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A study to determine differences in the level of perceived preparedness in teaching algebra to eighth graders between teachers in the United States and teachers in Lebanon

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A STUDY TO DETERMINE DIFFERENCES IN THE LEVEL OF PERCEIVED PREPAREDNESS IN TEACHING ALGEBRA TO EIGHTH GRADERS BETWEEN TEACHERS IN THE UNITED STATES AND TEACHERS IN LEBANON

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DEDICATION

I dedicate this dissertation to my family, my close friends, my coworkers, and my husband. They all gave me their unconditional love, acceptance, and support throughout this journey.

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ABSTRACT

Algebra is a branch in mathematics and taking Algebra in middle school is often a gateway to advanced courses in high school. The problem is that the United States and Lebanon had low scores in Algebra in the 2007 Trends in Mathematics and Sciences Study (TIMSS), an international assessment administered to 4th and 8th graders every 4 years. On the 2007 TIMSS, Lebanon's average score in Algebra was 465, a lower score than the United States' average of 501. This paper attempted to determine if there were differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching 8th graders the 4 Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, while controlling for the teachers years of teaching experience. Using data from the 2007 TIMSS, multivariate analyses of covariance (MANCOVA) 4 x 2 was performed to determine if there are differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching 8th graders the 4 Algebra content areas in mathematics. Results of the MANCOVA indicated that there were significant differences in at least 1 of the content areas. Further research is recommended, including having a clear definition of teacher preparedness and teacher sample for teachers who taught the representative sample of students. This study has implications to educational leaders and policy makers in mathematics.

Chapter 1: The Problem

Teaching is listed as one of the six principles for school mathematics in the *Principles and Standards of School Mathematics* by the National Council of Teachers of Mathematics ([NCTM], 2000). In the Teaching Principle section in the NCTM mathematics standards, good practices and expectations are described including effective teaching; the NCTM states, "Effective teaching requires continually seeking improvement" (p. 18). It further says that efforts should include learning about mathematics and engaging in ongoing professional development. Algebra is one branch of mathematics and taking Algebra I in middle school is repeatedly referred to as the gatekeeper to success in high school. The legendary civil rights activist, Robert Moses, mathematics teacher and the founder of the Algebra Project, believes that Algebra is critical to student early success. "Algebra, Moses perceived, was a 'gatekeeper' subject: Without it, middle school students couldn't advance in math, technology, and science. And without those courses, they wouldn't be able to meet the requirements for college" (Cole, 2006, para. 3).

This paper attempts to determine if there are differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching eighth graders the four Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, while controlling for the teachers years of teaching experience. The United States and the Republic of Lebanon are members of the United Nations and both are part of the 60-nation study by the International Association for the Evaluation of Educational Achievement (IEA), which carries out comparative research studies in education. The country of Lebanon was chosen for several reasons; one reason is that

Lebanon has had the highest average in eighth grade mathematics scores in TIMSS 2003 (Gonzales, Karoly, Constant, Salem, & Goldman, 2008) and TIMSS 2007 assessments among Arab nations. Although Lebanon's results showed an increase from the 433 average of the TIMSS 2003 results to a 449 score, it is still significantly lower than the TIMSS scale total mathematics average of 500 and lower than the United States average of 508. Also, there is a significant disparity in the eighth-grade mathematics Algebra content domain results in the 2007 TIMSS, where the eighth graders in the United States scored an average of 501 but the eighth graders in Lebanon scored 465; the average on the TIMSS scale was 500. In this paper, findings are used to explain the possible reasons for this disparity, looking for general deficiencies in preparation for Lebanese teachers, if they are indeed not so well prepared, based on the results.

Background

Assessment is part of education and for the longest time, assessments were done via formal testing. Assessments are performed at class, school, district, county, state, national, and international levels. The traditional assessment of formal testing is still the most common form of evaluation, although countries have reforms to evaluate better learning outcomes. "Exams—whether school summative exams or national level exams—kept their central place as a major assessment and evaluation tool in many countries" (Osta, 2007, p. 172); such is the case in Lebanon, where the national level exams, known as official exams, are traditionally highly regarded. They are still used as the only tool for advancement as well as to evaluate teaching practices and curricula. Lebanon's participation in TIMSS 2003, and subsequently in 2007, gave the country a tool to evaluate its mathematics curricula and teaching practices, as TIMSS scores are

used as indicators for program success (Gonzales et al., 2004; Osta, 2007). TIMSS is the only international assessment that measures knowledge for eighth graders in mathematics and science. TIMSS, in addition to assessments, surveys students, teachers, and principals, and provides the world with extensive and meaningful data about the participating countries and the corresponding curricula. *The Comparative Indicators of Education in the United States and Other G-8 Countries: 2009* (Miller, Sen, Malley, & Burns, 2009) completed by the National Center for Education Sciences, has listed teacher professional development in mathematics and science as indicators of education, where mathematics is indicator 18; the study uses teacher-reported data from TIMSS 2007.

Lebanon and the United States

Lebanon participated in the TIMSS assessment in 2003 and 2007 at the eighth grade level. Lebanon has a centralized education system regulated by the Ministry of Education and Higher Education (Skaf & Habib, 2008). Skaf and Habib wrote:

> The current structure of the education system in Lebanon divides pre-university education into three stages: Kindergarten: ages 5–6, Basic education: Elementary level (includes cycle 1, grades 1–3, and cycle 2, grades 4–6), and Intermediate level (cycle 3, grades 7–9), Secondary education: cycle 4, grades 10–12. (p. 361)

For an overview of the education system please see Table 1.

Table 1

Comparison of Education Systems in the United States and Lebanon

Lebanon				United States		
Grade	Grade Level	Age	Schooling Years	Age	Grade Level	Grade
HighSchool 2nd Diploma		18				
Grade	Grade Level	Age	Schooling Years	Age	Grade Level	Grade
HS 1st Diploma/Cycle4	12	17	12	17	12	SeniorHigh/ Senior
HS Year2/Cycle 4	11	16	11	16	11	SeniorHigh/ Junior
HS Year1/Cycle4	10	15	10	15	10	SeniorHigh/ Sophomore
Intermediate 3/Cycle 3	9	14	9	14	9	Senior High/Freshmen
Intermediate 2/Cycle 3	8	13	8	13	8	Junior High
Intermediate 1/Cycle 3	7	12	7	12	7	Junior High
Elementary Cycle 2	6	11	6	11	6	Elementary
Elementary Cycle 2	5	10	5	10	5	Elementary
Elementary Cycle 2	4	9	4	9	4	Elementary
Elementary Cycle 1	3	8	3	8	3	Elementary/ Primary
Elementary Cycle 1	2	7	2	7	2	Elementary/ Primary
Elementary Cycle 1	1	6	1	6	1	Elementary/ Primary
Pre-K to Kindergarten		3–5		3–5		Pre-K to Kindergarten

Note. Schooling years denotes the number of years students in both countries received formal schooling before they took the TIMSS 2007 assessment. As the table shows, students in both countries received eight years of formal schooling by the time of the test.

The United States of America does not have one national education system, as it varies from state to state. States, regions, and local districts oversee the educational

operation and are responsible for outcomes (Miller et al., 2009). Table 1 includes a general breakdown of the educational system of most of the United States. Pre-K to Kindergarten are attended as early as ages 3 to 5 and the students spend 1 to 3 years there; primary grades or elementary school is attended by students ages 6 to 11, for 6 years; middle school or junior high school is attended by students ages 12 to 14, for 3 years; high school or senior high school is attended by students ages 14 to 18 for 4 years.

The TIMSS 2007 Encyclopedia report states that the United States does not have a national mathematics curriculum and that it varies by state, and it reports that certain states are revising their curricula. However, there are nonbinding national guidelines provided in the National Mathematics Principles and Standards for Grades K-12, written by the NCTM, as a guide book for teachers and administrators (NCTM, 2000).

Importance of Algebra. The NCTM's official position on Algebra is stated on its Web site, "Algebra is an important gateway to expanded opportunities. Because of the importance and power of algebra, *all* students should have opportunities to learn it" (NCTM, 2008, para. 5). NCTM (2000) further states, "A strong foundation in algebra should be in place by the end of eighth grade" (para. 4).

In response to the importance of Algebra in middle school, and whether all students should be taking it, Sara Morgatto, a school psychologist and special education department chair at Seymour High School in Seymour, Connecticut, wrote on the views of Robert Moses, who founded and heads the Algebra Project: "He views algebra as the gatekeeper course from which poor children and children of color are often excluded" (Morgatto, 2008, p. 215). She believes that Algebra I is a gateway to better jobs and states:

> An understanding of algebra by the end of eighth grade was crucial for higher-level mathematics classes to be taken in high school, thereby increasing the likelihood that a student attends college and is able to compete in the job market. (p. 216)

Teacher preparedness. There are many factors affecting student learning outcome, of which one critical factor is teacher preparedness. The Glenn Commission in 2000 affirmed in the *Math & Science Teaching in the New Millennium* report titled *Before It Is too Late* that good teaching is key to improved student achievement (The Glenn Commission, 2000). This factor is reinforced in several literature sources; Roth and Swail (2000) said, "Good teaching is perhaps the most critical part of a solid education" (p. 1). The United States Congress passed new legislation known as Section 207, as reauthorization of the Higher Education Act of 1998, to serve as a reporting tool for teacher quality and preparation by mandating colleges and state governments to report on teacher quality. This strengthens the case of the importance of teacher preparedness and increases accountability of the institutions that prepare future teachers.

Teacher preparedness in mathematics. Senk, Keller, and Ferrini-Mundy (2000) stated, "According to data collected by the National Center for Education Statistics, mathematics teacher preparedness is the second largest of specialty areas considered by the Curriculum Foundations Project" (p. 146). Attention is given to mathematics teacher preparedness. The NCTM (1991) issued a recommendation report titled *Professional Standards for Teaching Mathematics,* and more recently, the Conference Board of the Mathematical Sciences (2001) published a book, *The Mathematical Education of Teachers,* to serve as a guide for mathematics teacher preparedness. Chapter 4 of this

book is geared toward preparation of middle school mathematics teachers; the Conference Board of the Mathematical Sciences provides clear understandings of the basic areas in mathematics. It defines middle school as Grades 5 through 8, and gives specific instructions to teachers and their knowledge competency for Algebra content for middle school.

IEA

The IEA has conducted educational research and comparative studies of students' academic achievement for more than 50 years. It is located in Amsterdam and the data processing center is in Germany. The IEA was founded in 1958 and legally established in 1967; it is an independent, international cooperative of national research institutions and governmental research agencies. One of IEA's five purposes, according to their Mission Statement (IEA, 2011b), is to "Provide high-quality data that will increase policy-makers' understanding of key school- and non-school-based factors that influence teaching and learning" (para. 3). IEA conducts cross national studies and it has conducted more than 23 research studies. Two prevalent examples are TIMSS and Progress in International Reading Literacy Study. As the IEA's mission states, its contribution to education is important, as the data is used to improve students' learning at the international, national, and local levels.

Trends in Mathematics and Science Studies

One of the major studies by IEA is TIMSS, which is directed by TIMSS and Progress in the International Reading Literacy Study center at Lynch School of Education at Boston College. It has been assessing trends in international mathematics and science study since 1995 by collecting data in mathematics and science at the fourth and the

eighth grade levels in 50 countries. The goal of IEA's TIMSS states that it helps countries make informed decisions about how to improve teaching and learning in mathematics and science (Mullis, Martin, Olson, et al., 2008). Mullis, et al. (2005) state that TIMSS studies are used by countries to "monitor and evaluate their mathematics and science teaching" (p. 10), and one of the six values of TIMSS is listed as "Monitor the relative effectiveness of teaching and learning at fourth as compared to eighth grade, since the cohort of fourth-grade students is assessed again as eighth graders" (p. 10).

In addition to administering the assessments and sharing results, IEA states that TIMSS 2007 (n.d.) has done the following:

> Students, teachers, and school principals in each participating country are asked to complete questionnaires concerning the context for learning mathematics and science, so as to provide a resource for interpreting the achievement results and to track changes in instructional practices. (para. 1)

Looking into the teachers' responses in the TIMSS questionnaires, and correlating the students' performance in those areas clarifies the interconnectedness, and will prove to be useful. TIMSS' inclusion of those questions to the teachers shows an importance of the effects of teaching preparedness on learning. In Lebanon's new education reform, the following teaching education goals are stated in the Strategies for Education Section, 5.2 and 5.3: Teaching Methods, and Teacher Preparedness (Al-Haykaliyya, 1995). In September 2000, the National Commission on Mathematics and Science Teaching for the 21st Century released a report in which it emphasized "that good teaching is key to improved study achievement" (The Glenn Commission, 2000).

TIMSS Report 2007

The last TIMSS was administered in 2007 with the participation of 60 countries; the study measured trends and assessed fourth grade and eighth grade student achievement in mathematics and sciences. TIMSS 2007 was designed broadly to include mathematics and science curricula in participating countries. Boston College (n. d.) stated, "TIMSS 2007 collected detailed information about mathematics and science curriculum coverage and implementation, as well as teacher preparation, resource availability, and the use of technology" (para. 1). TIMSS 2007 results and data, along with user guides, are published and accessible online and on compact discs.

Problem Statement

TIMSS 2007 mathematics results show the average Lebanon math score of 449 compared to the United States' score of 508, and the overall average score of 500. More specifically, the average score for Algebra is 465 compared to the United States' 501, with the average being 500. Based on the TIMSS 2007 scores, there is a clear disparity in Algebra performance between eighth grade students in the United States and Lebanon. Table 2 displays the average mathematics and algebra content scores.

Table 2

Average Mathematics and Algebra Content Domain Scores of Eighth Grade

Country	Total Mathematics	Algebra
TIMSS Average	500	500
Highest Score (Chinese Taipei)	598	618
Lebanon	449	465
United States	508	501

Note. Information retrieved from different sources, mostly from TIMSS 2007 publications.

Lebanon has survived a 30-year war, and this war put the country behind in its

educational goals, particularly the implementation of a new math curriculum. New education curriculum reform was developed and published in November 1995, and by the year 2000, it was fully implemented at all grade levels (Osta, 2007). The focus had not been, first and foremost, teacher preparedness. The education reform of 1996 was passed into law, by Decision 22 in the House of Ministers, on October 25, 1995. The new framework spells out teacher preparedness as one of its four goals in the New Strategies for Education in Lebanon section (Al-Haykaliyya, 1995). It calls for improving education environment and putting in place a plan to advance education in technology and modern methods. Since Lebanon lags in mathematics scores in the 2007 TIMSS assessment, the outcome of this research finding is to help create awareness and possibly trigger reform or changes in mathematics teacher preparedness in Lebanon and other countries.

