OUR NATION LEFT BEHIND:
A MEASURE OF THE SUCCESS OF A MATHEMATICS SYSTEMIC PROGRAM TO REVERSE THE DOWNWARD SPIRAL OF MATHEMATICAL LITERACY

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The purpose of this quasi-experimental study was to evaluate the effectiveness of the Texas Instruments MathForward program and its effect on specific student subgroups differentiated by gender, ethnicity, socioeconomic status, and the type of curriculum materials used in the classrooms in a large, diverse, urban public school district. Additionally, this study explored the relationship between the amount and type of professional development each teacher received, teachers’ perceived level of administrative support for the MathForward program, and the quality of classroom instruction with student mathematics achievement gains as measured by the October and June Measures of Academic Progress (MAP) mathematics assessments.

Eighteen middle school mathematics teachers in the Milwaukee Public School District participated in the MathForward program during the 2011-2012 and 2012-2013 school years. Teachers assigned to the control group were matched to the experimental group on factors of years of teaching experience, gender, ethnicity, and type of curriculum materials used in the classroom.

Independent $t$-tests and a one-way analysis of variance were conducted to compare the difference in mathematics MAP scores between the two groups of students.
The analysis showed no significant difference in mathematics achievement growth between students of MathForward teachers and students of non-MathForward teachers. The study also showed no significant difference in mathematics achievement growth based on gender and socioeconomic status of MathForward students; however, there was a significant difference found between MathForward student ethnic groups and between the types of curriculum materials used in the MathForward classrooms.

Finally, a multiple linear regression explored any correlation between the amount of both in-service trainings and in-classroom coaching received by MathForward teachers, MathForward teachers’ perceived level of administrator support as measured by responses from an online teacher survey, and the quality of instruction as measured by the Reformed Teaching Observation Protocol. The regression analysis found only the total amount of in-classroom coaching hours was significantly related to the MathForward teacher’s mean difference in students’ mathematics achievement gains.
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CHAPTER I
INTRODUCTION

Background of the Study

“America will not succeed in the 21st century unless we do a better job of educating our sons and daughters” (Obama, 2007)

Equipping citizens with the skills necessary to achieve their full potential, participate in an increasingly interconnected global economy, and ultimately convert better jobs into better lives is a central preoccupation of policy makers. Both the previous and the current U.S. presidents have enacted federal initiatives to spur education reform. President Bush enacted the No Child Left Behind Act of 2001 and President Obama enacted the Race to the Top Grant as part of the federal stimulus act. While both initiatives support the same goals of reducing the achievement gap, accountability, standards, school choice, and improved teacher quality, their approaches are different. The Race to the Top program provides incentives for schools to change, while the No Child Left Behind Act mandates educational reform.

President Bush signed the No Child Left Behind Act of 2001 into law on January 8, 2002. It expanded the federal role in education and took particular aim at improving the education of disadvantaged students. At the core of the No Child Left Behind Act were a number of components designed to foster broad gains in student achievement and to hold states and schools more accountable for student progress (U.S. Department of Education, 2001). While the underpinnings of the No Child Left Behind Act created
significant changes to the education landscape, the Act has yet to produce substantial changes to our education system.

In 2009 President Obama announced his administration’s most significant education initiative, the Race to the Top fund. Race to the Top, a $4.35 billion, competitive grant program, aims to kick-start key education reforms in states and districts and create the conditions for greater educational innovation (Boser, 2012). Part of the American Recovery and Reinvestment Act, Race to the Top promises to help states and districts close achievement gaps and get more students into college by supporting key reform strategies including:

- Designing and implementing rigorous standards and high-quality assessments by encouraging states to work together toward a system of common academic standards that are benchmarked to international standards.
- Attracting and keeping great teachers and leaders by expanding support to educators; improving teacher preparation; revising evaluation and compensation policies to encourage effectiveness; and helping to ensure that our most talented educators are placed in the schools and subjects where they are needed the most.
- Supporting data systems that inform decisions and improve instruction by fully implementing a statewide longitudinal data system and making data more accessible to key stakeholders.
- Using innovation and effective approaches to turn around low-performing schools.
Forty states and the District of Columbia applied for funding with two states awarded for Phase 1, which began in March 2010. Nine states and the District of Columbia were announced as recipients for Phase 2 in August 2010 followed by seven states awarded in Phase 3 in December 2011.

While a lot of work has to be done, Race to the Top has sparked significant school reform efforts and shows that significant policy changes are possible (Boser, 2012). Key successful measures of the initiative include the advancement of the reform agenda, particularly around the Common Core Standards and the next-generation teacher evaluations. Many of the awarded states are largely on track with their Race to the Top commitments with the U.S. Department of Education playing an important role in their success by holding states accountable for their performance.

Education is the key to the nation’s future and a strong middle-class, but our public school system is rigid and archaic. Most education institutions lack the tools, incentives, and opportunities to transform themselves in profoundly more effective ways. After years of weak reforms, our school systems consistently produce many students who are ill prepared for college or the modern workplace. The consequences of our ineffective education system have devastating effects on our economy, our dependency on the knowledge base of other nations, and our standard of living.

