveys and focus group study discussed in chapter 4. It also includes recommendations for action for educational leaders and future research using the literature review of chapter 2. The chapter concludes with the researcher's reflection and finishes with the conclusion.

The surveys and focus group discussions were completed by 12 high school mathematics teachers from northwest Florida. The purpose of this study was to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. The teachers presented their perceptions by completing an open-ended survey. A group of four teachers also participated in a focus study. The teachers shared their views about why a large number of the high school students who graduate are not ready for college mathematics and provided recommendations about ways to increase the students' achievement in mathematics. The data from the surveys and focus study were compared with the lesson plans the teachers used in the classrooms.

According to McCormick and Lucas (2011), a large number of students who successfully complete high school do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century. Furthermore, the high school students in the United States underperform in mathematics compared to other nations, which may affect their chances of finding a job that requires mathematics skills in this age of globalization (Organization for Economic Cooperation and Development, 2009). In the 2013 report by the Organization for Economic Cooperation and Development (2013a), the United States' ranking dropped from 25 to 36 in mathematics scores generated from the 2012 Program for International Assessment (PISA).

This qualitative study utilized an open-ended survey, a focus group study, and lesson plans to gather unrestricted data from the teachers. The data was imputed into NVivo for coding and data analysis. Fifteen themes emerged in the study from the teacher's perceptions on the problems that exists with the current high school mathematics curriculum and instruction, as well as possible solutions to these problems. All the teachers (100%) agree that many of the students who graduate high school are not proficient in mathematics. Therefore, they are not ready for college mathematics or the workforce. This problem was the reason for this research study.

Statement of the Problem

National and international studies reveal that high school seniors in the United States do not demonstrate mathematics proficiency (National Center for Educational Statistics, 2006, 2013b). The problem is that the United States has a large number of students who successfully complete high school but do not have the necessary mathematical skills to succeed in college and the labor force of the 21st century (McCormick & Lucas, 2011). This qualitative exploratory case research study explored the reasons why high school students in the United States are not ready for college mathematics through the perceptions of 12 high school mathematics teachers in a school district in northwest Florida. This study is important because having strong mathematics skills in high school will advance students throughout college and in the workplace (Achieve, 2011a).

Purpose Statement

The purpose of this qualitative exploratory case study was to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. The perceptions of teachers included problems that exist in the curriculum and more effective ways to teach mathematics. A case study was appropriate for this research because it focused on a particular phenomenon or situation, provided a description of it, and used qualitative research to discover new meaning that improve the situation (Shank, 2006). The case study included an open-ended survey and a focus group with study participants. This study included teacher perceptions to explore the current mathematics education that high school students are receiving and a focus group with volunteer participants to expand on the responses in the surveys. The teachers described the current curriculum and methods of instruction used in the classrooms and provided changes that may help students advance.

The sample of the population of this study was 12 high school teachers of the Panhandle in Florida, also known as northwest Florida. The teachers were asked to share their insight on the current mathematics curriculum and methods of instruction used in the classrooms to find the perceived reasons behind the students' poor performance. The teachers were asked to communicate their concerns regarding the high school mathematics education that contribute to the cause why many students are not ready for college mathematics and the workplace. The researcher also met with a focus group from the participating teachers and collected artifacts about the curriculum requirements to further support the outcome of the study.

Research Question

This qualitative research intended to answer the question of why the U.S. high school students underperform in mathematics through teacher perceptions on the current curriculum and methods of instruction used in high school mathematics class. The question was answered by exploring the perceptions of high school mathematics teachers through a survey of 16 open-ended questions (see Appendix C) and focus group questions (see Appendix D) that guided the research. Participants were encouraged to expand on their answers. The general population group of the qualitative exploratory case study was 12 high school mathematics teachers from northwest Florida.

It is very important to find the problems that cause students in the United States to be unprepared for college mathematics. It is also necessary to find the best way to educate students and provide them with the skills to succeed beyond high school. The answers to the questions may also provide teachers with effective instructional methods that can help their students advance. Answering the above questions may be a start to effective reform in mathematics education. This reform may benefit high school mathematics teachers around the nation. It may also help novice teachers learn what educational techniques work well in the high school mathematics classes and what has failed the students.

Research Design

The research design was an exploratory case study to explore the teacher perceptions of the current curriculum and methods of instruction to better understand why the U.S. students underperform in mathematics. A qualitative, exploratory case study was the suited method to understand the perspectives and experiences of the participants (Creswell, 2008). Qualitative case studies are increasingly being used in educational research to describe context-specific educational situations and to draw conclusions by generalizing the findings (Kyburz-Graber, 2004). Leedy and Ormrod (2010) stated that a case study methodology is the most appropriate to seek teachers' perceptions through open-ended questions and interviews. Stake (2005) stated that the face-to-face interviews and a focus group provide an opportunity to hear and understand first-person narratives of the teachers' experiences. The interview, along with the focus group, was used to answer the research question of why U.S. high school students underperform in mathematics.

Validity and Reliability

Using triangulation of multiple sources to research questions establishes a chain of supportive evidence that increases validity (Yin, 2009). Yin (2009) also stated that the use of multiple sources enhances the reliability of the design. This study included data collection from multiple sources to increase consistency, which included surveys, focus group interactions, and high school mathematics lesson plans in northwest Florida to explore the curriculum and instructional methods used in the classrooms. The focus group also provided an opportunity to confirm the information from the surveys, which will affirm the validity and reliability of the research (Fontana & Frey, 2005). Through the surveys, the teachers responded to 16 open-ended questions. During the focus group, the researcher confirmed the information from the surveys.

The focus group was a structured interview in which each teacher in the group answered the same questions. Then the teachers had the opportunity to comment on the responses of the other teachers. A structured interview process allows the researcher to maintain a neutral role in which the researcher does not interject the opinions of the participants during the interview process (Fontana & Frey, 2005). The researcher did not interfere or comment on the teachers' responses during the focus group.

Analysis of the Themes

This qualitative research intended to answer the question of why the U.S. high school students underperform in mathematics through teacher perceptions on the current curriculum and methods of instruction used in high school mathematics class. The question was answered by exploring the perceptions of high school mathematics teachers through a survey of the 16 open-ended questions (see Appendix C) and focus group questions (see Appendix D) that guided the research. Participants were encouraged to expand on their answers. All the participants (100%) agreed that the majority of high school students are not proficient in mathematics when they graduate.

Fifteen themes emerged during the data analysis of the teachers' responses that were collected from the surveys and during the focus group study. The most common themes that emerges are: gap in the students' knowledge that creates different levels in the same class, student encouragement, professional development, application to real world, resources, rigor, student encouragement, teacher collaboration, student ownership, standardized testing, traditional teaching, too many topics, two-tracks courses, time, practice and mental math, and student collaboration.

Theme One: Time

Time appears to be the biggest challenge for teachers, which they discussed the most and attributed to the reason why students are not proficient in math when they graduate high school. Teachers asked for more time to plan, teach, and collaborate. Research shows that the teachers in the United States spend more time teaching than the teachers in the academically highest achieving nations (Gardener, 2012). Teachers in the high achieving nations spend 40–60 percent of their time planning, collaborating, and learning to teach (Gardener, 2012). The Stanford Center for Opportunity Policy in Education released a report which revealed that the teachers in the United States only get three to five hours of planning a week, whereas the international educators average 15–25 hours per week (Darling-Hammond, Wei, & Andree, 2010). High school teachers are required to teach six 45-minute classes with only one 45-minute planning period. At the same time, the participating teachers also complained that there is not enough time to teach the students because the periods are short. Participant P5S talked about the seven 45-minute periods students get in high school, which provides very little time each day for students to practice and have a deeper learning of the subject. The teachers are also given less time to plan and hardly have time to collaborate with only one 45 minutes block to grade, plan, collaborate, and learn new concepts.