Purpose Statement

The purpose of this study is to determine if there are differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching eighth graders the four Algebra content areas in mathematics identified in the 2007 TIMSS assessment, while controlling for the teachers years of teaching experiences. The research uses TIMSS 2007 mathematics Algebra section and teachers' questionnaire responses regarding how well prepared they feel to teach mathematics content and in particular four content areas in Algebra. There are three major areas of algebraic content on the TIMSS 2007 assessment: patterns, algebraic expressions, and equations-formulas and functions (Mullis et al., 2005) broken down into four specific topics, which further have eight subtopics. Although the TIMSS 2007 report showed that two subtopics were not covered in the Lebanese mathematics curriculum for Grade 8, this study uses

teachers' responses from the entire algebra content areas. Because the Test-Curriculum Matching Analysis, a test conducted to investigate the impact on a country's performance by only including achievement items that were judged to be relevant to the curriculum, results showed that the average percentage of correct answers, after excluding those items, did not differ from the average percentage correct on all TIMSS items (Corinna, personal communication, August 3, 2010; Mullis, Martin, & Foy, 2008). Lebanon identified 236 out of 238 TIMSS items as relevant to the national curriculum.

The four algebraic content areas that teachers' questionnaire addressed specifically are listed as follows:

1. Numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns)
2. Simplifying and evaluating the algebraic expressions
3. Simple linear equations and inequalities, and simultaneous (two variables) equations
4. Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations. (Mathematics Teacher Questionnaire, 2007)

Research Questions

This paper answers the following four research questions:

1. Are there differences in teachers' self-reported preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the United States and Lebanon?
2. Are there differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the United

States and Lebanon?

3. Are there differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) equations between the United States and Lebanon?
4. Are there differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the United States and Lebanon?

Study Design Overview

This study uses SPSS statistical software for analytical methods, using data from TIMSS 2007 International Database that is made public by TIMSS and Progress in International Reading Literacy Study International Study Center, Lynch School of Education. The data was obtained from Boston College, where the TIMSS surveys are compiled. SPSS is commercial software that is used by many health, government, and education researchers.

Multivariate analyses of covariance (MANCOVA) 4 x 2 was performed to determine if there are differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching eighth graders the four Algebra content areas in mathematics. This study controlled teachers' years of teaching experience for the entire sample, keeping the literature review in mind. The median years of experience listed for Lebanon's teachers was 14.1 and for the United States was 13.5 (Foy & Olson, 2009).

The 2007 TIMSS Algebra section had four content areas. Teachers self-reported preparedness in each of those areas were set as the criterion variables; the countries of

Lebanon and the United States were used as the grouping variables; and the years of teaching experience were used as the covariates, at the value of 13.68 years. This average years' experience control was decided for two reasons. First, in examining the data of the characteristics of the teachers in TIMSS 2007 study and comparing the data for teachers from Lebanon and United States, the closest level of experience for both countries was the median that listed Lebanon's teachers as having 14.1 years of experience, and U.S. teachers as having 13.5 years of experience (Foy & Olson, 2009). The mode varied significantly; it was 10 for Lebanon and 14 for the United States. The second reason the mean of 14 years was chosen as the sample is that the literature supports how teachers' abilities vary based on the number of years they have been teaching. Bartell (2005) stated, "Few teachers will become expert in their early years" (p. 28). Berliner (1994) proposed levels of teaching expertise advance in five stages: Novice, Advanced Beginners, Competent, Proficient, and Expert. Therefore, if the average teaching career is about 30 years, following Berliner's model, at midpoint of 13 to 17 years teaching, a teacher is considered competent and falls into the third stage, competent.

This study looks at the scores of eighth graders, as the TIMSS study is administered at the end of the eight years of formal schooling, which is inclusive of compulsory schooling time for Lebanon and the Unites States, and also because independent of the students' age, they are at the same class level and have been exposed to the same number of years of formal schooling. TIMSS 2007 results show that the content assessment for TIMSS 2007 mathematics is included and taught in the curriculum in the Unites States and in Lebanon during middle school.

Educational Leadership: Policies and Implications for Leadership Styles

Leadership in education is affected by a nation's policies in education and how the education system is established and run. For the two countries, the educational policies in place are a set system, and thus, leadership and leadership styles will vary based on those preset protocols. Although the term leadership does not have one definition, Vroom & Jago (2007) state, "One of the problems stems from the fact that the term leadership, despite its popularity, is not a scientific term with a formal, standardized definition" (p. 17). This paper addresses leadership from the angle of situation, relative to the two countries, Lebanon and the United States.

Significance and Relevance of the Study

Given the importance of mathematics, a consensus has emerged that Algebra is the stepping-stone to advanced math and technology majors; it is the gatekeeper of success, and mastering it in eighth grade opens opportunities in high school and impacts future career choices. In his bestselling book, *The World is Flat*, Friedman (2005) devotes an entire chapter to education, titled "The Quiet Crisis," in which he focuses particularly on the gap in producing engineers and scientists in the United States compared to those in China and India. Friedman writes, "The education system in American junior high schools, in particular, seems to be a black hole that is sapping the interest of young people" (p. 351). Friedman draws attention to the importance of middle school mathematics instruction and points out that graduate students entering the science and engineering force in 2004 had decided to take the necessary math courses when they were in middle school. Friedman quotes Ina Mullis, codirector of the International Study Center at Boston College, "As one example, 44 percent of eighth-graders in Singapore scored at the most advanced level in math" (p. 350) and only 7% in the United States did.

This study hopes to bring awareness and highlight the importance of teacher preparedness in mathematics and how it affects student learning outcomes. It explores international mathematics curriculum as intended by the TIMSS 2007, and attempts to provide possible solutions to the low average scores in mathematics. This study also brings light to Algebra performance of students from Lebanon and the United States, and tries to connect similarities and possible reasons for a significant difference in averages for both countries. In addition, because TIMSS also includes questionnaires for teachers and students about teaching strategies and learning outcomes, this study could be valuable to both countries as to how mathematics is taught and learned. Boston College (n. d.) states that TIMSS was designed to measure trends in students learning of mathematics and science:

> …put an emphasis on questions and tasks that offer better insight into the analytical, problem-solving, and inquiry skills and capabilities of students. In addition, students, teachers, and school principals in each participating country are asked to complete questionnaires concerning the context for learning mathematics and science, so as to provide a resource for interpreting the achievement results and to track changes in instructional practices. (para. 1)

Study Limitations

This study had several limitations. First, the sample from Lebanon has questionable validity in presenting students' true abilities in Algebra. The Lebanese community looks at international assessments with little regard and importance if any; this attitude may have masked the real achievement ability of the students in Lebanon (Osta, 2007). Students may have not performed their best, knowing TIMSS assessment is

not a decisive exam for their future placement, as the government exams would have been. A second limitation of the study was the difficulty obtaining official documents regarding curriculum and governance from Lebanon; there was not enough or significant information available online, and communication, even via e-mail, was neither effective nor productive. A third study limitation that may have skewed the data is that the TIMSS 2007 database does not provide averages for each Algebra content area in the mathematics assessment for eighth grade, but rather provides averages for all Algebra content areas. A fourth study limitation was lack of specificity on the term teacher preparation. Wilson, Floden, and Ferrini-Mundy (2001) stated, "The lack of depth of research on teacher preparation poses challenges for a review. With a limited number of studies, we cannot discuss trends" (p. 6).

A final possible study limitation was the teacher sample size. Williams et al. (2009) stated, "The teachers in question do not constitute a representative sample of teachers in a country, but rather are the teachers who taught a representative sample of students" (p. 86).

Definitions

Certain terminology will be used throughout the text. The definitions are as follows.

Algebra. NCTM (2009a) states, "Algebra encompasses the relationships among quantities, the use of symbols, the modeling of phenomena, and the mathematical study of change" (para. 1) The intended and taught TIMSS 2007 Algebra topics encompass the same functions of relationships, use of symbols, modeling, and change, and they are listed as follows:

1. Numeric, algebraic, and geometric patterns or sequences
2. Simplifying and evaluating the algebraic expressions
3. Simple linear equations and inequalities, and simultaneous (two variables) equations
4. Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations.

Curriculum. John Kerr (Kelly, 1983), an educational philosopher, defined curriculum as, "All the learning which is planned and guided by the school, whether it is carried on in groups or individually, inside or outside the school" (p. 10).

IEA. IEA is an organization that started in 1958, and legally established itself in 1967. It is an independent, international cooperative of national research institutions and governmental research agencies. It conducts cross-national studies. The TIMSS is one of its several studies.

NCTM. NCTM was founded in 1920. NCTM is the world's largest mathematics education organization, with more than 90,000 members and 230 affiliates.

Teacher Preparedness. Teacher preparation indicates how well a teacher is prepared to teach the subject matter, how knowledgeable the teacher is of the standards of teaching, and how well versed the teacher is in the standards of the subject matter. Wilson et al. (2001) stated, "There is no single phenomenon, no monolith called 'teacher preparation'" (p. 6).

TIMSS. TIMSS is directed by the TIMSS and Progress in International Reading Literacy Study International Study center at Lynch School of Education at Boston College. They assess trends in international mathematics and science by collecting data in

mathematics and science at the fourth and the eighth grades in participating countries.

Summary and Organization of the Study

Algebra is an important topic to educators, families, and nations. Teacher preparedness is a critical factor in student learning outcomes. This study aimed to explore the relationships among learning outcomes and teacher preparedness in teaching subject matter.

This paper is divided into five chapters. The first chapter introduced the problem of low Algebra scores, in particular for the United States and Lebanon. This chapter provides a background of the education systems in both countries. Additionally, research questions are posed in this chapter along with purpose and significance of the study. Chapter 2 reviews the literature, laying the theoretical groundwork for the research study, and reviewing literature about education systems, mathematics curriculum in Lebanon and the United States, and mathematics and Algebra content in TIMSS 2007 assessment. Chapter 3 explains the methodology used in the study, and discusses the implemented research design, sample selection, data collection, and data analysis procedures. The results and the data of the study are provided in Chapter 4. Chapter 5 discusses the results and research study findings, and discusses implications and suggests further research possibilities.

Chapter 2: Literature Review

Education and improving education is on every nation's national and political agenda. The topic, along with the debate, is on national television, on cable news networks, special reports, blogs, and almost every media outlet. The concern usually focuses on the reasons students do not perform better, and if indeed teacher quality and preparedness is a key factor. There is a stream of research and studies that revolve around definitions of, criteria for, and circumstances in teacher preparedness and how it affects student learning outcome. A strong stand on teacher quality comes from the much debated No Child Left Behind Act of 2001, which is largely funded by the federal government that deals with educational standards nationwide. It has a strong stand on teacher quality. Title II is one of the nine titles of the No Child Left Behind Act, and it spells out and allocates millions of dollars in funding each year for preparing, training, and recruiting high-quality teachers and principals. Even before the No Child Left Behind Act, President William Jefferson Clinton's administration proposed, as a national goal, to have all eighth graders enrolled in advanced math. To accomplish that goal, one priority was to insure a well-prepared teacher in every classroom (United States Department of Education, 1997). A well-prepared teacher in every class and Algebra course for every eighth grader are challenges, especially because most of the research and focus on Algebra has been at the high school level: "We know little about younger students' learning of algebraic ideas and skills" (RAND Mathematics Study Panel, 2003, p. 48).

The National Center for Education Sciences prepared and published a report titled *Comparative Indicators of Education in the United States and Other G-8 Countries, 2009* (Miller et al. 2009). The report used teacher-reported data from the TIMSS 2007. Miller

et al. (2009) report that the percentage of students in the United States whose teachers reported participating in professional development in mathematics content in the previous two years was 81% at the eighth grade level. In the same report, using the same data from the TIMSS 2007, Miller et al. report the percentage of students whose teachers had participated in professional developments in mathematics assessment was 69% at the eighth grade.

Chapter Structure

This chapter will begin with an overview of the TIMSS 2007. The chapter will give some historical background and definitions of Algebra. Then it will present the mathematics content domains, particularly Algebra, in the 2007 TIMSS assessment. In addition, the chapter will detail the education system in the United States of America and in the Republic of Lebanon. It will relay the mathematics curriculum in both countries in addition to the mathematics curriculum in the TIMSS 2007 assessment, implementation of curriculum in both countries, and teacher education and certification. The chapter will also present educational policies and instructional and noninstructional practices. It will continue by expounding on teacher preparedness overall and teacher preparedness in mathematics and Algebra.

TIMSS 2007

TIMSS 2007 was the fourth iteration in the series of international mathematics and science assessments that began in 1995. It involved 50 countries at the eighth grade level (Mullis, Erberber, & Preuschoff, 2008). The TIMSS is one of the undertakings of IEA, an international cooperative of 66 educational research institutes, ranging from universities to ministries of education. IEA conducted educational research and

comparative studies for more than 50 years, and its partners in financing projects include governments of the member countries, private foundations, and other international institutions, including the United States National Center for Educational Statistics, the World Bank, the Inter-American Development Bank, the United Nations Development Program for Arab Countries, and the European Commission (IEA, 2011a).

In addition to being a tool for international assessment, TIMSS 2007 benefits different areas of international comparison research in education, including mathematics curriculum, teaching practices, and learning outcomes among nations. Mullis, Erberber, amd Preuschoff (2008) wrote:

> TIMSS provides comparative information about mathematics and science achievement at the fourth and eighth grades across countries in relation to the various curriculum and instructional approaches used. This enables policy makers and educators to focus on the quality of educational achievement, to monitor curricular implementation and effectiveness, and identify promising instructional practices. (p. 3)

Based on the information provided by TIMSS 2007 about mathematics curriculum in each country, it appears that both countries, Lebanon and the United States, had similar formatting available for the eighth grade: (a) Official publication containing the curriculum, (b) Ministry notes and directives, (c) Mandated or recommended textbooks, (d) Instructional or pedagogical guide, and (e) Specifically developed or recommended instructional activities (Mullis, Erberber, & Preuschoff, 2008).

The goal of the TIMSS is that to help countries make informed decisions about improving teaching and learning in mathematics and science (Mullis, Erberber, &

Preuschoff, 2008). For instance, TIMSS 2007 collected detailed information about mathematics and science curricula coverage and implementation, as well as teacher preparation, resource availability, and the use of technology (Boston College, n. d.).