Need for Change in Education System

The core problem with our current education system is that it was built for another era when the majority of the workforce required only a rudimentary education with basic literacy and computational skills. In today’s technological era, knowledge is expanding
at a breathtaking pace. In the nineties, information became the currency of business, the preferred medium of exchange, and the information managers became information officers (Wurman, 2001). It is no longer reasonable and acceptable to memorize facts and procedures with such a vast knowledge collection. Instead, schools must teach disciplinary knowledge in ways that focus on central concepts and help students learn how to think critically and learn for themselves so that they can use knowledge in new situations and manage the demands of changing information, technologies, jobs and social conditions. These new skills require the capacity to (Wagner, 2008):

- Design, evaluate, and manage one’s work so that it continually improves
- Frame, investigate, and solve problems using a wide range of tools and resources
- Collaborate strategically with others
- Communicate effectively in many forms
- Find, analyze, and use information for many purposes
- Develop new products and ideas

However, our classrooms are still organized in traditional rows facing a whiteboard instead of a blackboard. Students are rarely provided with complex problems requiring them to collaborate with their peers to formulate a solution and are rarely given the self-responsibility of evaluating their own academic growth. The need for change is substantiated by the international assessment conducted by the Program in International Student Assessment (PISA), which requires complex problem-solving skills and defines
literacy in mathematics, science, and reading as students’ ability to apply what they know to new problems. In the most recent study, 29 nations and other jurisdictions outperformed the United States in mathematics by a statistically significant margin, up from 23 three years ago. In science, 22 education systems scored above the U.S. average, up from 18 in 2009 (OECD, 2012).

**Effect of Education on National Economy**

The foundation for any solid economy is a well-educated workforce capable of fulfilling the demanding requirements of a technological age. This is substantiated by a 2010 report from the Organization for Economic Cooperation and Development (OECD) which suggests that an increase in the average U.S. PISA scores by 25 points over the next twenty years could add $41 trillion to the United States economy over the lifetime of the generation born in 2010 (OECD, 2010). Narrowing the achievement gap by bringing all students to a baseline level of proficiency based on the PISA could increase the Gross Domestic Product of the United States by $72 trillion, according to historical growth relationships (OECD, 2010).

Unfortunately, the United States is failing at improving the education of its young people and the effects are obvious by our struggling economy. Our high school graduation rates – stuck at about 70% - have dropped from first in the world to the bottom half of industrialized nations. At a time when advances in science and technology fuel economic growth in East Asian and European nations, our students rank near the bottom of industrialized countries in math and science achievement. It is estimated that there will be slightly more than 2.4 million science/technology/engineering/mathematics
(STEM) job openings in the United States between 2008 and 2018, with 1.1 million newly created jobs and the rest to replace vacated positions (Carnevale, Smith, & Melton, 2011). This forces many U.S. companies to hire skilled workers from other nations to fill these high-tech jobs, relegating our own young people to low-paying jobs requiring minimal skills. If we continue on this current course and the number of nations outpacing us in the education race continues to grow at its current rate, the American standard of living will steadily fall relative to these nations, rich and poor, that are doing a better job (Darling-Hammond, 2010).

While it is essential that we make changes to our K-12 education system to graduate students with more advanced skills, we must also better prepare our graduates for success in post-secondary schools. At a time when three-quarters of the fastest growing occupations require post-secondary education, our college participation rates have slipped from 1st in the world to 12th out of the 36 countries with only about 40% of our young people receiving a higher education (OECD, 2009). This compares to about 50% of European students and over 60% of Korean students who gain a college degree. The number of college graduates in the U.S. is far too few for the vast number of high-tech jobs in our current knowledge economy. While the new job market requires more advanced schooling and training in science and engineering fields, the number of Americans pursuing advanced degrees in these areas continues to decline (Darling-Hammond, 2010). The future of our standing as a world super-power and our ability to strengthen our national economy is contingent on our ability to better educate our young people at all levels from elementary school to graduate school.
Effect of Education on Social Welfare

Although the current state of our education system has stunted our economic growth, it has also created a drain on the social welfare of our people. While the U.S. must fill many of its high-tech jobs with individuals educated overseas, more and more of our own citizens are unemployable and relegated to the welfare or prison systems, representing enormous personal tragedy as well as a drain on the nation’s economy and social well-being, rather than a contribution to our national welfare (Darling-Hammond, 2010). Because the economy can no longer absorb this large number of unskilled workers at decent wages, their lack of education is increasingly linked to crime and welfare dependency. This group of the population did not find success in school, and the majority of them dropped out of high school. These dropouts cost the U.S. at least $200 billion a year in lost wages and taxes, costs for social services, and crime (Belfield & Levin, 2007). Our prisons are filled with high school dropouts and more than half of the adult prison system population is functionally illiterate (Barton & Coley, 1996). This growing population was not engaged in their education and did not have their learning needs met in the schools that were charged with developing them into productive citizens.