Theme Two: Professional Development

The second most common theme discussed by the participants is professional development. Thirty-three percent (33%) of the teachers agree that the professional development they receive is very helpful, and they use the information they learn in the classroom. Fifty-eight percent (58%) of the teachers think that the professional development they receive is fairly helpful, but they do not always use everything from professional development. Eight percent (8%) of the teachers think the professional development is not helpful, and they do not use any of the information inside the classroom. Participant P1B stated that the reason for not using the information from the professional development sessions is because of the lack of time. This goes back to theme one where the teachers need more time.

Fifty percent of the participants expressed that classroom management professional development was the most beneficial. Only two teachers (16.6%) commented specifically on the math professional development and said they were helpful. The majority of the teachers (83.4%) did not discuss math professional development because they either did not have training on teaching mathematics or found it unhelpful.

Theme Three: Two-Track Courses

The third major theme discussed by the participants and most common solution proposed by the teachers is two-track courses. Forty two percent of the participants stated that by offering students two-track courses, the students who plan to go to college would be more prepared, and all the students will be better prepared for the workforce. Seventy five percent (75%) of the focus group participants stated that schools should offer two-track courses and that preparing every student for college mathematics is not realistic.

Erefah (2005) conducted a longitudinal study to compare vocational and non-vocational education in Leon County, Florida, to see whether the vocational education programs provided the high school students in grades nine to twelve with more advantages in graduation, college, and the workforce. The study included 2,698 students from four high schools and indicated that students in high school vocational education programs may have some advantages over non-vocational education students in terms of high school graduation, college, and the workforce (Erefah, 2005). The study also revealed that vocational education programs may have motivational values to the advantage of academically disadvantaged students enabling them to remain in school and graduate (Erefah, 2005). As a result, vocational education students reported a higher rate of graduation from high school than the non-vocational students (Erefah, 2005). The study also showed that the vocational education high school graduates were very competitive against their non-vocational education high school counterparts in terms of college and university enrollments (Erefah, 2005). In addition, vocational education high school graduates had a higher rate of employment and higher wages (Erefah, 2005).

Theme Four: Gap among Students

The fourth most common theme was the gap in the students' knowledge that created different levels in the same class. For the majority of the participating teachers (75%), one of the biggest areas that causes high school students to graduate without mastery of math content was because they were trying to close this gap. Seventy-five percent (75%) of the focus study participants agreed that if they had students at the same level in mathematics, they could focus on what the group of students needs to know and what is missing. Participant P1B stated, "I would love to teach a class of 25 level one students cause I know exactly what the expectations are and what I need to fix." According to Johnson et al. (2008), one of the biggest challenges educators will endure is how to deal with societal change as classrooms become more diverse. However, Participant P2A disagreed saying, "There are strategies, differentiated instruction. In Discovery Education, I create probes and you can tweak a problem and make it go up a level. With the DOK, these classes we go to. With my students, they don't think about a grade, they think about their level because it's the effort they put forth." Differentiated instruction is the best educational practice for teachers to apply in a classroom with diversity and multiple readiness levels (Lawrence-Brown, 2004). Differentiated instruction benefits all students, from gifted to those with significant disabilities in the same classroom.

Students in classrooms worldwide have many diverse instructional needs, including different abilities, interests, learning styles, and cultural backgrounds (Chamberlin, 2011). Teachers need to present the content in a way that all students can understand and learn. Differentiated instruction is a process in which teachers are constantly changing their teaching methods, learning activities, and assessments to meet the diverse needs of students (Chamberlin, 2011). It is teaching to the diverse needs of all students by adjusting the curriculum and teaching strategies, rather than teaching to the average of the class, which may be too difficult or easy for some students (Batts & Lewis, 2005). According to Little (2009), effective mathematics instruction for students, both with and without learning disabilities, should include differentiated instruction. Chamberlin and Powers (2010) also found positive effects on mathematics learning because of differentiated instruction. Through differentiated instruction, teachers create different levels of expectations for tasks, in which students can complete alone, in flexible groups, or together as a class.

Theme Five: Student Collaboration

The fifth major theme discussed by the participants was student collaboration. Although all the teachers agree that collaboration is valuable, teachers were concerned about the time it takes students to complete their work. The teachers felt that they can cover more if they are in front of the board explaining the problems and solutions to the students, rather then letting them figure it out.

Student collaboration can lead to accomplishment of a specific goal through students working together, in which the basis is constructivism (Dooly, 2008). With constructivism, the students do not passively receive knowledge from the teacher (Dooly, 2008). When participant P1B reviews problems for the test with the students, they are passively receiving the knowledge without engagement or any critical thinking on their part. Student collaboration may require more time to solve the problems, but the students are the ones thinking critically, which will help them retain the information longer (Dooly, 2008).

Theme Six: Student Encouragement

The sixth major theme discussed by the participants was student encouragement. One out of three of the participants (33%) stated that student encouragement can help high school students succeed. The National Research published a report in 2003 on motivation and showed that 40 percent of high school students are chronically disengaged from school because they do not have encouragement or motivation to help them (Crotty, 2013). Student encouragement has led to higher achievement and lower dropout rates (Crotty, 2013).

Theme Seven: Standardized Testing

The seventh theme was standardized testing, in which 100% of the comments were against the current state standardized assessment. All the participants (100%) stated that standardized testing is time consuming and stressful. Standardized testing absorbs way too much money and time (Kamenetz, 2015). Kamenetz (2015) estimates students today spend 25 percent of their time preparing for tests or taking tests.

Theme Eight: Resources

The theme of resources emerged numerous times in the surveys and focus study. Some teachers complained about the lack of resources, while others complained that the resources were not being applied appropriately. Teachers are having to look for the resources and get those resources themselves. Fortunately, with the growth of the Internet, there is growing numbers of websites that offer free, quality professional development with many interactive and collaborative components (Bruder, 2013). There are also websites for teachers, such as DonorsChoose, in which teachers set up projects, and the public raises money to provide the teachers with the resources they need. DonorChoose helped more than 231,000 teachers and funded over 570,000 projects (DonorsChoose, 2015). These numbers increase daily. Therefore, there are plenty of resources if teachers search and apply for grants.

Theme Nine: Rigor

The participating teachers noted that the rigor in high school math classes depends on the course, curriculum, and students. All the teachers (100%) who spoke about Geometry stated that the geometry courses have lots of rigor with the geometric proofs, which require critical thinking. Most teachers (83%) agree that the curriculum is becoming more rigorous with Common Core and will prepare students for college math and the workforce. However, these participants stated that many teachers are not ready for Common Core. The teachers must learn the new standards and how to teach them, but most of them claim that they do not have time to do that, as stated in theme 1. The teachers also agree that Common Core is not for every student. The teachers stated that with Common Core, there exists a big gap among students, and the classes have too many levels to accommodate all students. The Common Core Standards ask teachers to significantly narrow and deepen how they spend time in class (Heitin, 2015). This change is new for the participating teachers, and they are struggling to accommodate all students to meet these rigorous standards. There is a lot of information online about Common Core and how to implement it. All that teachers need to learn in order to implement Common Core is time. Websites, like achievethecore.org, provide free content designed to help teachers understand and implement Common Core and include practical tools to help students and teacher achieve results (Students Achievement Partners, 2015).

Theme Ten: Practice and Mental Math

The tenth theme that emerged in the study was practice and mental math. Forty-two percent (42%) believed that the students are not getting enough practice and are not mentally able to calculate math problems. These teachers agreed that practice and mental math will help the students master new math skills. Some teachers may blame the use of calculators on the students' lack of mental math and believe that this hinders the students' learning in upper level classes. There have been mixed feelings about calculators. Some educators fear that students would not be able to retain their knowledge of simple arithmetic if they learned to use a calculator before fully grasping basic mathematical concepts (Banks, 2011). Other teachers saw calculators as a chance to increase student motivation to learn as reasons to utilize these new devices (Banks, 2011). Calculators are now used on standardized tests, such as SAT, ACT, and the National Assessment of Educational Progress.