TIMSS presents six values for participant countries; one value is that countries can, "understand the contexts in which students learn best. TIMSS enables international comparisons among the key policy variables in curriculum, instruction, and resources that result in higher levels of student achievement" (Mullis et al., 2005, p. 10).

The TIMSS reports and findings have been used by multiple countries as a basis for making educational changes. As a result of the TIMSS assessment, Macnab (2000) listed the following countries made mathematics curricular changes and teaching methodology changes:

> England, Cyprus, Denmark, France, Japan, Norway, Scotland, and Sweden all indicated a variety of changes in curricular emphasis, while England, Denmark, France, Japan, and Scotland also indicated changes to teaching methodology, mainly in the direction of increasing active pupil participation in the learning process. (para. 16)

In Canada, two provinces revised their mathematics curricula as a result of the TIMSS survey (Macnab, 2000).

The TIMSS reports are used extensively by the United States Department of Education's Institute of Education Sciences and the National Center for Education Statistics. In the Special Supplement to the Condition of Education 2009, U.S. student academic performance was compared to other nations using the 2007 TIMSS results for mathematics (Provasnik, Gonzales, & Miller, 2009).

Lebanon has not produced its special report to the TIMSS, but Lebanon's accomplishments and efforts are mentioned in several literature sources. In an evaluation report of the quality assessment of TIMSS for several Arab countries, Aggarwala (2004) reports that TIMSS has helped Lebanon to organize surveys, and that the test format would possibly influence the national exam formats, but revising the curriculum, though discussed, requires a review by regional commissions. In a book about education and market initiatives in four Arab countries, a chapter discusses Lebanon's human capital challenges, stating that Lebanon had made progress in raising student enrollment in the elementary and secondary sections and had been able to narrow the gender gap, but that the results of international assessments are not sufficient for the students to compete globally (Gonzalez et al., 2008).

Algebra: History and Definitions

The history of Algebra goes back to ninth century scientist, Muhammad ibn Musa al-Khwarizmi, who wrote several books explaining Hindu arithmetic and provided a systematic introduction to Algebra (Mathematics, 2010). Algebra (Algebra, Encyclopedia Britannica, n.d.) can be described in a variety of ways, but it is better known as a branch of mathematics,

> … which arithmetical operations and formal manipulations are applied to abstract symbols rather than specific numbers. The notion that there exists such a distinct sub-discipline of mathematics, as well as the term algebra to denote it, resulted from a slow historical development. (p. 1)

The NCTM defines Algebra as, "Algebra encompasses the relationships among quantities, the use of symbols, the modeling of phenomena, and the mathematical study

of change" (NCTM, 2009a, para. 1).

Algebra is known to be the stepping stone for higher mathematics understanding and thinking. Cavanaugh (2009) wrote that many policy makers and educators had argued that enrolling students in Algebra early on increased their chances of moving on to more advanced math and consequently succeeding in college. Cole (2006) speaks of the accomplishments of Robert Moses, the founder of the Algebra Project, and how important he finds it for students overall success and advancement, "Algebra, Moses perceived, was a 'gatekeeper' subject: Without it, middle school students couldn't advance in math, technology, and science. And without those courses, they wouldn't be able to meet the requirements for college" (para. 3). The State of California has in its mathematics content standards a goal to teach Algebra in eighth grade (California Department of Education, 2010). Moses and Cobb (2001) bring on a new dimension to Algebra as being "the new civil right" (p. 13), arguing that not only is Algebra the gatekeeper for higher mathematics, but it is the "gatekeeper for citizenship" (p. 14) because without it, students could not advance in the information age, and they would be disadvantaged and similar to those who could not read and write in the industrial age. Robert Moses, who is known for his enduring pursuit for civil rights during the 1960s, in the 1970s was concerned about the mathematical skills of students, especially in the public schools where he tutored. This triggered him to start the Delta Algebra Project, a math-science program for inner-city and minority school children located in Cambridge, Massachusetts. Moses is unrelenting of his belief of the importance of Algebra. In *Radical Equation*, (Moses & Cobb, 2001), Moses reflects on the public's acceptance of failure in mathematics but not in language and writing, and he faults math instruction, "In

effect, math instruction weeds out people and you wind up with what amounts to a priesthood, masters of the arcane secrets of math through what appears to be some God given talent or magic" (p. 10).

Loveless (2008), in the insightful Brown Center Special Report on American Education titled *The Misplaced Math Students: Lost in Eighth Grade Algebra,* mentions then U.S. Secretary of Education, Richard Riley, giving advice to middle school students planning to get into college, "Take Algebra beginning in the eighth grade and build from there" (p. 2). Loveless agrees that waiting until ninth grade to take Algebra would make it harder to take calculus in high school. Although controversial at times, Loveless, speaking before the Secretary of Education's Mathematics summit questioned mathematics standards and curriculum and what teachers are expected to teach in lower grades. His strong belief is "excellence in mathematics should be our highest national priority if we are to fulfill the true promise of America for all of our children" (Loveless, 2003, p. 31).

Table 3 demonstrates the averages for both Lebanon and the United States on the TIMSS 2007 mathematics performance.

Table 3

Average Mathematics and Algebra Content Domain Scores of Eighth Grade

Country	Total Mathematics	Algebra
TIMSS Average	500	500
Highest Score (Chinese Taipei)	598	618
Lebanon	449	465
United States	508	501

Note. Information compiled using TIMSS 2007 *International Math Report*, (Mullis, Erberber, & Preuschoff, 2008).

The Education System of the United States of America and of Lebanon

Most developed countries have a national education system; some are centralized some are decentralized. The United States has a decentralized education system in which states have educational governance and make educational policies (Jeynes, 2007), while the Republic of Lebanon has a centralized system in which the Ministry of Higher Education makes the educational policies (Mullis, Martin, Olson, et al., 2008).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) argues that improving education worldwide is key to social and economic development. UNESCO's Education for All has six internationally agreed upon educational goals, which members plan to meet by 2015. Goal six of Education for All is, "Improving all aspects of the quality of education and ensuring excellence of all so that recognized and measurable learning outcomes are achieved by all, especially in literacy, numeracy and essential life skills" (UNESCO, n. d.). Lebanon has been a member of UNESCO since 1946. With an active office in Beirut, Lebanon's capital, UNESCO's link to Lebanon's education page produces a page marked under construction, and there are no current publications that relay information or the status of education in Lebanon.

The education system in Lebanon. The Republic of Lebanon has a centralized educational system, and the Lebanese curriculum is used in all schools in Lebanon, including private, public, and foreign (Mathews & Akrawi, 1949; Mullis, Martin, Olson, et al., 2008). The country's education history dates to 1535 Ottoman rule, which shaped the secondary curricula added to the national curriculum by private schools until around 1968. In 1968, the educational system was revised (Harik, AbuRafiq, & Bashshur, 1999) but this curriculum was greatly criticized; therefore, a reform started until the civil war of

1976 delayed it. Finally, the reform was passed into law on October 25, 1994 (Harik et al., 1999; Inati, 1999; Nahas, 2009). In 1995, a new reformed curriculum was introduced by the Ministry of Education and Higher Education and was approved by the House of Ministers on October 25, 1995.

In Lebanon, the education system (see Table 4) is composed of the following: primary, basic, secondary, and university education. The preuniversity is divided into three sections: kindergarten, basic education, and secondary education (Mullis, Martin, Olson, et al., 2008). However, in Lebanon, those three sections are more known as four cycles. Kindergarten is for children ages 5 to 6. Basic education has two levels: Elementary level, which is composed of two cycles: cycle one is Grades 1 to 3 and cycle two is for Grades 4 to 6; and the intermediate level, also referred to as cycle three, is Grades 7 to 9. Secondary education is for grades 10 to 12, and is known as cycle four (Al-Haykaliyya, 1995; Mullis, Martin, Olson, et al., 2008). The education system could be classified like a three-tiered program: 6 years of elementary school, 3 years of middle school that ends in ninth grade with a mini diploma, and then three years of high school. By law, the elementary and intermediate levels are considered compulsory education, and are provided free to all students. However, mandating compulsory education is not fully enforced (Osta, 2007). There is a variance in the information about the age of compulsory education, where the TIMSS states it is until the sixth grade; however, the new curriculum reforms hope to push it until the eighth grade or age 15 (Inati, 1999). All Lebanese schools are required to follow a set curricula designed by the Ministry of Education. Private schools, approximately 1,400 in all, follow the same curricula, but may also add more courses to their curricula with approval from the Ministry of

Education. The public schools are financed by the Ministry and the private schools by student tuition fees. After primary education, English or French become the mandatory language of instruction for mathematics and science for all schools (World Bank, 2006).

Table 4

Comparative Table of Education Systems in the United States and Lebanon

Lebanon				United States		
Grade	Grade Level	Age	School Years	Age	Grade Level	Grade
HS 2nd Diploma		18				
HS 1st Diploma/ Cycle4	12	17	12	17	12	Senior High/Senior
HS Year2/Cycle 4	11	16	11	16	11	Senior High/Junior
HS Year1/Cycle4	10	15	10	15	10	Senior High/ Sophomore
Intermediate 3/Cycle 3	9	14	9	14	9	Senior High/ Freshmen
Intermediate 2/Cycle 3	8	13	8	13	8	Junior High
Intermediate 1/Cycle 3	7	12	7	12	7	Junior High
Elementary Cycle 2	6	11	6	11	6	Elementary
Elementary Cycle 2	5	10	5	10	5	Elementary
Elementary Cycle 2	4	9	4	9	4	Elementary
Elementary Cycle 1	3	8	3	8	3	Elementary/ Primary
Elementary Cycle 1	2	7	2	7	2	Elementary/ Primary
Elementary Cycle 1	1	6	1	6	1	Elementary/ Primary
Pre-K to Kindergarten		3-5		3-5		Pre-K to Kindergarten

Note. Schooling years denote the number of years students in both countries received formal schooling before they took the TIMSS 2007 assessment. Students in both countries received 8 years of formal schooling at the time of the test.

The TIMSS 2007 Encyclopedia states that Lebanon has a national mathematics curriculum that was implemented in 1998; it is under revision however (Mullis, Martin,

Olson, et al., 2008) but there have been no modifications or reviews made to the mathematics and science curriculum since 2003, when Lebanon joined the TIMSS (Skaf & Habib, 2008).

"In Lebanon, even though various assessment tools may be used in the classrooms, the major and dominant tool for decision making on students' promotion from one cycle to another, or for graduation from school, is the national examinations" (Osta, 2007, p. 172), and the official exams are crucial and decisive with authoritative influence. They are used for placement as well as to evaluate teachers and schools. Attention and major importance is given to the national exam. Although in the past few years, because of educational reform efforts, Lebanon has begun participating in international assessments (Gonzalez et al., 2008).

Algebra content in Lebanon. At the Intermediate level, eighth grade, Mullis, Martin, Olson, et al. (2008) lists the following arithmetic and algebra mathematics contents of basic education:

- Numbers: natural integers, fractions, decimals, square roots
- Operations: Powers of positive number having a positive integer exponent, powers of a negative integer exponent of 10
- Proportionality: Inverse proportionalities
- Algebraic Expressions: Remarkable identities, literal expressions with fractional forms
- Equations and Inequalities: Equations and inequalities of the first degree with one unknown, equations of the following types: $(ax + b)(cx + d)= 0$. (p. 358)

The education system in the United States. The United States education system

is one of the most recognized decentralized education systems in the world (Jeynes, 2007). As a decentralized system, the education in the United States varies between states because states, regions, and local districts oversee the operation of the schools and are responsible for student learning outcomes (Miller et al. 2009). The following is a general breakdown of the education system in most states: Preprimary school, also known as nursery school, prekindergarten, and kindergarten, are attended as early as ages 3 to 5 where the students spend 1 to 3 years; Primary grades, also known as elementary school or grade school, are attended by students ages 6 to 11, with a duration of 6 years; lower secondary school, known as middle school or junior high school, is attended by students ages 12 to 14; and lasts 3 years, upper secondary, known as high school or senior high school, is attended by students ages 14 to 18. The average ending age of compulsory education is 17, and this varies from state to state.

Even though the United States does not have a national mathematics curriculum, because policies vary from state to state (Mullis, Martin, Olson, et al. 2008), there are National Mathematics Principles and Standards for grades K-12, written by the NCTM, as a guidebook for educators and administrators and policy makers.

NCTM was founded in 1920. It is the world's largest mathematics education organization, and its 2009 revised mission statement is "a public voice of mathematics education supporting teachers to ensure equitable mathematics learning of the highest quality for all students through vision, leadership, professional development and research" (NCTM, 2009a, para. 2). NCTM is "dedicated to improving mathematics teaching and learning, kindergarten through high school, and facilitates ongoing dialogue and constructive discussion with all stakeholders about what is best for our students"

(Foy & Olson, 2009, p. 1).

TIMSS 2007 showed continued and significant improvement in mathematics for the United States' results. The 2007 average score of 508 for eighth grade students is 16 points higher than 1995 average of 492 (Gonzales et al., 2009). This improvement could well be the result of the focus on mathematics brought on by many mathematics advocates, especially with the strong support of the NCTM.

Algebra content in the United States of America. The following Algebra content is covered in most mathematics curricula taught through eighth grade (Mullis, Martin, Olson, et al., 2008):

- Numeric, algebraic, geometric patterns
- Sums, products, powers of expressions containing variables
- Evaluating expressions for a given numeric value
- Simplifying or comparing algebraic expressions
- Modeling situations using expressions
- Simple linear equations and simultaneous (two-variable) equations
- Equivalent representations of functions as ordered pairs, tables, graphs, words, equations. (p. 626)

Algebra content in the TIMSS 2007. Mullis et al. (2005) summarizes the TIMSS 2007 Algebra content as:

> The algebra content domain includes recognizing and extending patterns, using algebraic symbols to represent mathematical situations, and developing fluency in producing equivalent expressions and solving linear equations. The major topic areas in algebra are: Patterns, Algebraic expressions, and equations/formulas and

functions. (p. 26)

In the teachers' questionnaire, the Algebra content is detailed as follows:

1. Numeric, algebraic, and geometric patterns or sequences
2. Simplifying and evaluating the algebraic expressions
3. Simple linear equations and inequalities, and simultaneous (two variables) equations
4. Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations. (Mathematics Teacher Questionnaire, 2007, p. 4)

Educational Leadership and Policies

It is known that leadership in education happens at all levels: Class and departmental level, school and district level, and state level and country level. Contributing to the everyday workings of a school is an intricate process that involves parents, educators, administration, and policy makers, but most times, it is a trickle-down effect of policies that make up general leadership approaches. Even independently run schools follow certain education codes in their states or countries (NCTM, 2000.) "By association, educational leaders learn to lead indirectly through years of participation in their countries educational system(s)" (Kirkland, n.d., para. 5). Therefore, this paper also takes a quick look at the educational policies of the two countries and how they shape the school curriculum and leadership approaches. "Leadership depends on the situation. Few social scientists would dispute the validity of this statement" (Vroom & Jago, 2007, p. 17), this notion is repeated in literature; Goleman (2000) stated, "New research suggests that the most effective executives use a collection of distinct leadership styles—each in the right measure, at just the right time" (p. 37). This gift of using several leadership

styles is also in line and validated by Bennis (1994), who states that to be an effective leader one needs to utilize different skills and use several approaches.