Need for Reform of Mathematics Education

Political forces have repeatedly pushed most mathematics teaching in the U.S. back to drill-and-practice methods at odds with what research shows are the most effective strategies for developing high levels of mathematical competence (Schoenfeld, 2008). In an age now driven by the relentless necessity of scientific and technological advance, the current preparation that students in the U.S. receive in mathematics and
science is unacceptable. In a 2000 report from the National Commission on Mathematics and Science Teaching for the 21st Century Commission, four important and enduring reasons underscore the need for our children to achieve competency in mathematics and science. First, the rapid pace of change in both the increasingly interdependent global economy and in the American workplace demands widespread mathematics- and science-related knowledge and abilities. Second, our citizens need both mathematics and science for their everyday decision-making. Third, mathematics and science are inextricably linked to the nation’s security interests. Finally, the deeper, intrinsic values of mathematical and scientific knowledge shape and define our common life, history, and culture and are primary sources of lifelong learning and the progress of our civilization. (National Commission of Mathematics and Science Teaching for the 21st Century, 2000).

With the devastating consequences to our national economy and our social well being, along with the individual tragedies of crime, drug-abuse, and welfare dependency, the need for education reform has never been greater. Our current population of students needs to become engaged, active learners in their education while our education system must focus on developing independent thinkers and complex problem-solvers. This reform will require innovative, systemic programs, especially in the mathematics, science, and technology areas that foster the transition from traditional teacher-focused classrooms to student-centered classrooms that are able to face the demands of today’s technological age.
Challenges Facing Milwaukee Public Schools

In comparison to suburban and rural districts, urban school districts are frequently marked by higher concentrations of poverty, greater racial and ethnic diversity, larger concentrations of immigrant populations and linguistic diversity, and more frequent rates of student mobility (Kincheloe, 2010). They serve a much larger population of students than rural and suburban schools. Urban districts must deal with the negative notions of public education, lack of funding and support, and a growing bureaucracy (Alston, 2002). These school districts are struggling to combat overwhelming odds while successfully meeting the educational needs of a high-needs student population.

The Milwaukee Public Schools district, like many of its big-city counterparts in other states, continues to suffer from poor student performance. Student test scores on the Wisconsin Knowledge and Concept Examination (WKCE) hover at the bottom of the state with only about half of fourth grade students achieving at a proficient level or above. As students progress through the grades, the scores drop even further with only 30% of tenth graders at a proficient level or above (Dodenhoff, 2007). The district’s graduation rate is a dismal 67% with many students choosing to dropout, leaving them unable to find viable employment opportunities. The district’s poor performance has resulted in a steadily declining student population, decreased state funding, and a high staff turnover rate based on low morale.

Additionally, Milwaukee Public Schools has permitted schools to choose which set of curriculum materials they will use in their classrooms. Buildings are asked to select either Glencoe or the Connected Mathematics Project to use as classroom
instructional materials. These two sets of curriculum materials are founded on different ideologies. Glencoe uses a more traditional approach to instruction and is designed to strengthen students’ learning through a consistent instructional design where students are taught important mathematics skills and concepts principally by studying completely worked out examples with clear explanations that are paralleled by guided practice (Nie, Cai & Moyer, 2009). Conversely, the Connected Mathematics Project is designed to build students’ understanding of important mathematics through explorations of real-world situations and problems. Research indicates that the Connected Mathematics Project is a strong inquiry based instructional program where students are given time to delve, discuss, and think through problems (Prentice Hall, 2004).

In 2010 the Milwaukee Public Schools implemented the Texas Instruments MathForward program in three middle schools in an effort to increase student mathematics achievement. The program was expanded to ten schools during the 2011-2012 school year and continued to be implemented at those schools for the 2012-2013 school year. Due to a high teacher turnover rate, many of the teachers implementing in the 2012-2013 school year were in their first year of implementation while some of the second-year teachers were successfully implementing the program to its full potential.

**The Texas Instruments MathForward Program**

MathForward is an algebra-readiness program providing support for teachers in grades six through Algebra I. The primary objective of the program is to increase students’ success in mathematics and to provide a solid foundation of pre-algebra skills. Algebra I remains the most commonly acknowledged gatekeeper in the high school
Most states require passing Algebra I as a requirement for graduation with many struggling Algebra students choosing to dropout of school rather than re-take the course. MathForward focuses on strengthening students’ conceptual understandings of abstract pre-algebra concepts so students are more successful with more advanced concepts in Algebra I.

The MathForward program was established from a synthesis of research studies on effective implementation of innovations in education which detailed eight research-based practices proven to have positive results on student mathematics achievement (Carnine, 2000). The cornerstone of the MathForward program is the on-going professional development provided by MathForward Implementation Specialists. Throughout the school year Implementation Specialists provide full-day trainings focused on the integration of technology and best instructional practices as well as frequent in-classroom coaching sessions for mathematics teachers.

The remaining components of the program include an integrated curriculum, increased teacher content knowledge, increased instructional time, formative assessments, administrator support, integration of technology, and common planning times. These components form a cohesive systemic program focusing on increasing student achievement and teacher efficacy. MathForward was designed to provide a large amount of instructional support during the first year of implementation with a decreased number of days of support during the second year. During the second year, efforts are made to increase leadership capacity within each school to ensure the sustainability of the program without further support from Texas Instruments.
The MathForward program differs from many other mathematics reform programs in that its components foster a systemic change in the educational system rather than in isolated classrooms. The program emphasizes the need to educate administrators on leadership practices necessary to foster a successful program implementation and to direct a reform in classroom instruction.