The National Mathematics Advisory Panel (2008) found that a great use of calculators in class can delay fluency in computation that students need throughout life. However, Banks (2011) explored the history of calculator usage in mathematics classrooms in the United States since 1975 with a focus on the attitudes of parents, educators, and national organizations. The study revealed that all the groups agree that the calculator increases motivation and the desire for students to learn.

Theme Eleven: Student Ownership

The participating teachers spoke frequently about student ownership and how it contributes to the students' lack of mastery in high school mathematics classes. Student ownership was mentioned in both the surveys and focus study. Teachers expressed how some students come to school unprepared, unmotivated, and uninterested in learning. Supporting student ownership of learning is one way to improve student achievement (Chan, Graham-Day, Ressa, Peters, & Konrad, 2014). Teachers can help students take an active role in the learning by promoting student goal setting, self-assessment, and self-determination (Chan et al., 2014). When students are meaningfully engaged in their learning, they understand their learning goals better and can better assess themselves (Chan et al., 2014).

Theme Twelve: Application to Real World

All participating teachers (100%) agreed that applying mathematics to real world helps students retain the information, master the content, and be more prepared for college and the workforce. However, not every teacher is applying real-world problems. Participant P7B stated that students find mathematics boring and difficult because students "can't make the connection between the math they are learning and the real world." The Organization for Economic Development (2006) published a study about the importance of real-world problem solving worldwide. With the Common Core Standards, students must be able to apply mathematics to real-world problems to solve problems (NGA & CCSSO, 2010). Therefore, teachers must apply real-world mathematics problems in their lesson plans, curriculum, and instruction.

Theme Thirteen: Traditional Teaching

Fifty eight percent (58%) of the participating teachers favored traditional teaching and prefer the teacher-led, direct instruction strategy. For many years, traditional methods of teaching were the norm in the public school setting (Nesmith, 2008). In the traditional classroom, the teacher provides clear, step-by-step instructions on how to solve problems, while students observe and listen (Nesmith, 2008). The majority of time spent in traditional classes is with the teacher lecturing, the students answering questions and working independently, and assessments based on standard pencil and paper testing (Mathnasium, 2012). This is similar to what the participating teachers who favor traditional teaching describe.

Thirty percent (30%) of the teachers believe that the traditional teaching method is boring and does not prepare the students for success. Evidence suggested that many high school teachers still teach in a repetition lecture style that emphasizes on the teacher delivering information to unmotivated, uninvolved students (White-Clark et al., 2008). DuFour and DuFour (2008) stated that traditional schools have not been successful in providing excellent instruction for all students in the United States.

Theme Fourteen: Teacher Collaboration

Thirty-three percent (33%) of the participating teachers found teacher collaboration helpful and meet at least once a week. Thirty-three percent (33%) of the participating teachers viewed their teacher collaboration as a growing process that is small and mostly at the teachers' level. Twenty-five percent (25%) of the participants meet maximum once a month and prefer not to have what participant P5S call "forced collaboration" because they claim the teachers do not want to collaborate or share information.

A study revealed that schools with higher quality teacher collaboration have significantly higher student achievement in math and reading because their teachers learn how to improve their instructional practice (Goddard & Tschannen-Noran, 2007). Another study revealed that teachers who regularly collaborate and participate in professional communities how more growth in math achievement than teachers who work in isolation

(Sparks, 2013). Not only is teacher collaboration beneficial for the students, Goldstein (2015) found that collaboration also has a positive influence on the morale of teachers. Therefore, teachers should be encouraged to collaborate often. Goddard and Tschannen-Noran (2007) believe that lower levels of teacher collaboration may indicate that the teachers are unwilling to take personal risks because those teachers have worked in isolation for many years.

Theme Fifteen: Too Many Topics

The fifteenth theme of too many topics emerged in the focus study when the teachers were asked about the problems they see with the mathematics curriculum. The Trends in International Mathematics and Science suggested that the United States school mathematics curriculum covers too many topics (Milgram & Wu, 2002). However, the new Common Core Standards have reduced the number of topics and added more rigor and depth (Common Core State Standards, 2015). Therefore, the teachers who use Common Core Standards should have less topics to teach their students.

Teacher Lesson Plans

The participating teachers were asked to provide a lesson plan they utilized to teach high school mathematics. The teachers provided the lesson plans through email or referred to the lesson plans on the CPALMS site. CPALMS is the official source for standards information and course descriptions in Florida that provides curriculum planning, professional development tools, and lesson plans (CPALMS, 2013). Every participating teacher was provided with information on CPALMS by the school district and all use CPALMS to create their lesson plans or use the existing ones. Although the site was created for Florida educators, CPALMS transformed to a global resource with users from more than

200 countries and territories because all the resources are free and are high in quality (CPALMS, 2013).

The lesson plans were reviewed and compared with the information provided by the teachers in the surveys and focus study. Since all the participating teachers use CPALMS, the lesson plans were very similar. The lesson plans of P2A and P3G are attached in Appendix G. They both contain teaching phase, guided practice, formative assessment, and summative assessment. There is one word problem in the lesson plan of P3G that relate to the real world. The lesson plan of P2A had no evidence of real-world application. There is also no evidence of student collaboration in either lesson plan. On the other hand, there is evidence of independent practice.

The design of the lesson plans used by the teachers is aligned to the data presented in the surveys and focus study. The majority of teachers prefer the traditional method, which is evident in the lesson plans. The lesson plans indicate that the teachers lecture first and then give guided questions. There is no evidence of rigor, real-world application, or student collaboration. Perhaps this is due to the lack of time that the participating teachers spoke about often and was Theme 1, based on the largest percentage of coverage.

Recommendations for Action

The results of the study have led to some recommendations to all high school mathematics teachers, leaders, parents, and students. The recommendations were based on the data collected in the surveys, focus study group discussions, and lesson plans collected during the research, as well as the literature review, which provided evidence from various studies about the problems in high school mathematical education and recommendations to solve the problems. The teachers provided their perceptions in the open-ended surveys and focus group about what they believe are the problems in the current mathematics curriculum and instruction that cause graduating high school students to enter college and the workforce without the necessary mathematics skills. The teachers also provided recommendations on how to fix such problems.

Provide More Instruction and Planning Time

Time appeared to be the biggest challenge for teachers, which they discussed the most and attributed to the reason why students are not proficient in math when they graduate high school. Participating high school teachers were required to teach six 45 minutes classes with only one 45 minutes planning period. The teachers believed that 45 minutes is not enough time for students to fully understand the topic, practice problems solving, collaborate to solve problems, and apply the learning to real world. Participant P5S commented, "Taking the high schools off 4x4 and going to seven 45-minute periods was the most detrimental thing I have experienced in 32 years of teaching. Our math scores have plummeted and my students are not nearly as prepared for college classes as they were on 4x4." However, a case study on block scheduling conducted in 2009 published that the evidence is inconclusive on whether students benefit with block scheduling (Creech, 2012). Block scheduling is also significantly more expensive for schools than the traditional schedule in which a block schedule requires 61 teachers for a school compared to 53 teachers under a traditional schedule (Creech, 2012). The National Education Association (2015) listed the pros of block scheduling, which included more time for individualized instruction, longer cooperative learning activities, and more time for teachers to plan and collaborate. However, there are also cons for block scheduling, which include the lack of continuity from day to day, so if a student misses a day, they will actually miss two or sometimes more of instruction (National Education Association, 2015).