Educational leadership and policies—Lebanon. In Lebanon, with its centralized education system, the responsibility falls on the Minister of Education and Higher Education. All the schools are obligated to follow the national uniform curriculum set by the Ministry of Education and Higher Education (Ghamrawi, 2010; Haddad, 2004), which regulates through its regional educational offices (Skaf & Habib, 2008). This is well-known and possibly the mostly documented fact about education in Lebanon, but other than this information, other information such as procedural information pertaining to decision making and leadership, responsibilities, and hierarchy, is not readily available. Similar difficulty is experienced by other researchers. The United Nations Development Program's report, *A Profile of Sustainable Human Development in Lebanon*, states that a major impediment in writing the report was, "The paucity of data and low reliability of statistical and other information, sometimes anecdotal" (United Nations Human Development Program, 1997, p. *forward*).

The centralization of school systems diminishes the powers of school principals, especially at public schools, as the principals have limited control over budgets, teacher training, staffing, and other areas (Bahous & Nabhani, 2008). This setup imposes the educational leaders to practice situational leadership approaches. Northouse (2007) states that from the perspective leading differently in different situations, "To be an effective leader requires that a person adapt his or her style to the demands of different situations" (p. 91). Overall, Lebanon's education system lacks strategic planning and vision (El-Hassan, 2010). A reform effort in 1993 to decentralize decision making introduced in the

Ministry of Education was never approved. Other attempts have been made in education reform; however, most of them are either ill-planned or never implemented. They have fallen short of launching or completion, which has hindered progress of students and affected efficiency of the education system and lowered teacher quality expectations (El-Hassan, 2010). Osta (2007) attributes the delay in the reform efforts and implementation on the many years of war. Many of the tasks such as revising the curriculum and providing training for teachers, are carried out in a centralized manner by the Educational Center for Research and Development, also known as the National Center for Educational Research and Development, an organization that carries out essential duties for the Ministry of Education and Higher Education (Skaf & Habib, 2008). The Center for Research and Development (CRDP), a government agency with its own budget and administration, works independently but in partnership with the Ministry of Higher Education. It was instituted in 1971, by a government decree number 2356 (Center for Educational Research, n. d.). The CRDP supervises and facilitates the TIMSS assessment. The processes involved in drafting and modifying curricula, as well as providing teacher training, are mainly financed by nongovernment funds or international institutions such as the United Nations Development Programme or the World Bank (Mullis, Matin, Olson, et al., 2008).

Educational leadership and policies—the United States. In the United States of America, the Department of Education is the federal agency that is in charge of establishing policies related to federal education funding and assistance to the states; Its mission is to "Promote student achievement and preparation for global competitiveness by fostering educational excellence and ensuring equal access" (Boston College, n.d.).

The Department of Education also collects research and data about education, students, and schools. It is led by the secretary of education, who directs the department's operations and advises the President of the United States on educational policies.

Although the United States has a decentralized education system, school mathematics has a centralized professional organization in NCTM. NCTM membership includes more than 250,000 teachers, school administrators, and other educational professionals who put forth principles and standards for teaching, learning, and assessing school mathematics. NCTM policies, as well as its publications, are used as a guide for all those who make decisions in mathematics education: Developers of instructional materials, curriculum directors, schools, states, and policymakers alike (NCTM, 2000).

Another influential government entity in United States education is the National Center for Education Statistics, located within the United States Department of Education and its Institute of Educational Sciences. It is the official federal unit that collects and analyzes educational data in the United States and in other nations. The National Center for Education Statistics is the largest administrative body that facilitates the TIMSS in the United States. The National Science Foundation (NSF), a United States independent government agency, has also participated in facilitation of TIMSS assessment in the United States such as the 1999 TIMSS benchmarking assessments.

In the United States, since the education system is decentralized, educational leaders can use a different leadership approach. There are a number of leadership styles, and as mentioned before, at times more than one type of leadership needs to be exercised to get results. In education, the two approaches that have dominated are instructional leadership and transformational leadership. "The past 25 years have witnessed the

emergence of new conceptual models in the field of educational leadership. Two of the foremost models, as measured by the number of empirical studies, are instructional leadership and transformational leadership" (Hallinger, 2003, p. 329). As per Northouse (2007), transformational leadership was first coined by Downton in 1972, and then in 1978, his work was expanded by James Mc. Greggor Burns with in a book titled *Leadership*. The key characteristics of transformational leadership are that it focuses on the needs of the followers, and it creates a connection that raises the level of motivation and morality among leaders and followers.

Situational leadership is another approach practiced by many educational leaders, especially when leaders recognize the needs and maturity level of their employees and are flexible to change their leading styles based on those needs. The leaders can then be either supportive or directive. "The essence of situational leadership demands that a leader match his or her style to the competence and commitment of the subordinates" (Northouse, 2007, p. 92). The situational leadership approach was developed by Paul Hersey and Ken Blanchard in 1969 and then refined by them in 1985 (Northouse, 2007).

Educational Practices in Lebanon and the United States: Instructional and Noninstructional

Countries differ in their approach to administration, establishment, and implementation of educational policies, based on the infrastructure of their educational system and educational leaders. There are many factors that affect student learning: Students' socioeconomic backgrounds, parents' educational level, technology use at home and in the classroom, implementation of curriculum at school, teacher certification, teacher preparedness, teaching practices, textbook usage, class size, and others. Those

aspects are touched upon in the following pages.

Implementation. The 2007 TIMSS assessment provides information on the implementation of the mathematics curriculum in each country. Table 5 displays the methods of implementation in Lebanon and in the United States.

Table 5

Table of Methods Used to Evaluate the Implementation of the Mathematics Curriculum

	Lebanon	United States
Visits by inspectors	Yes	No
Research programs	Yes	Yes
School self-evaluation	Yes	Yes
National or regional assessment	Yes	Yes

Note. Information compiled using Exhibit 12, of TIMSS 2007 Encyclopedia (Mullis, Martin, Olson, et al., 2008, p. 41).

Teacher certification. Each country has different requirements in order for individuals to become mathematics teachers. Table 6 shows that both countries require that teachers pass a certification exam. This requirement is critical, as many educational leaders agree that certification is a major contributor to student success. For example, Darling-Hammond (2010) states, referring to her study in the article "Teacher Education and the American Future," "This study, like a recent Louisiana Board of Regents (2008) study, found that certification is a significant predictor of student achievement" (p. 39).

Table 6

Table of Current Requirements for Being a Middle or Lower Secondary Grade Teacher in Mathematics in Lebanon and the United States as Per Data Provided to the TIMSS by National Research Coordinators

	Lebanon	United States
Degree from education program	No	Yes

(*table continues*)

	Lebanon	United States
Prepracticum during teacher education program	No	Yes
Supervised practicum in the field	No	Yes
Passing certification exam	Yes	Yes
Completion of probationary period	Yes	Yes
Completion of a mentoring or induction program	No	No

Note. Information compiled using Exhibit 14, of TIMSS 2007 Encyclopedia (Mullis, Martin, Olson, et al., p. 43).

Even though there are different prerequisites for teaching in the two countries, and although certification is required in both countries, teachers in either country did not experience a mentoring or induction program. This may influence student learning. Bartell (2005), who was a contributor to writing the California Teaching Standards, is a strong believer of induction programs. Bartell, in her book *Cultivating High-Quality Teaching through Induction and Mentoring*, says, "A well-planned induction period allows new teachers to have the same opportunity as many other professionals have to experience a phased introduction to the responsibilities of the profession" (p. 23). Because this study includes teachers with median years of teaching experience, it is not certain if an induction program would have resulted in a significant change.

Teaching practices. Teaching practices vary between two parallel classes at the same school. It is not surprising to find differences between countries. Wenglinsky (2002), applying multilevel modeling to the 1996 National Assessment of Educational Progress (NAEP), provides data on 7,146 eighth graders who took the 1996 mathematics assessment, and found that classroom practices, when added to those of other teacher characteristics, can contribute as much to student learning as the students themselves and their background influences. Wenglinsky found that qualitative research implies that

classroom practices can produce qualitative improvements in students' academic performance, regardless of other circumstances. NCTM devoted part of its book *Principles and Standards for School Mathematics* to describe six principles for school mathematics, of which one principle is "effective teaching" (NCTM, 2000, p. 11). This emphasizes the great value that teaching holds. NCTM has generated attention to mathematics and the teaching of it and provided guidelines and recommendations. However, the real heavyweight in accountability is the No Child Left Behind Act of 2001. Unlike the NCTM, which serves more as an advisory entity, the No Child Left Behind Act of 2001(NCLB) serves as a regulatory law that enforces educational policies and increased accountability. As one its four pillars, Proven Education Methods dictates federal funding to be spent toward programs and teaching methods that have proved to increase student learning and achievement. "In reading, for example, *No Child Left Behind* supports scientifically based instruction programs in the early grades under the Reading First program and in preschool under the Early Reading First program" ("Overview," 2004, para. 4).

In Lebanon, the Lebanese educational reform and the new educational framework of 1995 called for new strategies in four areas: Content, teaching practices, teacher and administration preparation, and assessment methods (Al-Haykaliyya, 1995). The reform addresses teaching practices that guide them to use modern practices and hands-on activities in classrooms.

Teacher preparedness. It is often discussed and almost universally agreed that teacher preparedness is a key factor for student achievement arguably more than any other factor. Wenglinksy (2002) found that the effects of classroom practices along with

teachers' characteristics were equivalent to the effect of students' backgrounds, and that teacher contribution to student learning amounts to students learning by themselves. Many districts offer teachers a pay increase or rewards based on student learning outcomes. Parents, schools, and policy makers often address this issue in public, based on research and recent practices. It is often an agenda that resonates with many people. Research is continuous in the matter. Most universities have programs that prepare future teachers. Bartell (2005) declares that teachers enter the teaching profession through a range and multiple types of preparation programs. For example, not all teachers enter the profession via traditional approach; instead, a growing number of teachers enter the profession through what is known as 'alternate route' such as evening or weekend programs. Those alternate routes offer certification for those who demonstrate experience or knowledge where in the traditional programs future teacher learn "traditional student teaching experience under the guidance of an experienced teacher" (Bartell, 2005, p. 7). Bartell (2005) is concerned that "increasingly, numbers of teachers are entering the profession without even this basic preparation" (p. 6). *Education Week* published an article titled "Producing Well Prepared Teachers," which mentions a new book by the National Academy of Education (NAE) Committee on Teacher Education, *A Good Teacher in Every Classroom*. The article states that the book outlines current research on effective teaching. Darling-Hammond and Baratz-Snowden (2005) discuss teacher preparation for the changing world to be viewed in terms of "Teacher as a profession" (p. 6), pointing out three necessary areas of teacher knowledge: (a) Teachers need to know how students learn and develop and how they acquire and use language; (b) Teachers must understand their subject matter and the purposes of curriculum; and (c) They should

know and understand teaching.

In a 2009 report by the National Council on Teacher Quality regarding teacher education programs in New Mexico, authors Greenberg, Jacobs, and National Council on Teacher Quality (2009) admit that in general and nationally, teacher preparation programs are not known for having a positive reputation. Their study reinforced this finding. Specifically, when looking at the standards for preparing mathematics teachers in those programs, the authors found that in a sample of 77 national institutions of teacher preparation, only 13% were doing an adequate job. This finding was the result of their second national study of teacher preparation in a representative sample. Greenberg, et al. (2009) believe in providing a "purposeful and systematic preparation" (p. 1).

In the United States, to monitor better teacher preparation in university programs, Title II of the Higher Education Act was established along with Teacher Quality for Elementary and Secondary Schools. The purpose of the program was to increase student achievement by improving teacher quality. Title II requires teacher preparation programs produce three annual reports on the quality of teacher preparation (Department of Education, 2008).

Teacher preparedness in Algebra. It is often the case that middle grade teachers have not been prepared to teach middle grade mathematics, but rather elementary grade mathematics. This notion is confirmed by the NCTM and by the Conference Board of the Mathematical Sciences. The NCTM Standards (2000), for sixth to eighth grade mathematics affirms that special attention should be given to the preparation of teachers in the middle grades, as well as ongoing professional development. NCTM maintains that many middle school mathematic teachers hold elementary school generalist certification

that involves little specific mathematics preparation. It further testifies that special teacher-preparation programs must be developed to ensure successful teaching of the middle school mathematics content. Along the same lines, the Conference Board of the Mathematical Sciences (CBMS), in its 2001 report, *The Mathematical Education of Teachers*, presents recommendations to the teaching of middle school mathematics. In the report, the Conference Board of the Mathematical Sciences asserts that teaching middle grade mathematics requires preparation comparable to preparation for high school mathematics and that most current teachers have elementary mathematics teaching preparation. In fact, some published books about preparation of mathematics teachers in middle school leave out the topic of Algebra entirely; such is the argument advanced by the book *Providing a Foundation for Teaching Mathematics in the Middle Grades,* which states that few middle grade teachers know mathematics content well, "These teachers have experienced only traditional classroom teaching, from either side of the desk, and have had little opportunity to explore the mathematics appropriate for middle-grade learners in any depth" (Sowder & Schappelle, 1995, p. 2). Stiff (2000) shared his concerns that the issue was teacher quality; he stated that although many states require teachers to demonstrate proficiency in mathematics, many times those requirements are waived because of shortages in mathematics teachers.

The message is that too few teacher-preparation programs offer middle grades teachers targeted programs that completely cover mathematics curriculum content. Greenberg, et al. (2009) found that preparation of teachers for seventh and eighth grade mathematics in New Mexico's teacher preparation programs were seriously deficient, and "Algebra preparation is universally inadequate" (p. 8).