**Conceptual Underpinnings of the Study**

The mounting challenges facing our educational system today along with the devastating results of a failing system require educational administrators to be true instructional leaders possessing an understanding of the learning process. Effective principals must no longer be content with continuing the current status quo to maintain a smooth-running organization, but must be visionaries who are constantly seeking ways to effect school improvement with an emphasis on student learning.

**Leadership and Organizational Culture**

Innovation is required to face the changing landscape of education and provide our students with the education necessary for their success and our future success as a nation. One of the major factors repeatedly suggested to affect innovation is leadership (King, 1990; Osborne, 1998; Schein, 1985). Leaders can create and manage an organizational culture that promotes innovation, can be product champions or heroic innovators who support innovation throughout the process of its implementation, and can create organizational structure needed to support innovativeness (Van de Ven, 1986).

Leadership is often linked to the established organizational culture, a system of shared assumptions, values, and beliefs that govern how people behave in organizations.
In order to successfully implement the mission of the organization, a positive culture founded on these shared values, beliefs, and norms must be established. Leaders have a major impact on the formation of organizational culture (Schein, 1985). They can motivate employees to pursue goals that may not have otherwise been attempted, alter employees’ values through changes in the psychological contracts, and encourage the need for change (Rousseau, 1996; Schein, 1985). These descriptors of effective leadership are further established by Fullan (2001) who states that leadership has to have an explicit “making-a-difference” sense of purpose, use strategies that mobilize many people to tackle tough problems, be held accountable by measured and debatable indicators of success, and be ultimately assessed by the extent to which it awakens people’s intrinsic commitment or moral purpose.

Hallinger and Heck (2010) defines school improvement leadership as an influence process through which leaders identify a direction for the school, motivate staff, and coordinate an evolving set of strategies toward improvements in teaching and learning. This understanding of leadership highlights the effect of school leadership on academic and social conditions present in the school, which has an indirect impact on student achievement. This collaborative leadership style empowers the entire school community to drive towards continual improvement based on a shared vision. The principal’s role is best conceived as part of a web of environmental, personal, and in-school relationships that combine to influence organizational outcomes (Hallinger, Bickman, & Davis, 1996). These studies indicate that the impact of principal leadership is achieved through indirect
means such as school climate, school culture, and instructional organization (Hallinger & Heck, 1996).

The instructional leadership required of today focuses on strengthening teaching and learning, professional development, data-driven decision making and accountability with the end result of increasing student learning. A recent report by Hallinger and Heck (2010) shows principals influence school performance by shaping school goals, direction, structure, and organizational and social networks. Further, successful principal leadership guides the school policies, procedures and practices that contribute directly to student learning.

Singh and Manser (2008) and Lumpkin (2008) both emphasized the need for administrators to be an integral part of the achievement process. These authors noted the importance of the relationship that needs to exist between administrators and teachers. Their research focused on the need to establish a collaborative culture that includes the principal as an active participant in the learning process and a promoter for the innovative strategies implemented in the classrooms. This collaborative culture must include a critical balance between increasing student achievement scores while maintaining a high level of rigor enabling students to be successful in more challenging mathematics courses.

The principal of the future—the Cultural Change Principal—must be attuned to the big picture, a sophisticated conceptual thinker who transforms the organization through people and teams (Fullan, 2001). With the pressure to improve the learning environment and increase student achievement, school administrators must be able to
critique the vast amount of reform programs on the market that tout student success and be able to discern what components have a proven research basis to effect student achievement. Newmann, King, and Youngs (2000) defined school capacity as the collective power of the full staff to improve student achievement school wide. At the heart of school capacity is the leadership of principals that focuses on developing teachers’ knowledge, skills, and dispositions, establishing a professional community, ensuring program coherence, and providing technical resources.

While principals serve as the key instructional leaders within a school, they must continually support teachers’ efforts for continual improvement, including the call for reform measures when needed. If students are not performing at high levels, then a comprehensive and coordinated effort is necessary to examine the situation and plan for productive improvement strategies. A programmed approach is an organizing process developed to promote more faithful implementation of planned instructional changes (Berman, 1980). A programmed approach seeks to promote conformity to a well-defined set of instructional practices through reliance on two main organizing processes. First is the development of highly explicit instructional guidance and associated monitoring for fidelity (Desimone, Porter, Garet, Yoon, & Birmun 2002). Second is the enhanced coaching and implementation support by leaders at school sites (Weiss & Cambone, 1994).

**Effective Mathematics Instruction**

With the tremendous challenges facing mathematics education today, educational leaders must apply organizational theories to successfully implement the necessary
strategies to revolutionize the mathematics classrooms. The need for drastic changes in mathematics instruction is substantiated by the National Council of Teachers of Mathematics who recognizes the accelerating transformation in knowledge, tools, and ways of doing and communicating mathematics. In this rapidly evolving world, those who understand and can do mathematics will have significantly enhanced opportunities and options for shaping their futures. While mathematical competence opens doors to productive futures, a lack of mathematical competence keeps those doors closed (NCTM, 2000).