Another recommendation would be to increase the math periods from 45 minutes to anywhere between 60 to 90 minutes. Adding 15 to 30 minutes is a reasonable and realistic change that will provide the teachers and students with more time to practice and apply real-world problems. This time may be added to the school time or taken away from other periods, such as study hall.

Study Practices of Top Nations

To help improve the mathematics education for students in the United States, it can be helpful to learn how the top nations educate their children and prepare them for the workforce. The country of Finland tops the international rankings in various research reports (Abdul, 2013). Researchers have shown that the quality of educators in Finland is what makes its educational system so successful. All educators have a master's degree (Gillies, 2013). It is extremely competitive to find a teaching job in Finland that only about 10 percent of applicants are accepted (Gillies, 2013). With top scores in the world, one would think that Finnish students spend more time learning, but that is completely the opposite. Finns spend the least amount of time in the classroom, with just 640 hours a year between the ages of 9 and 11, as opposed to the average of the industrialized nations who spent 810 hours and the United States which spends over 1000 hours a year (Gillies, 2013). Furthermore, the Finns assign less homework and strongly encourage extracurricular activities (Gillies, 2013).

Two-Track Courses

The feedback from the participating teachers and previous research conducted on vocational high schools that is included in this study indicate that two-track courses are helpful for high school students. Therefore, this is something every school district should consider and try to accomplish. School districts may start small with a few two-track courses for the students who are likely to drop out of school if such an option was not available. The success story of the Leon County, Florida's vocational program, included in this study by Erefah (2005) is encouraging and worth trying out.

Recommendations for Educational Leadership

In Need of Time

According to the participating teachers, the top problem in high school mathematics education is the lack of time to teach, for students to practice and collaborate, and for teachers to plan and attend professional development and professional collaborative meetings. Therefore, the educational leaders need to look for ways to help the students and teachers get more time to work together and with their peers. The Recommendations for Action, above, highlighted different scheduling options that provide students and teachers with more time, which was the focus of theme one.

Professional Development

The second most common theme discussed by the participants was professional development. Only thirty-three percent (33%) of the teachers agree that the professional development they receive is very helpful, and they use the information they learn in the classroom. It is important for the educational leader to evaluate the professional development sessions and ask the teachers for feedback. With the limited time teachers have, the professional development must be valuable and not take time away from the teachers, unless the teacher will gain from the professional development. There also needs to be more professional development focused on teaching math. Most of the professional development the participating teachers attended and benefited from are the classroom management workshops. There must be more professional development to train the teachers on real world application. Studies have indicated that if mathematical ideas are taught using real-world contexts, then the students' performance on assessments involving similar real-world problems is improved (National Mathematics Advisory Panel, 2008). In addition, the teachers need professional development and training on learning and curriculum theories.

Learning and curriculum theories. A recommendation for educational leaders is to help teachers understand how the learning and curriculum theories have greatly contributed to the development of the mathematics curriculum and the education of students in the United States. Larson and Howley (2006) stated that most principals do not engage in much talk about the nature of learning mathematics or about new approaches to mathematics pedagogy. The instructional approach implemented in the classroom determines the students' motivation to learning new mathematical concepts (White-Clark et al., 2008). When teachers understand theories like behavioral theory, classical conditioning theory, and constructivist theory, they may integrate different theories in their lesson plans. This will help traditional teachers try new methods of instruction. In the traditional classroom, the teacher provides clear, step-by-step instructions on how to solve problems, while students observe and listen (Nesmith, 2008). The traditional method of teaching mathematics is the behaviorist approach, which emphasizes the students' observable behaviors (Nesmith, 2008). The direct opposite of this behaviorist approach is constructivism in which students approach a new task with prior knowledge and construct their own meaning by assimilating new information (Nesmith, 2008).

Fifty-eight percent (58%) of the participating teachers in this study favor traditional teaching and prefer the teacher-led, direct instruction strategy. However, if those teachers understand how the constructivist theory focuses on the learner constructing knowledge by experiences and that this interactive learning requires students to actively be involved in the learning process and not passively acquire knowledge, the teacher might try new instructional styles (McCarthy, 2010). Teachers also need professional development on how they can increase student collaboration, which was the fifth theme in this study. Training the teachers on problem-based learning will help them engage students in learning while they collaborate and work in groups to solve problems (Schunk, 2008).

Differentiation. The goal of the Common Core State Standards (CCSS) was designed to help close the gap and ensure all students advance to college and career-ready level by the end of high school (Achieve, 2010). However, for the majority of the participating teachers (75%), one of the biggest areas that causes high school students to graduate without mastery of math content is because they are trying to close the gap among the students. Seventy-five percent (75%) of the focus study participants agreed that if they had students at the same level in mathematics, they could focus on what the group of students need to know and what is missing. Differentiated instruction may solve this problem, which can be applied in a classroom with diversity and multiple readiness levels (Lawrence-Brown, 2004). Differentiated instruction benefits all students, from gifted to those with significant disabilities in the same classroom (Lawrence-Brown, 2004).

Teachers need professional development in differentiated instruction to learn how to constantly change their teaching methods, learning activities, and assessments to meet the diverse needs of students (Chamberlin, 2011). It is teaching to the diverse needs of all students by adjusting the curriculum and teaching strategies, rather than teaching to the average of the class, which may be too difficult or easy for some students (Batts & Lewis, 2005). The first step in teaching students in a differentiated manner is to train the teachers how to educate differentially (Hedrick, 2005). Hedrick (2005) believes that teachers need to comprehend the theory of differentiation, as well as the connected observations and developmental skills, before they begin the process of differentiation. They also should demonstrate how to develop an understanding related to the needs of different learners. Teachers may take differentiation workshops that provide information about different learner styles, specific differentiation activities, and most important the differentiated curriculum.

Teachers also need to learn to use Bloom's taxonomy of cognitive educational outcomes to design projects that meet the different levels of students in the class (Cox, 2008). As classrooms in American became more diverse, teaching to the average of the class leaves certain students behind and others unchallenged. Differentiation became a trend in the 21st century when educators realized that a one size fits all class could not tackle the increasing diversity that exists throughout the nation or appropriately move each child through his or her own personal zone of proximal development (Vygotsky, 1978). In differentiated classrooms, all students are active, engaged, challenged, interested, and respected (Tomlinson, 2001).

Differentiation and Technology. In addition, differentiated instruction, with the use of technology, offers teachers the opportunity to connect with students in various modalities, while also varying the rate of instruction, complexity levels, and teaching strategies to engage and challenge students (Stanford, Crowe, & Flice, 2010).

Technology allows teachers and students to interact in a manner that was not previously possible (Beeland, 2011). The use of technology in differentiated instruction offers teachers the opportunity to connect with students in various modalities, while varying the rate of instruction, complexity levels, and teaching strategies to engage and challenge students (Stanford, Crowe, & Flice, 2010). The integration of technology with curriculum and professional growth increases student achievement (Center for Applied Research in Educational Technology, 2012).

Resources. Participating teachers complained about the lack of resources, while others complained that the resources were not being applied appropriately. Therefore it is important to provide teachers with professional development on how to use the resources. The educational leader should also encourage the teachers to apply projects and grants to receive free resources. There are several websites that offer free, quality professional development with many interactive and collaborative components (Bruder, 2013). In addition, there are websites, like DonorsChoose, which provide teachers with free resources to enhance learning.

Recommendations for Future Research

The findings in this qualitative study suggest the need for future research to help improve the curriculum and instruction of high school mathematics class. The participating teachers stated that the main reason why a large number of high school graduates are not proficient in mathematics is because of the lack of time they have to educate students, plan lessons, and collaborate. Several recommendations have been made in this chapter to help schools provide additional time for teachers. However, more research is needed to determine how high schools can increase the instructional time for mathematics courses and provide teachers with more time to plan and collaborate. At the same time, it must be affordable for schools.