The Algebra I Success Initiative is for all California eighth grade students. It is a comprehensive plan to help schools prepare all eighth grade students for success in Algebra I. This came in reaction to the new policy by the California Department of Education, which mandates that all eighth graders be enrolled in Algebra I class by 2011. One challenge is that many math teachers water down the curriculum because they are not ready. The Algebra I Success Initiative along with programs for student support and staff development calls for recruiting and training effective teachers. The Algebra I Success Initiative calls for several actions. One call is for the California State Universities and University of California systems to "accelerate mathematics teacher training programs for teacher training programs that will enable kindergarten through grade twelve schools to recruit and retain highly qualified math teachers" (California Department of Education, 2010, para. 32).

In an effort to bring the different sides to a middle ground, Schoenfeld (2004) reintroduced and sheds light on Phil Daro's 2003 manuscript preposition titled *Math Wars Peace Treaty.* Schoenfeld summed a few poignant points such as "Teachers, especially K-8 teachers, should learn more mathematics throughout their careers" (p. 282) and "No students should be denied a fair chance to learn mathematics because they have been assigned unqualified mathematics teachers" (p. 282). Darling-Hammond (2007), advocating the United States to invest in mathematics and science teachers, advises the nation to develop a national policy to:

1. "Raise the quality of teacher preparation in mathematics and science
2. Enhance the supply of well-qualified science and math teachers

3. To build a program build successful models like North Carolina Teaching Fellows Program." (p. 1)

Darling-Hammond (2007) urges that the government increase its support of teacher preparation programs, as teachers need to be involved in practice.

Furner and Robison (2004) looked at how research from the 2003 TIMSS assessment could help prepare mathematics teachers for success in teaching mathematics. They used findings from the TIMSS and gave 10 recommendations for teacher education to prepare better future teachers to teach mathematics in a more effective way. For recommendation two, Furner and Robison proposed that teacher preparation institutions focus more in the areas of teaching algebra and geometry, and for teachers "to be trained to provide more challenging, less repetitive topics in more depth, especially in the areas of algebra and geometry, where geometric patterns lead to interesting algebraic patterns" (para. 10). This recommendation is in line with the complex math wars debate over the best way to teach mathematics: Knowing how to teach well or knowing the content of the mathematics discipline well. The complicated topic is somewhat simplified by Cuoco (2003), stating two issues that are at the heart of the argument: First, that in the United States, mathematicians and mathematics teachers live in different worlds with different cultures and different languages while talking about mathematics, and second, that at most universities, where teacher preparation programs are, mathematics educators are education scholars but are not part of the mathematics discipline department.

In general, most literature agrees that, though there are many facets to teaching and learning, effective teacher preparation and professional development play an integral part in mathematics proficiency (Kirkpatrick, Swafford, & Findell, 2001).

Noninstructional Aspects

There are many aspects of student performance that are noninstructional. There have been many studies on the cause and effects of such elements, and more research is being studied. Some of those factored were observed for this study and were found to be fairly comparable in both countries.

Age of students. The policy on entry age for primary schools in Lebanon is age 6, and most of the United States is age 6 although it varies between states. The average age of the students who took the TIMSS in 2007 in Lebanon was 14.4, and in the United States 14.3, and the minimum required age of students of all participating countries ranged between 13.8 and 14.2, depending on what month the school year began (Mullis et al., 2005).

Gender issues. Statistics from the United Nations show overall equal opportunities in education among males and females, as the ratio is approximately 50:50, where females outperform males in the mathematics and sciences (United Nations Human Development Program, 1997). This fact is also true with the TIMSS 2007 results, for which, on average, at the eighth grade level across the participating countries, females had higher scores than males; however, with the exception of Lebanon and the United States, the boys scored on average more than the girls. The girls represented a higher percentage of student population than boys in Lebanon and the United States, but their scores averaged lower than the boys (Foy & Olson, 2009); although, the gender achievement gap in the United States is statistically insignificant, in Lebanon the gender achievement gap is significant. The numbers are represented in Table 7.

Table 7

Table of Gender and Achievement by Gender in Lebanon and the United States in TIMSS 2007 Mathematics Total

	Girls	Average Score	Boys	Average Score
Lebanon	54%	443	46%	456
United States	51%	507	49%	510
International	50%	453	50%	448

Note. Information compiled using TIMSS 2007 International User Guide (Foy & Olson, 2009, pp. 57–59).

Class size. Class size is known to be a factor in teaching and learning. Although the general belief is that a smaller classroom is better, research has shown conflicting reports on the effectiveness of reducing class size, and the question still remains whether reducing a class size helps raise student achievement (Reichardt, 2001). Reichardt listed costs and consequences to reducing class sizes. If indeed the optimum class size were to be 15 students as Glass and Smith (1979) proposed, Reichardt (2001) states that a consequence of having smaller classes may well result in hiring a larger number of less qualified teachers.

The TIMSS 2007 International Mathematics Report states that the average class size was the following: The total average was at 29 students, Lebanon's class size was at 26 students and the United States was listed with 24 students (Mullis, Martin, Foy, et al., 2008).

Textbook use. The TIMSS 2007 International Mathematics Report found that in most participating countries, the textbook was used as the primary instructional tool in eighth grade, stating, "60 percent at eighth grade had teachers who reported using a textbook as the primary basis of their lessons" (Mullis, Martin, Foy, et al., 2008, p. 288).

There are hundreds of textbook publishers in the world. In the United States, textbooks adoption varies between states; some states leave it up to the local districts to choose, other states are known as textbook adoption states. Currently there are 20 textbook adoption states (Zinth, 2005). However most publishers designed their books to meet California, New York, and Texas school standards (Schoenfeld, 2004). The case is different in Lebanon where there are fewer options. For example, there are only two types of eighth grade mathematics textbooks for English-language instructed classes. One version is used by the public school students and the other by the English-language private school students.

Global and Economic Implications

Mathematics in school have become the building blocks of today's technologically infused economy. All the in-demand jobs are in information technology, or are jobs that require strong emphasis in technological skills. "As workplaces evolve, the mathematical ideas that students need on the job will change, and people must be prepared to learn, analyze, and use mathematical ideas they have never encountered in school or used before" (RAND Mathematics Study Panel, 2003, p. 3).

Moses and Cobb (2001) talk about a new technological shift that requires mathematics literacy, in which they indicate that in the 1960s there were barriers of entry to politics that were reserved for the elite and the white; now similar barriers to entry exist but take the form of economic access. The authors refer to Algebra as a civil right that everyone should have access to, and have it early on, because students in engineering, sciences, and computer specialties need advanced math courses early, "Math literacy and economic access are how we are going to give hope to the young generation"

(p. 12). By mathematics Moses and Cobb refer to knowing and understanding Algebra, because they argue that content of Algebra, symbols and representations, control the tools of technology, and, therefore, Algebra is the new barrier to entry to the business world and in a sense not knowing Algebra deprives individuals from economic access.

In his bestselling book, *The World Is Flat*, Friedman (2005) devotes an entire chapter to education titled "The Quiet Crisis." Friedman draws attention to the importance of middle school mathematics instruction and points out that graduate students entering the science and engineering force in 2004 had decided to take the necessary math courses when they were in middle school. The book focuses on the real problem of the United States, stating that it is not Islam or terrorism, but it is rather global economic competition. Two Million Minutes, a DVD, has been shown in economic and educational circles highlighting the challenges of the new generation in the United States. The blurb on the cover of the DVD states, "The battle for America's economic future isn't being fought by our government. It's being fought by our kids" (Raney & Heeter, 2007, p. 1). The film gives the following statistics: 51% of degrees earned in computer science or engineering are by foreign students. In the past few years, there has been repeated warnings that the global economic competition has shifted locations and has indeed started in schools.

Summary

There is an unprecedented national and international collective effort to focus and improve mathematics teaching and learning. Most educational literature supports the notion that teacher preparedness is a key to better learning outcomes. Although there are the so-called math wars that fuel controversy on how to teach and what is best,

researchers, governments, and educational policy makers are in agreement that Algebra taken early opens doors and more opportunities for students; therefore, proficiency in Algebra by eighth grade is a meaningful goal for all students. Along with this goal comes the burden of knowing how to teach and how to prepare better middle grade teachers of mathematics. Affirming and agreeing with The RAND Mathematics Study Panel (2003) that Algebra is the foundation of modern mathematics because of its ability to provide general and unifying mathematical concepts. The issue is that when there is no well-developed knowledge about the practice of teaching mathematics, it creates a gap between research and practice, which is the major reason that school mathematics does not work well. The solution, as proposed by the RAND Mathematics Study Panel, is "the development of new knowledge and practices that are rooted in systematic, coordinated, and cumulative research" (p. 5).

Chapter 3: Methods

The purpose of this research is to determine if there are differences in the level of perceived preparedness between teachers in Lebanon and teachers in the United States, in teaching eighth graders the four Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, while controlling for the teachers years of teaching experiences. To conduct this research, publicly available data from the TIMSS 2007 assessment is examined, using questions related to teacher preparedness in different content areas in Algebra for the two countries and self-reported responses from teachers.

McMillan and Schumacher (2001) stated research has been defined as, "A systematic process of collecting and logically analyzing information (data) for some purpose. This definition is general because many methods are available to investigate a problem or question" (p. 9). The two overall categories are quantitative and qualitative approaches. The quantitative approach often supposes that there are individual variables that are measurable, where the researcher is detached and where the purpose of the study is to establish relationships between measured variables with the intention of producing a universal context-free generalization. This study uses a quantitative approach.

Chapter Structure

The chapter begins with a design of this study. It then provides a description of the TIMSS 2007 international assessment, describing the framework and data analyses used in the TIMSS. Issues such as population and sampling, validity, and consideration for human subjects will be presented.

Design of the Study

This dissertation study is secondary data analysis of the 2007 TIMSS data set. It uses the SPSS statistical software for analytical methods. The study uses data from TIMSS 2007 international database that is made public in TIMSS and Progress in International Reading Literacy Study International Study Center, Lynch School of Education of Boston College.

The 2007 TIMSS Algebra Mathematics Teacher Questionnaire (2007) section had four content areas:

1. Numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns)
2. Simplifying and evaluating the algebraic expressions
3. Simple linear equations and inequalities, and simultaneous (two variables) equations
4. Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations. (p. 4)

Teachers' self-reported preparedness in each of those areas were set as the criterion variables, the countries of Lebanon and the United States were used as the grouping variables, and the years of teaching experiences as the covariates. When there is more than one dependent variable, a group design such as multivariate analysis of variance and multivariate analysis of covariance (MANCOVA) analyses are used, and instead of a univariate *F* value, a multivariate *F* value, Wilks' *Lambda* is obtained (Hill & Lewicki, 2006). Wilks' lambda is the most widely used test. Crichton (2000) states it "performs, in the multivariate setting, with a combination of dependent variables, the same role as

the F-test performs in one-way analysis of variance" (p. 381). MANCOVA is a popular analysis technique used in situations in which there are two or more dependent variables (Hill & Lewicki, 2006.) Finally, this study ran a post hoc univariate analysis of covariance, which is a follow-up test for the researcher to understand better why there was a significant *F* (Huck, 2008).

Nature of TIMSS Assessment

The TIMSS assessment is administered at the end of the 8 years of formal schooling, which is inclusive of compulsory schooling time for Lebanon and the United States, and because, independent of the students' age, they are at the same class level, having received the same number of years of formal schooling. Olson, Martin, and Mullis (2008) stated, "To be educationally useful, the amount of schooling represented by the grade assessed should be comparable across countries. Therefore, the focus should be on comparing student achievement after the same amount of schooling" (p. 78).

In the spring 2007 TIMSS administration, a sample of 9,723 eighth grade students participated from 239 schools (Kerachsky, 2008). Mullis, Martin, Olson, et al. (2008) stated it involved, "approximately 425,000 students from 59 countries around the world" (p. 14).

The unit of analysis in TIMSS is not individual student knowledge assessment, but rather a national performance in a content area. The TIMSS 2007 uses a matrix sampling system. Matrix sampling of items is an accepted approach to assess broad curriculum coverage. Childs and Andrew (2003) wrote:

> Matrix sampling involves developing a complete set of items judged to cover the curriculum, then dividing the items into subsets and administering each student

> one of the subsets of the items. Matrix sampling, by limiting the number of items administered to each student, limits the amount of testing time required, while still providing, across students, coverage of a broad range of content. (para. 8)

Ruddock (2008) stated, the 2007 TIMSS assessment booklet design "divided the 429 items for eighth grade into 28 item blocks at each grade, with 14 mathematics blocks and 14 science blocks" (p. 17). Mathematics had 214 items out of the 429 items and Algebra made up 29% of the total mathematics content. Table 8 details the mathematics exam breakdown of number of items and percentages given for each math topic.

Table 8

Details of Eighth Grade Content Domains of Mathematics Section on the 2007 TIMSS

Content	Number of Items	Points	Percentage
Total Mathematics	214	236	100
Algebra	64	69	29
Number	63	72	30
Geometry	47	49	21
Data and Chance	40	46	20

Note: Information compiled using different TIMSS 2007 Publications (Mullis, Martin, Foy, et al., 2008).

Validity and reliability. The notion of reliability in statistics simply means consistency, and the word validity refers to accuracy (Huck, 2008). A strong testament of validity also comes from the fact that many institutions use the Item Response Theory model. Foy, Galia, and Li (2008) wrote:

> The procedures used in TIMSS have been used in several other large-scale surveys, including Progress in International Reading Literacy Study (PIRLS), the U.S. National Assessment of Educational Progress (NAEP), the U.S. National Adult Literacy Survey (NALS), the International Adult Literacy Survey (IALS),

and the International Adult Literacy and Life Skills Survey (IALLS). (p. 226)

To ensure high quality and uniform standards among all countries, all participants followed the uniform sampling approach and methodology that was specified by the TIMSS 2007 sample design, with minimum deviations. Joncas (2008) stated, "This uniform approach also facilitated an efficient approval process of the national designs by the international project team" (p. 77).

Item statistics. The 2007 TIMSS assessment has about one third of its items in constructed-response format, which produces about half of the score. Therefore, it was crucial for TIMSS to review item statistics to ensure quality assurance of the data, because it enabled the detection of unusual item properties that could signal a problem or an error for a particular country (Olson, Martin, Mullis, Foy, et al., 2008). A constructed-response item with unusually low scoring reliability could indicate a problem with a scoring guide in a particular country. The 2007 TIMSS analysis for the within-country scoring reliability for the eighth grade constructed-response mathematics items yielded the following: Lebanon's scoring reliability for correct score agreement across items resulted in an average of 100%.