Shellard and Moyer (2002) identified three critical components for effective mathematical instruction including: teaching for conceptual understanding, developing children’s procedural literacy, and promoting strategic competence through meaningful problem-solving investigations. These constructivist aspects of instruction are promoted by the National Council of Teachers of Mathematics (NCTM) who provides evidence that suggests providing students with participatory and inquiry-driven mathematical opportunities that highlight reasoning and problem-solving skills allows them to develop conceptual understandings of mathematical ideas that are often neglected by traditional instructional approaches (NCTM, 2000; NCTM., 2014).

Further research supports a constructivist theory-based approach to teaching mathematics in which students make personal sense of mathematics content through exploring, reasoning, or problem solving (Draper, 2002). This instructional approach encourages a hands-on, student-centered classroom that provides students with opportunities to make connections with prior learning and personal experiences while
exploring complex problems and discussing their problem-solving strategies. Wenglinsky (2002) found that students performed better on achievement tests when teachers provided inquiry-driven, hands-on learning opportunities and focused on higher-order thinking skills. The skills fostered in student-centered mathematics classrooms not only increase success on achievement tests, but also better prepare students for the technological job opportunities of today which require the capacity to evaluate for continual improvement, solve problems with a wide range of resources, collaborate with others, and communicate effectively (Darling-Hammond, 2010).

**Statement of the Problem**

When compared with other developed countries, it is apparent that we are failing to adequately educate our youth to meet the international standards of our global world. We must seek innovative instructional programs that meet the learning needs of our students and foster complex problem-solving skills. It is the educational leaders who need to develop and maintain high expectations for learning and encourage the implementation of programs that promote student achievement and result in a high degree of learning for ALL students. While these are the objectives challenging all districts across the nation, urban school systems in particular are facing great difficulty in meetings the educational needs of our youth.

The Milwaukee Public Schools is the 38th largest district in the country and features a wide array of school types and grade structures. These schools serve a diverse cultural and social population of approximately 80,000 students, an enrollment that has been steadily declining due to white flight. Many successful students from middle-class
families have chosen to enroll their children in private schools and suburban districts. The remaining student population faces many economic and social challenges with 82% of all students eligible for free or reduced lunch. More than half of the students are African-American though the proportion of Hispanic students has been rising significantly. Students with disabilities represent a growing sub-group of the student population, as do English-Language Learners.

Milwaukee’s low attendance rate may be an indication of the lack of student engagement in the learning process. The graduation rate is a dismal 67% which equates to a large population of young adults without the necessary skills to seek productive employment. Another challenge in the district is the high mobility rate of students particularly in lower-income, financially distressed neighborhoods (Milwaukee Public Schools, 2012).

Student test scores and dropout rates are at deplorable levels, both in comparison with the rest of Wisconsin and the rest of the nation’s largest school districts. When compared with 20 other large urban school district using 2011 NAEP (National Assessment of Educational Progress) mathematics scores, the district was fourth lowest at grade 4 and third lowest at grade 8 (National Center for Education Statistics, 2011). A primary district achievement measure is the Wisconsin Knowledge and Comprehension Examination, a criterion referenced test administered in grades 3-8 and at grade 10. In 2010-2011, students at all grades performed below Wisconsin’s annual measurable objective of 68.5% in mathematics with only 48% of all students scoring proficient or above. Proficiency levels decreased across the grade levels with only 30% of 10th graders
scoring proficient or above. Achievement gaps on the state exam between White students and both African-American and Hispanic students remain a pressing issue for the district.

Milwaukee Public Schools unacceptable achievement scores and graduation rate have resulted in the district failing to make Adequate Yearly Progress for the last seven years making it a Level 5 District Identified for Improvement. This status has resulted in the state requiring the district to apply an array of improvement strategies, including more support for lower performing students in reading and math, a corrective action plan in attendance and other programs, initiatives to improve teacher quality and various academic and financial oversight actions. Over 50% of all district schools missed Adequate Yearly Process in 2010-2011 with a third of all district schools labeled as Schools Identified for Improvement (Milwaukee Public Schools, 2012).

The MathForward program has been implemented in thirty-eight classrooms across ten schools in the district. These schools were chosen by the district based on the level of administrator interest in the program and student learning needs. Two of the ten schools have implemented the program for three years with the other eight schools implementing for two years. Unfortunately, as in many urban districts, there is a high turnover rate both with building administrators and teachers in Milwaukee Public Schools, which has resulted in many teachers learning the program anew, each school year. This has caused the MathForward Implementation Specialists to adjust their in-classroom coaching schedule to provide additional support to the teachers that are new to the program. While the high teacher turnover rate has made it difficult to build program
capacity within the district, the experienced MathForward teachers have implemented the program with fidelity.

Milwaukee Public Schools, much like many large urban districts across the nation, is facing severe challenges with struggling student achievement results and low graduation rates and is in much need of finding a successful solution to improve instructional effectiveness in the classrooms. With the publicized district report cards and the many educational choices, many large, urban districts are losing a large amount of their student enrollment to charter schools and private schools resulting in a decrease in funding to meet the needs of the students who remain in the district.