The Researcher's Reflection

Although 100% of the participants agree that many high school students are not proficient in mathematics when they graduate, they are diverse in their responses on why this problems exists and what solutions can help resolve the issue. The 15 themes that emerged are all important in high school mathematics education and provide a valid response to the research question of why the U.S. high school students underperform in mathematics. The teachers provided in-depth responses in the surveys and elaborated on those responses during the focus study group. The lesson plans that the teachers used in class align with the descriptions they provided of high school mathematics education.

Every theme that emerged in the study provides information for the educational leaders, teachers, students, and parents of the problems that exist in the current high school mathematics curriculum and instruction. The teachers also provided solutions that research proves can be very helpful, such as more time, student collaboration, teacher collaboration, professional development, and two-track courses.

Summary

The focus of this qualitative case study was to explore the perceptions of high school mathematics teachers on the current curriculum and instruction used in class. This helps educators understand the reasons why U.S. high school students are not ready for college and the highest achieving states within the United States are still significantly below the highest achieving countries (Phillips, 2007). There are various problems in mathematics education that can relate to why a large number of high school students enter college without the necessary skills to be successful in college mathematics and beyond. The participating teachers provided their perceptions on the problems that currently exist in high school mathematics curriculum and instruction. Chapter 5 provided recommendations to resolve these problems. The main problem presented by the teachers was the lack of time they have to teach, plan, and collaborate. This is a problem that requires further research to find the best solution that will improve mathematics education and will be affordable for schools.

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Appendix A

Premises, Recruitment and Name Use Permission

University of Phoenix®

PREMISES, RECRUITMENT AND NAME (PRN) USE PERMISSION

Northwest Florida School District

Name of Facility, Organization, University, Institution, or Association

Please complete the following by check marking any permissions listed here that you approve, and please provide your signature, title, date, and organizational information below. If you have any questions or concerns about this research study, please contact the University of Phoenix Institutional Review Board via email at IRB@phoenix.edu.

☑ I hereby authorize Soha Abdeljaber, a student of University of Phoenix, to use the premises (Northwest Florida School District) to conduct a study entitled *High School Mathematics Teachers' Perceptions of Curriculum and Instruction used in Mathematics Classes in Northwest Florida.*

☑ I hereby authorize Soha Abdeljaber, a student of University of Phoenix, to recruit subjects for participation in a conduct a study entitled *High School Mathematics Teachers' Perceptions of Curriculum and Instruction used in Mathematics Classes in Northwest Florida.*

☑ I hereby authorize Soha Abdeljaber, a student of University of Phoenix, to use the name of the facility, organization, university, institution, or association identified above when publishing results from the study entitled *High School Mathematics Teachers' Perceptions of Curriculum and Instruction used in Mathematics Classes in Northwest Florida.*

Lynn M Chester-d'Alberts EdD   7/16/13

Signature   Date

Lynn M Chester-d'Alberts, EdD

Name

Program Evaluator

Title

Address of Facility 1311 Balboa Ave Panama City FL 32401

Appendix B

Informed Consent

University of Phoenix®

INFORMED CONSENT: PARTICIPANTS 18 YEARS OF AGE AND OLDER

Dear (Teacher's Name),
My name is Soha Abdeljaber and I am a student at the University of Phoenix working on a PhD in Educational Leadership degree. I am doing a research study entitle *High School Mathematics Teachers' Perceptions of Curriculum and Instruction used in Mathematics Classes in Northwest Florida*. The purpose of the research study is to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. The perceptions of teachers will include possible problems that may exist in the curriculum and present more effective ways to teach mathematics, if available.

Your participation will involve sharing your insight on the current mathematics curriculum and methods of instruction used in the classrooms to find the perceived reasons behind the students' poor performance. You will be asked to communicate your concerns regarding the high school mathematics education that may contribute to the cause why many students are not ready for college mathematics and the workplace.

An open-ended survey with 16 questions will be sent to you to complete, which will take no more than 30 minutes. In addition, a voluntary focus group will take place, which you may volunteer for, and at least one artifact used to plan the lesson will be collected. The data will be secured locked in a fireproof storage for three years. The interview will be video recorded, downloaded onto a personal computer, and saved on a USB, which will be securely stored. The answers will be transcribed for data analysis to ensure confidentiality. Participants may also volunteer to be part of a focus study discussion, which will also be video recorded. The video recording will start at the beginning of the interview and focus study discussion and end when the interview and focus study discussion end. The focus study discussion is scheduled for 60 minutes. The interview will take place at a district public school. Approval from the district superintendent has been granted to conduct the focus study interview in school. The sample of the population of this study will be the 12 high school teachers of the Panhandle in Florida.

You can decide to be a part of this study or not. Once you start, you can withdraw from the study at any time without any penalty or loss of benefits. The results of the research study may be published but your identity will remain confidential and your name will not be made known to any outside party.

In this research, there is no risk to you in any way.

Although there may be no direct benefit to you, a possible benefit from your being part of this study is it may allow educators to explore innovative methods that the teachers in the study use to assist students in meeting or exceeding the state standards. This study is important for students, parents, teachers, administrators, and everyone who cares about the education of the students in United States. It may provide school leaders and teachers with information that will identify possible problems with the curriculum and instruction in high school mathematics classes and how to resolve those problems.

If you have any questions about the research study, please call me at (850) 454-3639 or jabersa@bay.k12.fl.us. For questions about your rights as a study participant, or any concerns or complaints, please contact the University of Phoenix Institutional Review Board via email at IRB@phoenix.edu.

As a participant in this study, you should understand the following:

1. You may decide not to be part of this study or you may want to withdraw from the study at any time. If you want to withdraw, you can do so without any problems by calling or emailing me.
2. Your identity will be kept confidential.
3. Soha Abdeljaber, the researcher, has fully explained the nature of the research study and has answered all of your questions and concerns.
4. If interview and focus group are done, they will be recorded. You understand that the information from the recorded interview and focus group may be transcribed. The researcher will develop a way to code the data to assure that your name is protected.
5. Data will be kept in a secure and locked area. The data will be kept for three years, and then destroyed.
6. The results of this study may be published.

"By signing this form, you agree that you understand the nature of the study, the possible risks to you as a participant, and how your identity will be kept confidential. When you sign this form, this means that you are 18 years old or older and that you give your permission to volunteer as a participant in the study that is described here."

(☐) I accept the above terms. **(☐) I do not accept the above terms.** **(CHECK ONE)**

Signature of the interviewee ___________________________________ Date _____________

Signature of the researcher ____________________________________ Date _____________

Appendix C

Survey Questions

Demographic Information

1. How many years have you been teaching high school mathematics classes?

2. What high school mathematics courses have you taught?

3. Your age: ___ 21–30 ___31–40 ____41–50 ____51–60

Open-ended Questions

1. How rigorous is the mathematics curriculum for the different courses you teach? Please specify the level of rigor for each math course. How does the rigor contribute to the students' understanding of the content?

2. How do you include real-world applications in your instruction? How do these real-world applications help your students' understanding of the content?

3. How do you provide your students the opportunity to participate during modeling of the lessons? How does this engagement help your students?

4. What type of professional development have you participated in? How has the professional development helped you improve your instructional methods?

5. What is your preferred method of instruction? How do you feel it helps your students better understand mathematics?

6. What suggestions can you provide to help district and state improve the curriculum to help the students advance? Do you think Common Core will better prepare students for college mathematics and the workforce?

7. In what ways can high school teachers improve the instruction to help their students advance?

8. Research shows that a large number of students who graduate from high school are not ready for college and the labor force of the 21st century (McCormick & Lucas, 2011). What do you think are the reasons for this?