The United States' scoring reliability for correct score agreement across items resulted in average of 97% (Olson, Martin, Mullis, Foy et al., 2008). Olson, Martin, Mullis, Foy, et al. stated, "Item statistics was conducted before applying item response theory (IRT) scaling to the TIMSS 2007 achievement data to derive student mathematics and science achievement scores for analysis and reporting" (p. 193).

Sampling reliability. The definition of eighth grade students includes all students enrolled in the grade who have had eight years of formal schooling and taking to account

that the mean age at the time of testing is at least 13.5 years. It is critical to assess students who have had the same amount of formal schooling and within an age range (Joncas, 2008). For sampling purposes, each participating country had its own national defined population, provided that the national defined populations included at least 95% of the national desired populations. TIMSS 2007 has followed a classical, systematic, two-stage probability proportional-to-size sampling method; "The method usually is referred to as a systematic, two-stage *probability proportional-to-size* (PPS) sampling technique, where schools are first sampled and then classes within sampled (and participating) schools" (p. 83).

Test reliability. For the mathematics test reliability, the TIMSS 2007 utilized Cronbach's alpha reliability median across the 14 test booklets. In the 2007 TIMSS Technical Report, the eighth grade median reliability was recorded relatively high, with an international median, the median of the reliability coefficients for all countries, of 0.88 for eighth grade. Cronbach's alpha reliability coefficient for mathematics scores for Lebanon was 0.84, and for the United States was 0.89 (Olson, Martin, & Mullis, 2008).

Restatement of Purpose and Research Questions

The aim of this dissertation is to determine if there are differences in the level of perceived preparedness between teachers in the United States and teachers in Lebanon in teaching eighth graders the four Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, when controlling for their years of teaching experiences. This paper aims to answer the following four research questions:

1. Are there differences in teachers' self-reported preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the United

States and Lebanon?

2. Are there differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the United States and Lebanon?
3. Are there differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) equations between the United States and Lebanon?
4. Are there differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the United States and Lebanon?

Population and Sample

Characteristics for the eighth grade study from two countries, Lebanon and the United States, are as follows: Lebanon had 143 teachers, female 42.1%, male 57.9 %; and the United States had 357 teachers, 68.6% female, 31.4% male. Table 9 shows number of characteristics and variables of the samples and comparisons for Lebanon and the United States.

Table 9

Table of Characteristics and Variables of Population in Both Countries

	Lebanon	United States
Compulsory Education Start Age	6	6
Years of Formal Schooling	8	8
Average Age at Testing Time	14.4	14.3
Number of Schools Sampled	150	300
Eligible Schools	148	287

Original Sample Schools Plus Replacement Schools That Participated	120 + 16	197 + 42
Total Number of Schools Participated	136	236
Students Sampled	4,062	8,447
Students Assessed	3,786	7,377
Teacher Population	182	532
Teacher Population—Repeat/Missing	143	357
Class Size	Average 26	Average 24
Students' Gender	F:54%, M:46%	F:51%, M:49%
Exclusions	School-level. Very small schools.	Within schools, special education, or disabled students in regular classes
Stratification	2 types: Private and public	None
Stratification: Explicit	Private 86, Public 64	None
Stratification: Explicit, Sampled	Private 61, Public 59	None
Stratification: Implicit	None	None

Note: Information compiled using the 2007 TIMSS Technical Report (Olson, Martin, & Mullis, 2008).

In order to evaluate the quality of the samples, the IEA data processing and research center provided WinW3S sampling software to the national coordinators and trained them in how to select the school and student samples. Staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample selections. Mullis, Martin, and Foy (2008) stated, "The sampling documentation was used by the TIMSS & PIRLS International Study Center in consultation with Statistics Canada and the sampling referee to evaluate the quality of the samples" (p. 382). Teachers in the TIMSS 2007 international database were the teachers of nationally representative samples of students. Williams et al. (2009) stated, "It is important to note

that the teachers in question do not constitute a representative sample of teachers in a country, but rather are the teachers who taught a representative sample of students" (p. 86).

Considerations for Use of Human Subjects

There was no risk to human subjects, as the researcher observed and analyzed archival data only. All the records had codes to eliminate any kind of privacy infringement; therefore, the human subjects could not be identified directly or indirectly. In conformity with the federal policy for the protection of human subjects, an Institutional Review Board (IRB) exempt application was submitted, as this case study research involves the use of educational diagnostic and achievement tests. On March 7, 2011, Pepperdine University IRB approval was granted with the following Protocol Number E0211D10.

Data Collection

The study used data from TIMSS 2007 international database, which includes student achievement data as well as student and teacher background data for participant countries. The database is available for public use together with the *TIMSS 2007 User Guide* (Foy & Olson, 2009). "The mathematics teachers of the students tested were asked to complete questionnaires about their experience and education" (p. 257). The *Mathematics Teachers Questionnaire* has 33 questions and a copy of the questionnaire is displayed in Appendix A. Questions covering information such as teachers' background and training, gender, years of teaching, use of textbook and resources, instructional approaches, etc. were asked. Williams et al. (2009) wrote:

Teachers who taught more than one class were expected to complete only one set

of general background questions (part A) irrespective of the number of classes taught, and a separate part B (class-specific questions) for each class they taught. (p. 86)

For the purposes of this study, only data collected for Lebanon and the United States were analyzed. Table 10 gives a description of the variables and shows the different codes used in TIMSS and in this study.

Table 10

Description of Variables and Codes in TIMSS and This Study

How Well-Prepared Do You Feel You Are to Teach the Following Math Topics:	TIMSS	STAP
Numeric, algebraic, and geometric patterns or sequences	BT4MTT06	Algebra_A
Simplifying and evaluating the algebraic expressions	BT4MTT07	Algebra_B
Simple linear equations and inequalities, and simultaneous (two variable) equations	BT4MTT08	Algebra_C
Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations	BT4MTT09	Algebra_D
Years Teaching, Mean Controlled	BT4GTAUT	BT4GTAUT
Country ID	US = 840 Lebanon = 422	US = 840 Lebanon = 422

Data Analysis Techniques

Archived data from the TIMSS study was examined using the following key variables:

1. Mathematics teachers' experience.
2. Mathematics' teachers' responses to how well-prepared they felt and their

responses in TIMSS range from 1 = not applicable, 2 = very well prepared, 3 = somewhat prepared, and 4 = not well prepared, to teach the following topics (Mathematics Teachers' Questionnaire, 2007):

- Numeric, algebraic, and geometric patterns or sequences (extensions, missing terms, generalization of patterns)
- Simplifying and evaluating the algebraic expressions
- Simple linear equations and inequalities, and simultaneous (two variable) equations
- Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations (para. 4)

Their responses were recoded so that 1 = not well prepared, 2 = somewhat prepared, 3 = very well prepared, and all other values were not included in the analysis.

Summary

Chapter 3 gave an explanation of the statistical techniques used to analyze the study. It described key variables and discussed the methods used by 2007 TIMSS and its validity in content and study measures. Chapter 4 discusses the results of the statistical analyses.

Chapter 4: Results

This study examined secondary data from the 2007 TIMSS assessment. It looked at the responses of teachers' questionnaires and their self-reported preparedness in teaching eighth graders, for four Algebra content areas in mathematics. The data is from two countries: Lebanon and the United States.

This chapter presents the findings of this study. It provides a review of the study purpose and research questions. It also provides an overview of the data collection and data analyses. The results from the data analyses of the four research questions are then presented. Possible differences in the results of both countries are explained. Chapter 4 concludes with a summary.

Restatement of Purpose

This dissertation aims to determine if there are differences in levels of perceived preparedness between teachers in the United States and teachers in Lebanon teachers in teaching eighth graders the four Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, when controlling for their years of teaching experiences.

Restatement of Research Questions

This paper aims to answer the following four research questions:

1. Are there differences in teachers' self-reported preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the United States and Lebanon?
2. Are there differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the United States and Lebanon?

3. Are there differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) equations between the United States and Lebanon?
4. Are there differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the United States and Lebanon?

Demographics

Teachers of mathematics of students who took the 2007 TIMSS assessment were asked to complete questionnaires about their experiences and education. This study used the data for two countries: Lebanon and the United States. The sample size for Lebanon is 143 teachers, and for the United States 357 teachers. Table 11 has a breakdown of teachers' gender, age range, and trend average years of teaching.

Table 11

Teachers' Demographics Table

Teachers' of Mathematics	Lebanon *N* = 143	United States N = 357
Gender in %	Female: 42; Male: 58	Female: 69; Male: 31
Age range		
29 Years or Younger	33	20
30–39 Years	27	29
40–49 Years	22	26
50 Years or Older	18	25
Total	100	100
Trend Average Years of Teaching	14	14
Covariates controlled in this study, for years teaching, has value of:	13.68	13.68

Note. Information compiled from TIMSS 2007 International User Guide (Foy & Olson, 2009).

The average age of the students who took the TIMSS in 2007 in Lebanon was 14.4 years, and in the United States 14.3 years (Mullis et al., 2005). The minimum required age of eighth grade students in all participating countries ranged between 13.8 years and 14.2 years, depending on what month the school year began. TIMSS 2007 targeted student population at the end of their formal schooling in each country, at the end of eighth grade.

Review of data collection. This study used data from TIMSS 2007 international database, which includes teacher background data for participant countries. IRB exempt approval was requested and received from Pepperdine University, a copy of IRB approval letter is displayed in Appendix B. Once IRB approval was obtained from Pepperdine University, TIMSS secondary data were analyzed.

Results

MANCOVA 4 x 2 was conducted with the four content areas of Algebra preparedness as the criterion variables, country (United States vs. Lebanon) of the teacher as the grouping variable, and the years of teaching experiences as the covariate. This examined if there are differences in teachers' self-reported perceived preparedness between those teachers in the United States and those in Lebanon, when controlling for their years of experiences. Covariates used are evaluated at the following value: General number of years teaching = 13.68. This study controlled teachers' years of teaching experience for the entire sample, keeping the literature review in mind. The median years of experience listed for Lebanon's teachers was 14.1 and for the United States is 13.5 (Foy & Olson, 2009).

Results of the MANCOVA indicated that there were significant differences in at

least one of the content areas, *Wilks' λ* = .98, *F* [4, 494] = 2.52, *p* = .404. Means and standard deviation of teachers' self-reported preparedness in the four Algebra contents of the mathematics section of the 2007 TIMSS test are listed in Table 12.

Table 12

Means and Standard Deviation

	Algebra Content Areas							
	A		B		C		D	
Country	M	SD	M	SD	M	SD	M	SD
Lebanon	2.82	0.41	2.91	0.36	2.91	0.32	2.85	0.41
United States	2.91	0.33	2.95	0.28	2.92	0.31	2.92	0.32

Post Hoc univariate analysis of covariances revealed that there were differences in the Algebra content area A; Numeric, algebraic and geometric patterns or sequences, *F* (1, 497) = 5.66, *p* = .018, and in the area of Algebra D; Equivalent representations of functions as ordered pairs, tables, graphs, words or equations, *F* (1, 497) = 4.20, *p* = .041. This suggests that those teachers in the United States reported significantly higher levels of preparedness in the areas of Algebra A and D than those in Lebanon. These significantly higher level of preparedness corresponded to the average student achievement outcome differences for both countries. Lebanon had an average country score of 449 and 465 respectively in mathematics and Algebra, which are much lower than those of the that United States average with scores of 508 and 501 in mathematics and Algebra respectively.

Results

Research question 1 asked: Are there differences in teachers' self-reported

preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the United States and Lebanon? MANCOVA analyses showed that there were significant differences in teachers' self-reported preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the teachers in the United States and those in Lebanon.

Research question 2 asked: Are there differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the United States and Lebanon? MANCOVA analyses showed that there were no significant differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the teachers in the United States and in Lebanon.

Research question 3 asked: Are there differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) equations between the United States and Lebanon? MANCOVA analyses showed that there were no significant differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) between the teachers in the United States and in Lebanon.

Research question 4 asked: Are there differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the United States and Lebanon? MANCOVA analyses showed that there were significant differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the teachers in the United States and those in

Lebanon.

Data Display

Results of the data analyses were displayed using tables and figures. Students' average country scores in Algebra are shown in Figure 1. The United States scored higher than Lebanon in Algebra, but is at average compared to the world.

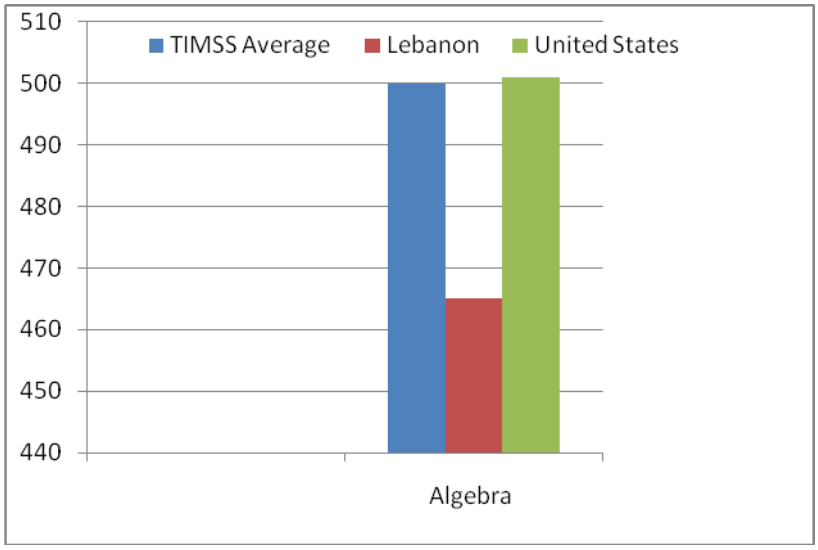

Figure 1. Algebra scores for Lebanon and the United States with the TIMSS average scores.

In this study, teachers of mathematics of eighth grade students in the United States showed significantly higher levels of preparedness in two areas of Algebra: Area A—Numeric, Algebraic and Geometric Patterns or Sequences, and Area D—Equivalent Representations of Functions as Ordered Pairs, Graphs, Words, or Equations. The 2007 TIMSS summary results of the percentage of students whose teachers reported feeling very well prepared to teach the four topics in Algebra, for Lebanon and the United States, is in accordance with this study. The numbers are depicted in Figure 2.