**Purpose of the Study**

While the relationship between the MathForward program and student mathematics achievement scores has been examined, these initial studies were performed in small pilot sites in Ohio, Texas, New York, and Florida during the research and development stage of the program (Winick & Lewis, 2007; Stroup, Pham, & Alexander, 2007). These studies showed mixed results for the effect of MathForward on student mathematics achievement based on a wide range of variables. This study analyzed the program’s results as well as the effect of two of the program’s components, professional development (both training hours and in-classroom coaching hours) and administrative support, on student achievement in a true educational setting fraught with the typical challenges of implementation in a large urban district.

Milwaukee Public Schools, a large, diverse, urban, public school system in Wisconsin is the setting for this study that examined the mathematical achievement gains
of students participating in their teachers’ second implementation year of the MathForward program compared to students in non-MathForward classrooms as measured by the October and June administrations of the Northwest Evaluation Association’s Measure of Academic Progress (MAP) assessment. An independent *t*-test was used to determine if there was a difference in the MAP score gains of students instructed using MathForward and those that were not. Independent *t*-tests were also used to determine if there was a difference in MAP score gains based on the student demographic factors of gender and socio-economic status determined by free or reduced lunch status of the MathForward students as well as the type of curriculum materials used in the MathForward classrooms (Glencoe or Connected Mathematics Project). A one-way analysis of variance (ANOVA) was used to determine if there was a difference in MAP score gains based on student ethnicity.

Additionally, this study examined the quantitative relationship between the amounts of professional development, both training hours and in-classroom coaching hours, received by MathForward teachers and their perceived level of administrator support with the mean difference in the MAP score gains of their students using multiple linear regression with the independent variables entered into the equation in a stepwise fashion. The amount of professional development as measured in hours, divided into training and in-classroom coaching hours received by each teacher, was compared to student mathematics achievement gains. To measure the teachers’ perceived level of administrator support, an anonymous, confidential, and online survey was completed by the teachers. The survey contained scaled questions that measured their perceptions of
their building administrator’s support for the MathForward program. This investigation analyzed the crucial role of the building administrator in fostering an effective school culture and motivating teachers to successfully implement school reform initiatives.

Finally, this study used the Reformed Teaching Observation Protocol (RTOP) to measure the quality of classroom instruction in the MathForward classrooms. The RTOP provided a holistic measure of the presence/absence of specific teaching strategies divided into five subscales: lesson design and implementation, propositional knowledge, procedural knowledge, student-teacher classroom interaction, student-student classroom interaction. This tool provided a quantitative measure of the quality of classroom instruction. The total RTOP score was added into the multiple linear regression analysis as one of the independent variables.

**Research Questions**

The primary research questions addressed in this study are:

1. Does MathForward classrooms have higher mathematics achievement gains than non-MathForward classrooms as quantified by the Measure of Academic Progress (MAP) assessment after the teachers have achieved two years of MathForward program implementation experience?

2. To what extent does the amount of professional development, both training and in-classroom coaching, as quantified by hours measured through in-service attendance and in-classroom coaching records affect student achievement gains after the teachers have achieved two years of MathForward program implementation experience?
3. To what extent does the teachers’ perceived level of administrator support affect student achievement gains after the teachers have achieved two years of MathForward program implementation experience as measured by teachers’ survey responses?

4. To what extent does the quality of classroom instruction effect student achievement gains after the teachers have achieved two years of MathForward program implementation experience as measured by the Reformed Teaching Observation Protocol (RTOP)?

To focus directly on the effects of the MathForward program, student demographic factors of gender, ethnicity, and socioeconomic status determined by free or reduced lunch status as well as the type of curriculum materials used by the students was examined as part of the analyses. These factors were addressed by the following secondary research questions:

1. Are there differences in mathematics achievement gains between males and females as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

2. Are there differences in mathematics achievement gains between students receiving free or reduced lunch and students not receiving free or reduced lunch as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?
3. Are there differences in mathematics achievement gains between Caucasian students, African-American students, Hispanic, and Other (Asian, American Indian, and Alaskan Native) students as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

4. Are there differences in mathematics achievement gains between students using Glencoe curriculum materials and students using Connected Mathematics Project curriculum materials as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

Limitations

Even though the MathForward program is implemented in over forty districts across fifteen different states, Milwaukee Public Schools was chosen as the district to study due to the numerous challenges facing large urban districts across the nation. Due to the unique demographics of Milwaukee Public Schools, the results of the study may not be generalizable beyond the specific population from which the sample was drawn.

The quasi-experimental research design used students previously assigned to classrooms, creating the internal validity issue of teacher effect on the class as a whole. The MAP assessment was also administered by the classroom teacher causing the potential for teacher effect on students. The mathematics achievement gains determined by the MAP assessment may be a reflection of classroom instruction as well as other instructional programs and/or tutoring which was not accounted for in this study.
Since this study employed a pre-post-test quasi-experimental design, mortality and maturation may be issues. Due to the high mobility rate of students in the Milwaukee Public Schools, a significant number of subjects in both the control and experimental group may have been lost during the course of the school year. The large sample size for both the control and experimental groups should have reduced the effect of mortality. Maturation of students is also an issue with a repeated measures design because of the natural cognitive development of students. The issue of maturation was minimized however, due to the span of the study being one school year.