9. What do you think is the main problem why a large number of high school students enter college without the appropriate mathematics skills to succeed in college level mathematics courses?

10. How do you think that teachers can be more proactive in helping high school students succeed in college mathematics and the workforce?

11. Does your school support math teachers' collaboration? If so, how does this collaboration of the high school mathematics teachers benefit students? How often do these collaborations take place?

12. How does your school leader support the mathematics high school teachers with the curriculum and instruction? What type of support as a math teacher do you need to ensure student success in mathematics?

13. How do the high stake assessments affect what teachers teach and how they present the mathematics content to the students? Do you feel that high stake assessments impact and affect how you teach and present the mathematics content to the students? Please explain.

14. Research shows that many students find mathematics boring and difficult (Onion, 2004). Why do you think this is so?

15. Researchers Petkov and Rogers (2011) suggest that students need a more challenging curriculum and engaging forms of instruction that is motivating for them. How do you think teachers can help in achieving that?

16. How do you think teachers can help close the gap that exists between the current mathematics education in high school and the topics and methods that will be of interest for students in the 21st century and help them success in college and beyond?

Appendix D

Focus Group Questions

1. Why do you think the high school seniors in the United States do not demonstrate mathematics proficiency, which affects their mathematics performance in college and beyond (National Center for Educational Statistics, 2006, 2013b)?
2. What are your concerns regarding the high school mathematics education that may contribute to the cause why many students are not ready for college mathematics and the workplace?
3. How do we close the gap that exists between the current mathematics education in high school and the topics and methods that will be of interest for students in the 21st century?
4. What are problems that may exist in the high school mathematics curriculum and instruction?

Appendix E

Subject Recruitment and Selection Message

Hello (Name of Teacher),

My name is Soha Abdeljaber. I am a doctoral student at the University of Phoenix. I am conducting research for my dissertation on the perception of high school mathematics teachers regarding the curriculum and instruction. The purpose of this study is to explore why a large number of the high school mathematics students in the United States are not ready for college mathematics and the workplace through the perceptions of high school teachers. The perceptions of the teachers will include possible problems that may exist and present more effective ways to teach mathematics, if available. Teachers will also be asked to share their views about ways to increase the students' achievement in mathematics. Teachers who accept to take part in this study are expected to participate in an open-ended survey, which will be no more than 30 minutes long, at the high school. Then there will be a voluntary focus group to discuss the curriculum and instructional methods used, which will be 60 minutes. Finally, at least one artifact, which may include a lesson place, curriculum requirement, or supplemental data to support instruction, will be collected. Your participation in this study is voluntary. The teacher may withdraw from the study at any time. All information will remain confidential and the teacher's name will not be used or identified. Your name will not be disclosed to any outside party. There is no risk for participating in this research. There may be possible benefits to help educators improve mathematics education at the high school level.

If you will like to participate in this study, please inform me via phone at 850-630-4536, email at jabersa@bay.k12.fl.us, or through the inter-office mail by simply stating that you will like to be part of the study. You will then be sent an Informed Consent form to sign with the survey. Thank you very much for your time.

Appendix F

Media Release Form

Media Recording Release Form

Title of Research: High School Mathematics Teachers' Perceptions of Curriculum and Instruction used in Mathematics Classes in Northwest Florida

Study Investigators: Soha Abdeljaber

Record types. As part of this study, the following types of media records will be made of you during your participation in the research:

- Video Recording

Record uses. Please indicate whether you permit the use of the media records listed above by initialing below and signing the form at the end. The media records will only be used in ways that you agree to.

- The media record can be studied by the researcher for use in this research project.

  Please initial: _______

- The media record and/or transcriptions can be used for scientific or scholarly publications, in which your name will remain anonymous.

  Please initial: _______

I have read the above descriptions and give my consent for the use of the media recordings as indicated by my initials above.

Name: ______________________________

Signature: ______________________________ Date: ______________________________

Appendix G

Sample Lesson Plans

Sample Lesson Plans from Participant P3G

- **Lesson Plan Template:** General Lesson Plan
- **Formative Assessment**

Prior knowledge of the quadratic formula will be assessed as a bell ringer activity at the beginning of the teaching phase. Students will be asked to solve two quadratic equations. One will contain real solutions and one will contain complex solutions. It is important to circulate the room and monitor students' work. Provide the formula for students who need it. Focus more on the correct use of the formula than on the simplifying of the answers.

$$x = \frac{4 \pm \sqrt{72}}{4} = \frac{2 \pm 3\sqrt{2}}{2}$$

$$2.\quad x^2 - 2x + 9 = 0$$

$$x = \frac{2 \pm i\sqrt{32}}{2} = 1 \pm 2i\sqrt{2}$$

- **Feedback to Students**
  During both the teaching phase and guided practice, the teacher should circulate the room answering questions when necessary. Also, immediate feedback can be given by showing completed problems worked out on the board.
- **Summative Assessment**
  The students will be asked to work questions independently at the end of the lesson. They will check their answers when the teacher displays the answers and hold up fingers to represent their level of understanding. One finger will represent little understanding and 5 fingers will represent mastery of the material.

Questions

1. Is $P(x)=4x(x+1)^2(x^2+4)$ written as a product of linear factors? If no, why?

2. Express the polynomial as a product of linear factors $P(x)=x^2+4x+5$

3. Write a polynomial of degree 3 with given roots 6 , 2+3i and a leading coefficient of 4 as a product of linear factors.

4. An architect is constructing a scale model of a building that is in the shape of a pyramid. If the base is a square and the height is three more than its length, write a polynomial in factored form that describes the volume of the model in terms of its length. How is the Fundamental Theorem of Algebra connected to the concept of volume for this problem?

Answers

1. No, x^2+4 is not a linear factor.

2. $P(x)=(x+2-i)(x+2+i)$

3. $P(x)=4(x-6)(x-2-3i)(x-2+3i)$

4. $V(l) = \frac{1}{3}(l)(l)(l+3)$ Volume contains three dimensions and we obtained three linear factors.

- **Learning Objectives: What should students know and be able to do as a result of this lesson?**
  - The student will be able to determine if a polynomial is written as a product of linear factors.
  - The student will be able to write a quadratic polynomial as a product of linear factors with real and complex roots.
  - The student will be able to write a cubic polynomial as a product of linear factors with real and complex roots.
- **Guiding Questions: What are the guiding questions for this lesson?**
  - Will a quadratic polynomial with imaginary roots ever cross the x-axis?
  - Will a cubic polynomial with imaginary roots ever cross the x-axis?
  - Will all odd degree polynomials cross the x-axis?
  - Will all even degree polynomials cross the x-axis?
  - Is there a relation between the fundamental theorem of algebra and the zeros of a polynomial?
  - What is the connection between the fundamental theorem of algebra and the linear factorization theorem?
- **Prior Knowledge: What prior knowledge should students have for this lesson?**
  - Students should know the quadratic formula.
  - Students should know imaginary and complex numbers
- **Teaching Phase: How will the teacher present the concept or skill to students?**

  As a bell ringer activity have students solve the following equations using the quadratic formula. Your less experienced students do not need to worry about simplifying the radical but they do need to express number 2 as a complex number.

1. $2x^2 - 4x - 7 = 0$

2. $x^2 - 2x + 9 = 0$

Circulate the room and check with students. Offer the quadratic formula for those who have forgotten it. When students have finished, show the worked out solutions on the board. Now is an opportunity to review simplifying radicals depending on the level of the class.

To start the lesson put the following statement on the board and ask the students if they know what it is:

- **A polynomial function of degree n has exactly n zeros, including repeated zeros, in the complex number system.**
- If no one is able to produce a correct answer, tell them it is the**Fundamental Theorem of Algebra.**

Now let's look at the problem $x^2+6x+9=0$.