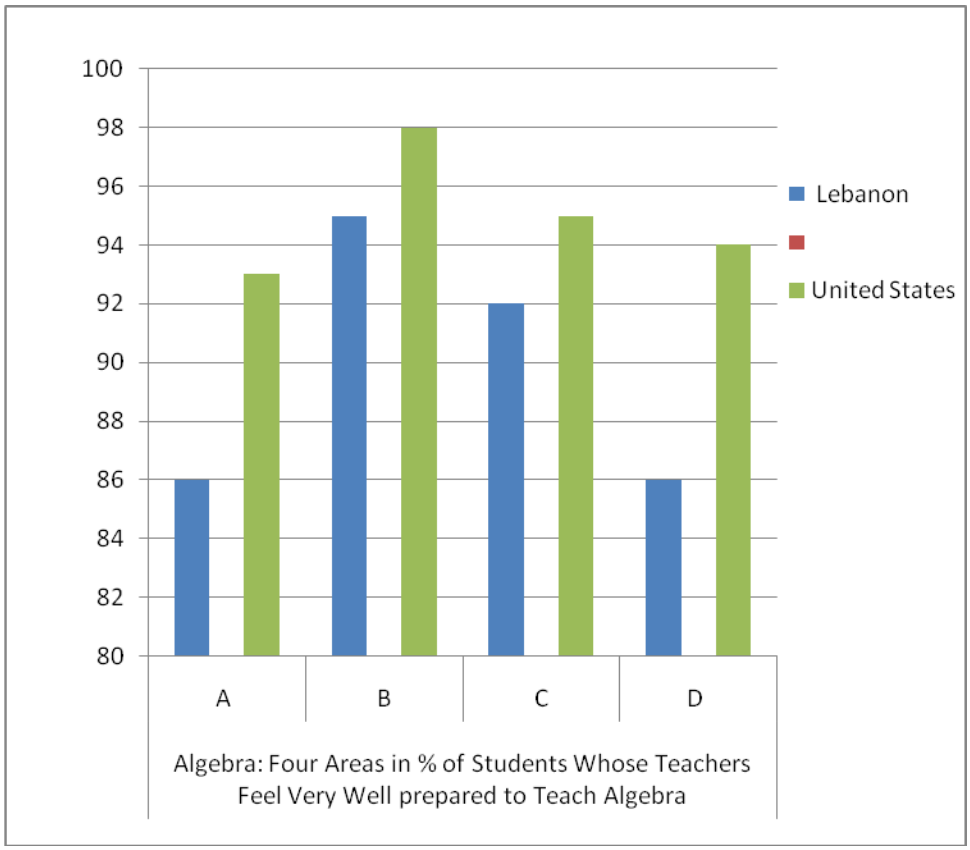

Figure 2. Teachers' felt preparedness in Lebanon and the United States.

Figure 2 shows that 6% more students in the United States reported that their teachers felt very well prepared to teach content A in Algebra, and 8% more for content D. This study also showed that there was a significant difference in the teachers' self-reported level of preparedness in those two areas between the teachers of the United States and those of Lebanon.

Summary

Chapter 4 discussed the results of the study. The chapter began with a review of the purpose and restatement of the research questions of the study. It then presented the demographics and gave a quick review of the data collection procedures. Next, the results were presented and data analyses the research questions were addressed. The results of the statistical analyses showed that the teachers in the United States reported significantly

higher levels of preparedness in the areas of Algebra content area A—Numeric, algebraic, and geometric patterns or sequences, and Algebra content area D—Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations, than those teachers in Lebanon. Chapter 5 presents a conclusion of the results of these analyses and their importance.

Chapter 5: Conclusions and Recommendations

Mathematics remains a core learning subject in most elementary and secondary educations systems around the world, and Algebra is a main component of elementary mathematics. Although research is ongoing regarding the best teaching methods, one factor of student success is still related to teacher's preparedness in teaching a subject matter.

This study examined whether there were differences in the level of teachers' perceived preparedness in teaching four Algebra contents as identified in the 2007 TIMSS, between two countries, Lebanon and the United States.

Chapter Structure

Chapter 5 begins with an overview of this study. It includes a review of the problem and restatement of purpose and the research questions. Then it discusses the findings of the analyses results of each research question, along with any significant implication. Conclusions are presented, followed by implications to educational leaders in both countries. Then, limitations of the study are discussed and future recommendations for research are proposed. Finally, a summary of the study is presented.

Overview

Restatement of the problem. TIMSS 2007 mathematics results showed the average math score of Lebanon was at 449 compared to the United States' score of 508, and the overall participating countries' average score of 500. More specifically, the average score for Lebanon in Algebra is 465 compared to the United States' 501, with the overall average being 500. Based on the TIMSS 2007 scores, there is a clear disparity in Algebra performance between eighth grade students in the United States and Lebanon.

Restatement of the purpose. The purpose of this dissertation is to determine if there are differences in the level of perceived preparedness between teachers in the United States and teachers in Lebanon in teaching eighth graders the four Algebra content areas in mathematics, identified in the 2007 TIMSS assessment, when controlling for their years of teaching experiences.

Discussion of Findings

This paper aimed at answering four research questions. Reflecting on each of the four questions, findings of the study are discussed as follows:

Research question 1. The purpose of research question 1 was to examine whether there were differences in teachers' self-reported preparedness in teaching numeric, algebraic, and geometric patterns or sequences between the United States and Lebanon. The MANCOVA analyses showed that there were significant differences in teachers' self-reported preparedness between the teachers in the United States and in Lebanon. The results were significantly higher for the United States' teachers. Post hoc univariate analysis of covariances yielded $F(1,497) = 5.66$, $p = .018$. This result corresponds with the country average results of the students' performance in Algebra, where the United States country average in Algebra was 501, while Lebanon's country average was 465.

Research question 2. The purpose of research question 2 was to examine whether there were differences in teachers' self-reported preparedness in teaching simplification and evaluation of the algebraic expressions between the United States and Lebanon. The MANCOVA analyses showed that there were no significant differences in teachers' self-reported preparedness between the teachers in the United States and in

Lebanon. This result was not expected, as the country average results of the students' performance in Algebra for the United States was 36 points higher at 501, while Lebanon's country average was 465. Thus, the study expected the United States teachers' self-reported preparedness to be significantly higher than those of Lebanon.

Research question 3. The purpose of research question 3 was to examine whether there were differences in teachers' self-reported preparedness in teaching simple linear equations and inequalities, and simultaneous (two variables) equations between the United States and Lebanon. The MANCOVA analyses showed that there were no significant differences in teachers' self-reported preparedness between the teachers in the United States and in Lebanon. This result was not expected, as the country average results of the students' performance in Algebra for the United States was 36 points higher at 501, while Lebanon's country average was 465. The study expected United States teachers' self-reported preparedness to be significantly higher than those of Lebanon.

Research question 4. The purpose of research question 4 was to examine whether there were differences in teachers' self-reported preparedness in teaching equivalent representations of functions as ordered pairs, tables, graphs, words, or equations between the United States and Lebanon. The MANCOVA analyses showed that there were significant differences in teachers' self-reported preparedness between the teachers in the United States and in Lebanon. Post hoc univariate analysis of covariances yielded F (1, 497) = 4.20, p = .041. This result corresponds with the country average results of the students' performance in Algebra, where the United States country average in Algebra was 501 while Lebanon's country average was 465.

Conclusions

This study looked at teachers' perceived preparedness in Algebra in two countries using secondary data from the 2007 TIMSS. The findings that the United States' teachers had significantly higher level of preparedness than teachers in Lebanon, in two areas of Algebra, is in accordance with the two countries' average scores in Algebra. Looking at the general mathematics scores for both countries, those also show parallel performance. Table 13 shows that TIMSS average for Algebra content and mathematics overall content is the same at 500. Table 13 also displays the total mathematics averages. Compared to the TIMSS averages, the United States has higher overall mathematics average than Algebra average; however, Lebanon has a higher Algebra average than overall mathematics average.

Table 13

Average Mathematics and Algebra Content Domain Scores of Eighth Grade

Country	Total Mathematics	Algebra
TIMSS Average	500	500
Highest Score (Chinese Taipei)	598	618
Lebanon	449	465
United States	508	501

Note. Adapted from "TIMSS 2007 Mathematic Report," by Mullis, Martin, & Foy, 2008.

In this study, the United States teachers' self-reported preparedness results showed significantly higher levels of preparedness in two areas: A and D. Looking at the percentage of the students whose teachers reported feeling very well prepared to teach Algebra, it shows that in the two particular areas, A and D of Algebra content, there was a higher range in the percentages, as depicted in Table 14.

Table 14

Percentage of Eighth Grade Students Whose Teachers Reported Feeling Very Well Prepared to Teach Four Contents in Algebra on TIMSS 2007

Country	Four Contents of Algebra on the TIMSS 2007			
	A	B	C	D
Lebanon	86	95	92	86
United States	93	98	95	94
Difference in the percentage	7	3	3	8

Note. Adapted from "TIMSS 2007 Mathematic Report," by Mullis, Martin, & Foy, 2008.

In order to understand possible reasons for this difference in the perceived preparedness levels for the teachers in both countries, several factors were examined. One factor was teacher certification. Teachers in both countries pass a certification exams; this requirement is ongoing in most of the United States, meaning that teachers have to renew their certification, and in Lebanon it is a one-time process. Also, Duffrin (2006) states that studies indicate, "Credentials appear to only have a modest impact on student achievement" (p. 18). So teacher certification may not be a critical factor in this case.

Another factor could be how curriculum is implemented. Both countries, the United States and Lebanon, have measures that ensure curriculum implementation—Measures such as school self-evaluation and national and regional assessment. In fact Lebanon has an added measure that the United States does not have, and that is visits to schools by inspectors. Therefore, curriculum implementation may not be a strong cause for the self-perceived differences in teachers' preparedness. However, preparedness in teaching the intended curriculum and the implemented curriculum in each country may be a reason. Mullis et al. (2005) states TIMSS has a three-aspect curriculum: "A) The Intended curriculum which is the national, social, and educational context, B) The

Implemented Curriculum, which is the school, teacher, and classroom context, and C) The Attained Curriculum, which is student learning outcomes and characteristics" (p. 5).

The teachers answered questionnaires for perceived-preparedness levels for each of those four topics in Algebra: (a) Numeric, algebraic, and geometric patterns or sequences; (b) Simplifying and evaluating the algebraic expressions; (c) Simple linear equations and inequalities, and simultaneous (two variables) equations; and (d) Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations. This study's findings indicated that there are significant differences in the teachers' self-reported preparedness in two areas, namely A and D. Looking at the intended and taught TIMSS Algebra topics in the International Mathematics Report (Mullis, Martin, & Foy, 2008), it shows that in Lebanon, content area A is taught in Grade 4, content area B is taught at Grade 7, content area C is taught at Grades 8 through 9, and content area D is taught at Grade 9. All of the four content areas are taught at Grades 6 through 8 in the United States.

The fact that content areas A and B are taught outside of the middle school years could be a strong factor in the differences of the perceived levels of preparedness for both countries, since teachers do not teach that content at eighth grade and, therefore, may feel they are very well prepared.

Implications for Educational Leaders and Policy Makers

Teacher preparedness, whether perceived or actual, is a factor in student learning. In the United States, there are continuing efforts to improve teaching. Federal requirements of highly qualified teachers through the NCLB's mandate helps place certified teachers in every classroom. Although NCLB is a highly debated policy, most

research shows positive relationships between teachers' ability to teach and student performance (Smith, Desimone, & Ueno, 2005). In the NCLB's definition of highly qualified teachers, there are different requirements for new teachers versus teachers who are not new to the profession, sending the message that teachers' experience is related to student achievement.

Unlike the United States, where there are governmental mandates as well as professional association influences such as the NCTM's strong presence in providing forums for dialogue and research and guidance, in Lebanon there has been little structured effort to improve mathematics instruction. This is usually attributed to the sporadic political unrest and lack of funding. However, there was one project, Mathematics Reform for All in Lebanon, which attempted to reform and to support the education reform through teacher development. The Mathematics Reform for All in Lebanon project was initiated in order to start research-based educational and instructional changes in Lebanon (Henningsen, 2003). However because the continuation of the project was subject to funding, it was not completed. Jurdak (as cited in Henningsen, 2003) wrote:

> Little systematic study of Lebanese classrooms exists; however, it is widely believed that typical mathematics instruction in Lebanon is characterized by a focus on memorization and procedural practice, especially after grade six when students begin facing high stakes national examinations that are oriented toward achievement in procedural and mechanistic mathematical skills. In Lebanon, researchers have recently begun to articulate the necessity for more careful study of classroom instructional processes in mathematics. (p. 110)

Education reform is often discussed, more so in the past few years as Lebanon finds economic and political stability. Along with the efforts toward educational reform in Lebanon and the Arab world in general, an important component for the success of the reform process, is the "establishment of clear indicators to monitor performance of education and those of teachers and students" (Billeh as cited in El-Amine, 2005, p. 12). In their paper, El-Amine and Jurdak reveal that reform efforts often decline because of political reasons and because of problems in reform management.

The United States has a decentralized education system, giving more power to states and local districts to adopt policies that fit and meet the needs of their schools. Lebanon's centralized education system could be hindering the progress and management of such reforms. Changes happen quicker in decentralized systems where the red tape is not as prevalent. A good example is France's education system, which went through a paradigm shift between the years 1981 and 2003. Derouet (2005) showed that effectiveness is not ensured through a centralized system. France's abandonment of centralized control along with enhancement of achievement indicators has made France's schools independently thinking schools. Derouet states that this independence brought with it uncertainties, but that it is a stage in the process. In a global context, one implication for both countries' educational leaders is to establish clear indicators of achievement, locally, nationally, and internationally along with ongoing efforts that measure this progress, particularly in mathematics.

Limitations and Recommendations for Further Research

The results of this study indicate that teacher preparedness, although based on self-reported data, is a significant factor in student learning and achievement. Out of the

four content areas of Algebra in the 2007 TIMSS mathematics test, two content area outcomes were affected by teacher preparation levels. Further research is suggested and several recommendations are made based on this study's the findings.

First, this study was limited to two countries: Lebanon and the United States. Lebanon's country average scores were lower than the United States' average. Future research could include a high-performing country such as Chinese Taipei, to determine if there are differences in the level of preparedness between teachers in Chinese Taipei and teachers in the United States. Chinese Taipei's average score in Algebra was a hefty 618 points compared to Lebanon and United States respectively at 465 and 501.

Second, the study compared teachers' responses to the country's average scores in Algebra. TIMSS does not have individual student performance in each area of Algebra, as it uses matrix testing and plausible values. Future research could use those plausible values and correlate teacher self-reported preparedness to determine if the results will correspond with the study's findings.