Additionally, the limitation of research bias cannot be completely eliminated from this study due to the professional role of the researcher with the MathForward program. The researcher was employed by Texas Instruments as the MathForward supervisor and was responsible for overseeing the program implementation. The researcher’s preconceived beliefs and prejudices are abated by the quantitative design of the study.

Assumptions

This study assumed that the sample group is representative of the general student population of the Milwaukee school district and that the demographics of the control and experimental groups are similar. Including the demographics of both control and experimental groups and analyzing any significant effects on gender, race, and socio-economic status on student mathematics achievement gains addressed this concern.

The study examined the effect of perceived administrator support by collecting survey data from the participating teachers. The administration of the survey assumed that all respondents participated and completed the survey questions truthfully and to the
best of their abilities. The concern of validity was addressed by preserving the anonymity and confidentiality of the participants.

The final assumption in the study is that the moderators of perceived administrator support, amount of professional development, and quality of instruction will have an effect on the dependent variable of student achievement gains in mathematics.

**Delimitations**

This study examined the student mathematics achievement gains in the Milwaukee Public School District. This district was chosen from other districts implementing the Texas Instruments MathForward program due to its large-scale implementation and its urban setting.

This study also examined only the students of teachers who have had two years of MathForward program implementation experience. At the time of the study, three teachers in the district had implemented the program for three years, four teachers had implemented the program for only one year, and eighteen teachers had implemented the program for two years. In order to provide a large sample size, this study only examined the effect of the program on teachers with two years of implementation experience.

Additionally, this study used an online survey to measure the teachers’ perceived level of administrator support for the MathForward program. In order to assure manageability of the collected survey data, the survey used only multiple-choice items and did not include open-ended response items.
Definitions of Key Terms

The following terms are directly related to the study and will be used throughout the research. Their definitions will provide a clear understanding of each concept that is critical to the significance of the study.

Administrator Support Survey – An online anonymous and confidential survey was provided to MathForward teachers. The survey consisted of six questions designed to assess the perceived level of administrator support by the MathForward teachers in each school.

Mathematics Student Achievement Gains – The difference in raw scores between the October and June administration of the MAP assessment results was a measure of each student’s mathematics achievement gains during the 2012-2013 school year.

MathForward Implementation Specialist – A MathForward Implementation Specialist was assigned to each district implementing the MathForward program. The implementation specialist provided professional development through trainings on the integration of technology as well as best instructional practices. Additionally, the implementation specialist provided in-classroom coaching to each MathForward teacher consisting of modeling, co-teaching, and observations with post-conferences.

MathForward Program – The MathForward program is a comprehensive mathematics pre-algebra and algebra-readiness program developed by Texas Instruments for students in sixth grade through Algebra I. Eight research-based components form the foundation of the program aimed at increasing student mathematics achievement and teacher efficacy.
*Measured Academic Progress Assessment (MAP)* – Northwest Evaluation Association provides a Measured Academic Progress assessment to measure students’ mathematical progress. The assessment was administered to students in the Milwaukee Public Schools in October and June.

*Professional Development Hours* – Total number of hours each MathForward teacher had spent engaged in both in-service trainings on best instructional practices and receiving in-classroom support from the MathForward Implementation Specialist.

*Reformed Teaching Observation Protocol (RTOP)* – The Reformed Teaching Observation Protocol is an observational instrument designed to measure reformed teaching. It was created by the Evaluation Facilitation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers and has been measured for validity and reliability.

*Student Achievement* – Student achievement is considered the status of subject-matter knowledge, understanding, and skills at one point in time as measured by a standardized test.

**Summary**

Large urban districts across the nation are struggling with student achievement, especially in the content area of mathematics. The lack of student engagement and student comprehension of mathematics leads to devastating consequences including graduates not able to fulfill the high-tech job openings resulting in an increased reliance on social welfare programs. These districts are in desperate need for solutions to increase student mathematics achievement.
Educational leaders of large urban districts have the massive responsibility to lead the necessary instructional reform movements within their buildings. To make knowledgeable decisions, administrators must be aware of the effective instructional components that will have a positive impact on both teacher effectiveness and student success. The actions chosen by building administrators also have a direct impact on the success of instructional reform initiatives within their buildings.

This study examined the effects of one mathematics reform program, the Texas Instruments MathForward program, on student mathematics achievement in the Milwaukee Public Schools. The effects of the amount of professional development, both in-service trainings and in-classroom coaching sessions, and the amount of administrator support on student mathematics achievement were also analyzed. The results of this study provide information to educational leaders on the efficacy of the MathForward program as well as the effect of professional development, both in-service trainings and in-classroom coaching sessions, and administrator support on the successful implementation of the program.