- Ask students to solve for x without any hint on how they should work the problem. Circulate the room and check both for answers and the method used to solve.
- Quadratic formula and factoring should be the popular two
- Hint: most students will probably use the quadratic formula because they remember it from the bell the ringer

Ask for a volunteer to provide an answer. Call on a student that you know came up with the correct answer(negative 3)and ask the student to describe how the answer was achieved.

Now ask if anybody came up with the same answer and used a different method.

The two methods you want to highlight here are factoring and the quadratic formula.

Expand on the concept that since their answer of negative three makes the function $f(x)=x^2+6x+9$ equal to zero it is considered a zero.

Now refer to the Fundamental Theorem of Algebra and ask the students how many zeros this problem should produce. When the class realizes they should have two zeros, ask what the other zero should be. If no one can make the connection to repeated zeros, explain this concept to them.

Note it is important here to remind students that a complex number can be written as a real number when the imaginary part is zero. Show students that when you have a complex number, a + bi where b = 0, the result will look like a real number.

Now let's review the Factor Theorem: A polynomial f(x) has a factor (x - c) if and only if f(c)=0.

In our problem f(-3)=0 therefore (x+3) is a factor. More specifically it is considered a linear factor since it is of degree one.

Point out that the students who solved the problem by factoring have already come up with (x+3)(x+3).

Lead students to the connection between linear factors and the Fundamental Theorem of Algebra. One way to accomplish this is to provide polynomials in factored form. Ask students to find all zeros. Now have students multiply the polynomial out and determine the degree. Here is an example:

Use $P(x)=4x(x+3)(x-2)$, zeros $x = 0, -3, 2$

Multiplying it out gives you $P(x) = 4x^3 + 4x^2 - 24x$, degree 3

Once this discovery has been established, point out that there is another theorem that connects both the Factor Theorem and the Fundamental Theorem of Algebra.

Linear Factorization Theorem: If f(x) is a polynomial of degree $n > 0$, then f has exactly n linear factors and $f(x)=a_n(x-c_1)(x-c_2)\ldots(x-c_n)$ where a_n is some nonzero real number and $c_1, c_2, \ldots, c_n$ are complex zeros(including repeated zeros) of f.

- **Guided Practice: What activities or exercises will the students complete with teacher guidance?**
  - Which of the following polynomials is not written as a product of linear factors?
  - a) $P(x)=4(x+1)(x-1)^2(x+5)$

    b) $P(x)=x(x^2+2)(x-3)$

    c) $P(x)=(2x+7)(3x+5)$
  - Correct answer b.

  - Write a polynomial of degree three in factored form with given zeros; 5, -6, 0
  - Possible answer: $P(x)=ax(x-5)(x+6)$ where a is any real number not equal to zero

  - Rewrite the polynomial in standard form as a polynomial in factored form $P(x)=4x^3-2x^2-2x$
  - Answer $P(x)=2x(2x+1)(x-1)$

  - Write a polynomial of degree two in factored form with given zeros: $5+3i$, $5-3i$
  - Answer $P(x)=(x-5-3i)(x-5+3i)$

  - Express the quadratic polynomial ,$P(x)= x^2+25$, as a product of linear factors.
  - Answer $P(x)= (x-5i)(x+5i)$
- **Independent Practice: What activities or exercises will students complete to reinforce the concepts and skills developed in the lesson?**
  Questions

  1. How do you know if a factor is linear?

2. Express the polynomial as a product of linear factors $P(x)=x^2+4x-5$

3. Given a polynomial of degree 3 that does not contain any repeated zeros with given roots 8 and 4+5i, how many more zeros exist? Verify your answer.

4. How can you determine the remaining zero(s) to the above problem without any more information? Note, this is a high level question for students who have not previously been taught the Conjugate Root Theorem.

Answers

1. If it can be expressed in the form x - c where c is a constant.

2. P(x)=(x+5)(x-1)

3. one, the fundamental theorem assures us that there will be 3 zeros.

4. Since 4 + 5i is given, 4 - 5i must also be a zero.

- This is true because we know the polynomial is degree 3 and has 8 as a zero. Therefore, x - 8 will be a factor leaving the remaining zeros to come from the product of two linear factors. If you multiply two linear factors you get a quadratic equation. When using the quadratic formula to solve a quadratic equation, having a negative discriminant will produce complex solutions. Since the radical is preceded by +/-, this ensures that whenever you have a positive imaginary number you will also have a negative one as well.

- **Closure: How will the teacher assist students in organizing the knowledge gained in the lesson?**
In order to help students organize what they have learned from the lesson, ask them to outline five things they know that they didn't know at the beginning of the lesson. Let them know it is ok to list something that was considered a review topic if they didn't know before hand.

Examples:

I. The Fundamental Theorem of Algebra

II. The Linear Factorization Theorem

III. The Factor Theorem

IV. Repeated zeros

V. A real number can be thought of as complex if the imaginary unit is zero

ACCOMMODATIONS & RECOMMENDATIONS

- **Accommodations:** Students who struggle with the quadratic formula can be allowed the use of a calculator that will express answers as complex numbers in the for a + bi. One on one individual help is encouraged for all students who still have difficulty working with the quadratic formula.

- **Extensions:** The lesson can be extended to included higher order polynomials that would entail prior knowledge of long division or synthetic division.
- **Suggested Technology:** Document Camera, LCD Projector
- **Special Materials Needed:**

  Graphing calculators may be needed to assist a student with special needs.
- **Further Recommendations:** For a basic course, it would be helpful for the students to write polynomials as linear factors limited to complex roots of the form a + bi where a = 0.

Sample Lesson Plans of P2A

Spinning Angles in Radians and Degrees (Introductory lesson to exact trigonometric values)

Resource ID#: 30170

Primary Type: Lesson Plan

This lesson introduces concepts that are the prerequisites to defining trig functions on the unit circle. Radian measure and converting between degrees and radians are introduced. Students will also learn how to draw and measure positive and negative angles in standard position, identify and draw co-terminal angles, and determine a reference angle.

Subject(s): Mathematics

Grade Level(s): 9, 10, 11, 12

Intended Audience: Educators

Suggested Technology: Document Camera, Computer for Presenter, Internet Connection, Interactive Whiteboard, LCD Projector, Adobe Flash Player, Microsoft Office, Java Plugin

Instructional Time: 1 Hour(s)

Freely Available: Yes

Keywords: Unit circle, angles in degrees, angles in radians, angles in standard position, co-terminal angles, reference angles

Instructional Component Type(s): Lesson Plan, Worksheet, Presentation/Slideshow

Instructional Design Framework(s): Direct Instruction , Demonstration, Confirmation Inquiry (Level 1) , Structured Inquiry (Level 2)

Resource Collection: CPALMS Lesson Plan Development Initiative

ATTACHMENTS

Linamen 3 Prior Knowledge Check.docx

Linamen3 Homework doc.docx

Linamen3 Homework Solutions.docx

Linamen Lesson 3_new_Degrees_Radians_Reference Anglescor.pptx

LESSON CONTENT

• Lesson Plan Template: General Lesson Plan

• Formative Assessment

At the beginning of the lesson, the students will complete questions to prompt prior knowledge. The teacher will circulate, monitoring students' work, and providing assistance while students complete this warm up activity. The teacher can also embed review within the lesson to remind students of prerequisite concepts and skills.

• Feedback to Students

Students will have guided practice with an answer check during the lesson. Students will have a website where they can practice concepts and receive immediate feedback using the quiz feature on the website. Using the interactive whiteboard, students will have an opportunity to take the quiz, on the website, and reset it for multiple attempts. The teacher will be able to call students to the whiteboard to try the quiz. A new version of the quiz is generated when the quiz is reset; therefore, the teacher can use the quiz feature until satisfied students understand the concepts.