Third, this study did not have a clear definition of teacher preparedness and TIMSS 2007 did not provide one. Teachers who self-reported their level of preparedness answered the teacher questionnaire based on their individual understanding of the term. A suggestion would be to clarify the concept of teacher preparedness on the questionnaire in order to provide a standard understanding of preparedness for all participants.

Fourth, Williams et al. (2009) stated that the teacher sample size was not a representative sample of teachers in a country, but instead they are the teachers who taught a representative sample of students. A suggestion for further research is to obtain a representative sample of teachers in a county and compare its level of preparedness to

student achievement in the subject.

Another recommendation for future research is to control and test the many other variables that affect teaching and learning, including intended and implemented curricula. Since TIMSS has provided a forum and available data and questionnaires, future studies using different variables could provide answers to improve students' scores in Algebra and mathematics in general.

A final recommendation, for both countries, is to establish a short term or a long term program where one of the purposes would be to establish clear indicators of achievement, locally, nationally, and internationally along with ongoing efforts that measure this progress, particularly in mathematics. Another purpose of this program could include parent involvement around understanding the importance of international tests results, such as TIMSS. Such a program should be planned securing funding for the length of the program in order to avoid discontinuation as it happened with Mathematics Reform for all in Lebanon (MARAL) Project in Lebanon.

This was a very significant project because it aimed toward a close intertwining of research and teacher development (Henningsen, 2003). Jurdak (2001) has referred to MARAL where he stated that researchers have articulated the necessity of classroom instructional practices in mathematics. This recommendation for a program could also have a joint venture component, where the policy makers of the Republic of Lebanon can recruit or work closely with mathematics education reform partners in the to establish achievement indicators or to collaborate on classroom instructional practices and teacher preparedness in teaching mathematics.

Summary

Proficiency in mathematics is critical to today's technologically oriented degrees and dominant computer industry. In the ever-evolving global village of the cyber world, high demands in computer careers will only increase; whether in the fields of computer communications, media, Internet social games, scientific research, or other. The myriad openings in a technologically oriented job market will add to expectations of well-versed mathematicians.

Algebra in middle school remains the gateway to higher mathematics in high school and beyond. The United States, although having an average score of 508 on mathematic and 501 in Algebra on the 2007 TIMSS, is still 90 points lower than Chinese Taipei, which was the highest-scoring country at 598 in mathematics and 618 in Algebra. Although the United States scored higher than Lebanon in Algebra, the teachers did not perceive themselves as being very well prepared in the four content areas of Algebra, but rather only in two areas. Further research is needed to establish causes and effects of the perceived preparedness in teaching the other two Algebra content areas.

The purpose of this study was to determine if there was a difference in the level of perceived preparedness in teaching Algebra to eighth graders in Lebanon and the United States. The study aimed to answer four research questions and in order to answer these questions, secondary data was analyzed using the MANCOVA method. The results of the study indicated that the country that had teachers' who reported higher levels of preparedness to teach Algebra, had higher average country scores on the Algebra test portion compared to teachers in Lebanon, the average scores of which were significantly lower than the United States.

Suggestions for future research includes studying the answers of high performing countries and correlating the results with this study, as well as including a more specific definition of well-preparedness and a better sampling of teachers.

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APPENDIX A

TIMSS 2007 Mathematics Teachers' Questionnaire

Identification Label

Teacher Name: _____

Class Name: _____

Teacher ID: _____ Teacher Link #_____

Trends in International Mathematics and Science Study

TIMSS 2007

IEA TIMSS 2007

Teacher Questionnaire

MATHEMATICS
<Grade 8>

<TIMSS National Research Center Name>
<Address>

Directions

Your school has agreed to participate in TIMSS 2007, a large international study of student learning in mathematics and science in more than 60 countries around the world. Sponsored by the International Association for the Evaluation of Educational Achievement (IEA), TIMSS (for Trends in International Mathematics and Science Study) is measuring trends in student achievement and studying differences in national education systems in order to help improve the teaching and learning of mathematics and science worldwide.

As part of the study, students in a nationwide sample of <eighth-grade> classes in <country> will complete the TIMSS mathematics and science tests. This questionnaire is addressed to teachers who teach mathematics to these students, and seeks information about teachers' academic and professional background, instructional practices, and attitudes toward teaching mathematics. As a teacher of mathematics to students in one of these sampled classes, your responses to these questions are very important in helping to describe mathematics education in <country>.

Some of the questions in this questionnaire refer specifically to students in the "TIMSS class." This is the class that is identified on the cover of this questionnaire, and that will be tested as part of TIMSS 2007 in your school. It is important that you answer each question carefully so that the information that you provide reflects your situation as accurately as possible.

Please identify a time and place where you will be able to complete this questionnaire without being interrupted. This should require no more than 45 minutes. To make it as easy as possible for you to respond, most questions may be answered simply by checking or filling in the appropriate circle.

Once you have completed the questionnaire, place it in the return envelope provided and return it to: <Country Specific Information>

Thank you very much for the time and effort you have put into responding to this questionnaire.

Background Information

1

How old are you?

*Fill in **one** circle only*

- Under 25 ○
- 25–29 ○
- 30–39 ○
- 40–49 ○
- 50–59 ○
- 60 or older ○

2

Are you female or male?

*Fill in **one** circle only*

- Female ○
- Male ○

3

By the end of this school year, how many years will you have been teaching altogether?

_____

Number of years you have taught

Preparation to Teach

4

What is the highest level of formal education you have completed?

*Fill in **one** circle only*

- Did not complete <ISCED 3> ○
- Finished <ISCED 3> ○
- Finished <ISCED 4> ○
- Finished <ISCED 5B> ○
- Finished <ISCED 5A, first degree> ○
- Finished <ISCED 5A, second degree> or higher ○

5

During your <post-secondary> education, what was your major or main area(s) of study?

*Fill in **one** circle for each row*

		Yes	No
a)	Mathematics	○	○
b)	Education - Mathematics	○	○
c)	Science	○	○
d)	Education - Science	○	○
e)	Education - General	○	○
f)	Other	○	○

6

Do you have a teaching license or certificate?

	Yes	No
*Fill in **one** circle only*	○	○

7

How well prepared do you feel you are to teach the following topics?

Fill in one circle in each row

		Not applicable	Very well prepared	Somewhat prepared	Not well prepared
A. Number					
a)	Computing, estimating or approximating with whole numbers	○	○	○	○
b)	Representing decimals and fractions using words, numbers, or models (including number lines)	○	○	○	○
c)	Computing with fractions and decimals	○	○	○	○
d)	Representing, comparing, ordering, and computing with integers	○	○	○	○
e)	Problem solving involving percents and proportions	○	○	○	○
B. Algebra					
a)	Numeric, algebraic, and geometric patterns or sequences (extension, missing terms, generalization of patterns)	○	○	○	○
b)	Simplifying and evaluating the algebraic expressions	○	○	○	○
c)	Simple linear equations and inequalities, and simultaneous (two variables) equations	○	○	○	○
d)	Equivalent representations of functions as ordered pairs, tables, graphs, words, or equations	○	○	○	○
C. Geometry					
a)	Geometric properties of angles and geometric shapes (triangles, quadrilaterals, and other common polygons)	○	○	○	○
b)	Congruent figures and similar triangles	○	○	○	○
c)	Relationship between three–dimensional shapes and their two-dimensional representation	○	○	○	○
d)	Using appropriate measurement formulas for perimeters, circumferences, areas of circles, surface areas and volumes	○	○	○	○
e)	Cartesian plane - ordered pairs, equations, intercepts, intersections, and gradient	○	○	○	○
f)	Translation, reflection, and rotation	○	○	○	○
D. Data and Chance					
a)	Reading and displaying data using tables, pictographs, bar graphs, pie charts and line graphs	○	○	○	○
b)	Interpreting data sets (e.g., draw conclusions, make predictions, and estimate values between and beyond given data points)	○	○	○	○
c)	Judging, predicting, and determining the chances of possible outcomes	○	○	○	○

Professional Development

8

How often do you have the following types of interactions with other teachers?

*Fill in **one** circle for each row*

	Never or almost never	2 or 3 times per month	1-3 times per week	Daily or almost daily
a) Discussions about how to teach a particular concept	○	○	○	○
b) Working on preparing instructional materials	○	○	○	○
c) Visits to another teacher's classroom to observe his/her teaching	○	○	○	○
d) Informal observations of **my** classroom by another teacher	○	○	○	○

9

In the past two years, have you participated in professional development in any of the following?

*Fill in **one** circle for each row*

	Yes	No
a) Mathematics content	○	○
b) Mathematics pedagogy/instruction	○	○
c) Mathematics curriculum	○	○
d) Integrating information technology into mathematics	○	○
e) Improving students' critical thinking or problem solving skills	○	○
f) Mathematics assessment	○	○

Your School

10

Thinking about your current school, indicate the extent to which you agree or disagree with each of the following statements.

*Fill in **one** circle for each row*

	Agree a lot	Agree	Disagree	Disagree a lot
a) This school is located in a safe neighborhood	○	○	○	○
b) I feel safe at this school	○	○	○	○
c) This school's security policies and practices are sufficient	○	○	○	○

11

In your current school, how severe is each problem?

*Fill in **one** circle for each row*

	Not a problem	Minor Problem	Serious problem
a) The school building needs significant repair	○	○	○
b) Classrooms are overcrowded	○	○	○
c) Teachers do not have adequate workspace outside their classroom	○	○	○

12

How would you characterize each of the following within your school?

*Fill in **one** circle for each row*

	Very high	High	Medium	Low	Very low
a) Teachers' job satisfaction	○	○	○	○	○
b) Teachers' understanding of the school's curricular goals	○	○	○	○	○
c) Teachers' degree of success in implementing the school's curriculum	○	○	○	○	○
d) Teachers' expectations for student achievement	○	○	○	○	○
e) Parental support for student achievement	○	○	○	○	○
f) Parental involvement in school activities	○	○	○	○	○
g) Students' regard for school property	○	○	○	○	○
h) Students' desire to do well in school	○	○	○	○	○

The TIMSS Class

The remaining questions refer to the TIMSS class. Remember, "the TIMSS class" is the class which is identified on the cover of this questionnaire, and which will be tested as part of TIMSS 2007 in your school.

13

How many students are in the TIMSS class?

_____
Write in the number of students

14

How many minutes per week do you teach mathematics to the TIMSS class?

_____
Write in the number of minutes per week

15

A. Do you use a textbook(s) in teaching mathematics to the TIMSS class?

	Yes	No
*Fill in **one** circle only*	○	○

*If **No**, please go to question* **16**

B. How do you use a textbook(s) in teaching mathematics to the TIMSS class?

*Fill in **one** circle only*

- As the primary basis for my lessons ○
- As a supplementary resource ○

16

In a typical week of mathematics lessons for the TIMSS class, what percentage of time do students spend on each of the following activities?

Write in the percent
The total should add to 100%

a) Reviewing homework _____%

b) Listening to lecture-style presentations _____%

c) Working problems with your guidance _____%

d) Working problems on their own without your guidance _____%

e) Listening to you re-teach and clarify content/procedures _____%

f) Taking tests or quizzes _____%

g) Participating in classroom management tasks not related to the lesson's content/purpose (e.g., interruptions and keeping order) _____%

h) Other student activities _____%

Total 100%

APPENDIX B

IRB Letter

PEPPERDINE UNIVERSITY

Graduate & Professional Schools Institutional Review Board

March 7, 2011

Seta Khajarian
[redacted]

Protocol #: E0211D10
Project Title: ***A Study Of The Relationship Between Teacher Preparedness And Students' Performance On The 2007 TIMSS Mathematics Section For Two Countries: Lebanon And The United States***

Dear Ms Khajarian:

Thank you for submitting the revisions requested by Pepperdine University's Graduate and Professional Schools IRB (GPS IRB) for your study, *A Study Of The Relationship Between Teacher Preparedness And Students' Performance On The 2007 TIMSS Mathematics Section For Two Countries: Lebanon And The United States*. The IRB has reviewed your revisions and found them acceptable. You may proceed with your study. The IRB has determined that the above entitled project meets the requirements for exemption under the federal regulations 45 CFR 46 - http://www.nihtraining.com/ohsrsite/guidelines/45cfr46.html that govern the protections of human subjects. Specifically, section 45 CFR 46.101(b)(4) states:

> (b) Unless otherwise required by Department or Agency heads, research activities in which the only involvement of human subjects will be in one or more of the following categories are exempt from this policy:
>
> **Category (4) of 45 CFR 46.101**, research, involving the collection or study of existing data, documents, records, pathological specimens, or diagnostic specimens, if these sources are publicly available or if the information is recorded by the investigator in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects.

Your research must be conducted according to the proposal that was submitted to the IRB. If changes to the approved protocol occur, a revised protocol must be reviewed and approved by the IRB before implementation. For any proposed changes in your research protocol, please submit a **Request for Modification Form** to the GPS IRB. Because your study falls under exemption, there is no requirement for continuing IRB review of your project. Please be aware that changes to your protocol may prevent the research from qualifying for exemption from 45 CFR 46.101 and require submission of a new IRB application or other materials to the GPS IRB.

A goal of the IRB is to prevent negative occurrences during any research study. However, despite our best intent, unforeseen circumstances or events may arise during the research. If an unexpected situation or adverse event happens during your investigation, please notify the GPS IRB as soon as possible. We will ask for a complete explanation of the event and your response. Other actions also may be required depending on the nature of the event. Details regarding the timeframe in which adverse events must be reported to the GPS IRB and the appropriate form to be used to report this information can be found in the *Pepperdine University Protection of Human Participants in Research: Policies and Procedures Manual* (see link to "policy material" at http://www.pepperdine.edu/irb/graduate/).

Please refer to the protocol number denoted above in all further communication or correspondence related to this approval. Should you have additional questions, please contact me. On behalf of the GPS IRB, I wish you success in this scholarly pursuit.

Sincerely,

Jean Kang
Manager, GPS IRB & Dissertation Support
Pepperdine University
Graduate School of Education & Psychology
[redacted]

cc: Dr. Lee Kats, Associate Provost for Research & Assistant Dean of Research, Seaver College
Ms. Alexandra Roosa, Director Research and Sponsored Programs
Dr. Yuying Tsong, Interim Chair, Graduate and Professional Schools IRB
Ms. Jean Kang, Manager, Graduate and Professional Schools IRB
Dr. Eric Hamilton
Ms. Christie Dallo

APPENDIX C

Certificate of Completion of NIH

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Seta Khajarian** successfully completed the NIH Web-based training course "Protecting Human Research Participants."

Date of completion: 09/10/2008

Certification Number: 88328