• Summative Assessment

At the end of the lesson, students will complete a homework assignment which can be started at the end of class. The teacher can circulate and assess their understanding of the new concepts. Students will complete the homework which will be evaluated on the next school day. This is a lesson to given at the beginning of the unit; therefore, concepts will also be assessed at the end of the unit when students take an End of Unit Exam.

• Learning Objectives: What should students know and be able to do as a result of this lesson?

o Students will be able to draw and identify angles in standard position in both degree and radian measure.

o Students will be able to convert angles from degree measure to radian measure and radian measure to degree measure.

o Students will be able to find and draw both positive and negative coterminal angles.

o Students will be able to sketch an angle, in standard position, and then find its reference angle.

• Guiding Questions: What are the guiding questions for this lesson?

o What is the radian measure of 180°?

o How do you know whether an angle in standard position is positive or negative?

o In which direction is the terminal side of an angle, in standard position, rotated if the angle is positive? Negative?

o How do you convert degrees to radians? How do you convert radians to degrees?

o On the unit circle on the website, where is ∏/8? On the unit circle on the website, where is 15°?

o How many coterminal angles does an angle have?

o What would you add or subtract to determine the measure of coterminal angles?

o How is the reference angle determined?

• Prior Knowledge: What prior knowledge should students have for this lesson?

Students should have the following prior knowledge:

1. Students should be able to solve a right triangle using the Pythagorean Theorem.

2. Students should be able to solve special right triangles.

3. Students should be able to multiply and divide with numbers containing radicals.

4. Students should be able to order sides of a triangle from smallest to largest when knowing the angles of a triangle.

5. Students should be able to determine the largest or smallest ratio of sides of a triangle when the angles are known.

• Teaching Phase: How will the teacher present the concept or skill to students?

This lesson will be presented by PowerPoint to an interactive whiteboard.

Slide 1: Students are given the learning goal and agenda of the lesson.

Slide 2: Students are given a prior knowledge check. They may use their own paper or the worksheet attached with this lesson. Students may work independently or in pairs at the teacher discretion. The teacher will circulate while students complete these problems to assess their understanding. After 10 minutes, the teacher can go to slide 16 for students to check their answers.

Slides 3 – 5: Students an introduction to trigonometric functions as well as the necessary vocabulary to find and draw angles in standard position.

Slide 6: A blank unit circle is provided so that the teacher can use the interactive white board to reinforce student comprehension of vocabulary including degree and radian measure of angles in standard position.

Slides 7 – 8: Students are shown how to convert angles in degrees to radians, and angles in radians to degrees. An example is given with the correct answer to be revealed followed by more practice for students. Students can complete these problems working in pairs at the teacher's discretion.

Slides 9 – 10 are the most important slides. Directions are given to use the website to draw positive and negative angles. When drawn the angles measure is shown both in degrees and radians. After drawing several practice angles, students should be selected to take the quiz at the whiteboard. There is immediate feedback on the quiz and when reset a new quiz appears. This should be continued giving as many students as possible a turn at answering the questions.

Slide 11: Students should find coterminal angles verifying their answers on the website unit circle. There are 12 problems on this slide; however, complete only as many problems as necessary for students to understand the concept of coterminal angles.

Slide 12: Students have prior knowledge of sine, cosine, and tangent, but on this slide they are introduced to cosecant, secant, and cotangent. Students should understand that these ratios are dependent on the size of the angle used to evaluate the trigonometric function.

Slide 13-14: Students are shown the method to determine reference angles and then are given problems to practice. They are to use the website to verify their results.

Slide 15: Homework problems although the teacher may choose to use homework problems from their textbook.

Slide 16: Prior knowledge answers to slide 2.

Slide 17: Homework Solutions which can be used when continuing to the next lesson.

• Guided Practice: What activities or exercises will the students complete with teacher guidance?

In the PowerPoint, slide 6 has a unit circle to practice drawing angles in standard position. Slides 7 and 8 have guided practice for students to change angles from radians to degrees and degrees to radians. Slides 9 and 10 have guided practice using the website with the interactive unit circle. This practice can be fun and competitive for students. The quiz is non-threatening and provides immediate feedback. If students have trouble, they simple reset the quiz and try again. Slide 14 offers guided practice to determine reference angles. Again, the website makes this more visual to see the correct answers. By drawing on the interactive whiteboard, students can "see" the reference angles.

• Independent Practice: What activities or exercises will students complete to reinforce the concepts and skills developed in the lesson?

Students will complete a homework assignment reinforcing each of the concepts that they have learned. They may use the website, independently, to check their solutions.

• Closure: How will the teacher assist students in organizing the knowledge gained in the lesson?

Teachers can go to the website and ask one of each of the concepts taught in the lesson. Teachers ask, how would we draw a positive angle in standard position? Where are the vertex, the initial side, and the terminal side located? Repeat this with a negative angle. Given an angle in standard position, name 2 coterminal angles. Be sure this is done with an angle in degrees and then an angle in radians. What is the reference angle for the given angle? Have students begin their homework by completing one problem in each section before the end of class.

ASSESSMENT

• Formative Assessment:

At the beginning of the lesson, the students will complete questions to prompt prior knowledge. The teacher will circulate, monitoring students' work, and providing assistance while students complete this warm up activity. The teacher can also embed review within the lesson to remind students of prerequisite concepts and skills.

- Feedback to Students:

Students will have guided practice with an answer check during the lesson. Students will have a website where they can practice concepts and receive immediate feedback using the quiz feature on the website. Using the interactive whiteboard, students will have an opportunity to take the quiz, on the website, and reset it for multiple attempts. The teacher will be able to call students to the whiteboard to try the quiz. A new version of the quiz is generated when the quiz is reset; therefore, the teacher can use the quiz feature until satisfied students understand the concepts.

- Summative Assessment:

At the end of the lesson, students will complete a homework assignment which can be started at the end of class. The teacher can circulate and assess their understanding of the new concepts. Students will complete the homework which will be evaluated on the next school day. This is a lesson to given at the beginning of the unit; therefore, concepts will also be assessed at the end of the unit when students take an End of Unit Exam.

ACCOMMODATIONS & RECOMMENDATIONS

Accommodations:

o Preferential seating is used to make sure that every student is placed in a seat that meets his or her needs.

o Seating is structured so that when students seated in rows use their face partner or shoulder partner the high-learner, medium-high learner, a medium low-learner and a low-level learner are carefully paired.

o The visual example of the interactive unit circle used in a large group setting, accommodates the visual learner.

o Using the website at home or in the media center allows the student individual interactivity.

Extensions:

Students should produce a product where they quiz their peers on angle measurement and reference angles. They should give the reference angle and ask their peers to determine the angle(s) in standard position with that reference angle. They should also be given the latitude to come up with their own ideas on how to determine the measurement of angles in the surroundings.

Suggested Technology: Document Camera, Computer for Presenter, Internet

Connection, Interactive Whiteboard, LCD Projector, Adobe Flash Player, Microsoft Office,

Java Plugin

Special Materials Needed:

o Individual unit circle dry erase boards and dry erase pens may be used for guided practice.

Further Recommendations:

The teacher should practice with the website to see how to use the degree and radian boxes and to move the terminal side of the angle. The teacher should take several quizzes on the website to see the challenges the students will face.

Additional Information/Instructions

By Author/Submitter

Important questions are given; however, students may ask and need answers as they inquire for themselves. Teachers my choose homework from their textbook instead of the problems on the PowerPoint allowing the PowerPoint Homework question to be available for additional guided practice.

The following standard of math practice may align with this lesson:

MAFS.K12.MP.2.1 - Reason abstractly and quantitatively.