In conclusion, educational leaders must find effective solutions to engage students in the learning process and to effectively meet their instructional needs in the classroom in order to preserve and renew the foundation of public education. District administrators play a critical role in determining and providing appropriate support for instructional initiatives that result in increased student achievement. If potential effective instructional programs are not examined as solutions to the current educational crisis and appropriate
supports are not put in place to ensure successful implementations, our nation will continue to be left behind.
CHAPTER II

LITERATURE REVIEW

Challenges Facing Urban School Districts

“To create urban schools which really teach students, which reflect the pluralism of the society, which serve the quest for social justice – this is a task which will take persistent imagination, wisdom, and will” (Tyack, 1974)

The struggle to establish and maintain high performing schools in urban centers is largely the outcome of broader social changes that transformed urban America in the last half of the 20th century. In spite of its good intentions, the implementation of the decision by the U.S. Supreme Court in Brown v. Board of Education (1954), which ordered the dismantling of the legal system supporting the segregation of schools, did not lead to sustained integration of most school systems and ultimately, much of its early impact has been negated by White resistance and White flight from the central cities of large urban metropolitan areas (Caldas & Bankston, 2007). Without resolving the problem of unequal educational opportunity, the educational vestiges of urban school districts’ segregationist pasts continue to invade its contemporary school systems (Ladson-Billings, 2006).

Between 1960 and 2012, the national poverty rate for those living in urban areas rose from 13.4% to 24.1%, more than double the 11.7% rate in suburban areas (U.S. Bureau of the Census, 2012). While urban cores have experienced the best decade for net population increases, more than 80% of the population growth in these areas was below the poverty line (U.S. Bureau of the Census, 2010). Urban school districts felt the full
force of these economic and demographic trends as their student populations became poorer and brought with them the academic, health, and social disadvantages associated with concentration of poverty (Brooks-Gunn & Duncan, 1997). The historical remnants of deindustrialization, concentrated poverty, and segregation have left urban schools characterized as institutions embedded with symbols of poverty, oppression, and racism (Kozol, 1991). As a result, urban school districts face increased and concentrated poverty in its schools as well as decreased tax revenues to meet students’ instructional and non-instructional needs (Anyon, 1997).

In comparison to suburban and rural districts, urban school districts are frequently marked by higher concentrations of poverty, greater racial and ethnic diversity, larger concentrations of immigrant populations and linguistic diversity, and more frequent rates of student mobility (Kincheloe, 2010). While these socio-demographics are not the challenges of urban school districts, the concentration of poverty and racial isolation matters in that it is directly related to school processes that significantly influence achievement trends (Rumberger & Palardy, 2005). As Orfield (2004) explained, segregation and poverty underlie grander issues in urban education systems.

Urban school districts have been described as “sliding schools” (Myers & Goldstein, 1997), “schools in a cycle of failure” (Reed & Davis, 1999), and as schools having “a vast web of interconnected social challenges (Burnett, 1994). Haberman (2000) describes more successful urban schools as “day camps” and less successful schools as “custodial institutes”. These descriptors all lead to the current view of urban
schools as places where one finds low test scores, a high number of discipline referrals, a high drop-out rate, little safety, and high levels of stress among teachers and students.

Students enrolled in urban schools represent the widest range of diversity in the nation. When compared with the national average, schools that are members of the Council of Great City Schools, an organization composed of 57 large, city school districts, have 21% more African-American students, 14% more Hispanic students, 23% more students on free or reduced lunch, and 10% more English language learners (Council of the Great City Schools, 2003). Howey (1996) described many urban students as having low, distorted academic expectations, nominal understanding of the ramifications of not acquiring a good education and minimal vocational aspirations, minimal adult supervision, cultural dissonance with the middle class and cultural isolation from other cultures, early and strong negative peer socialization aspects, forms of social, psychological and physical deprivation due to extreme poverty, and common exposure to drugs and violence.

These social and psychological issues contribute to a variety of academic concerns. The National Assessment of Educational Progress (NAEP) report of its Trial Urban District Assessment of grades 4 and 8 found that performance in urban public schools was well below the national average (NCES, 2011). In 2006, Rampey, Lukus and Dion reported that 75% of 12th graders in urban schools lack basic skills in mathematics, and 80% lack basic skills in science based on the NAEP. Poor African American, Hispanic American, and Native American students perform well below Whites in all subjects and at all grade levels (Olson, 1997). These inadequate academic skills
and low levels of literacy result in a higher percentage of urban youths than youths from the general population to drop out of school (Fossey, 1996). When these students drop out of school, they become unemployed or underemployed during their adult lives (Lewis, 1996). Not only does a high percentage of urban students not complete high school, but they also do not pursue aspirations for higher education. Over one half of urban high school students are not enrolled in a college-preparatory curriculum and this rate drops to only one in four for minority and low-income students (Freel, 1998). The vast majority of students want to succeed in school and view school as important to being successful in life, but structural barriers both inside and outside school often stand in the way of the realization of this (Theoharis, 2009). Additionally, negative stereotypes about families often misinform educators and lead to negative views about urban students (Harry & Klingner, 2006).

While the common definition of an urban school is its location in a central city of a metropolitan area, a high population of at-risk students often characterizes urban schools. There are many descriptions of at-risk students with Dr. Arthur Pearl (1972) providing an over-arching definition of “any child who is unlikely to graduate, on schedule, with both the skills and self-esteem necessary to exercise meaningful options in the areas of work, leisure, culture, civic affairs, and inter/intra personal relationships.” A 2001 report by the U.S. Bureau of the Census describes three personal and four familial at-risk conditions for the school age population. The personal conditions are: presence of a disability, ever retained in school, and speaking English less than very well. The familial conditions are: either or both parents absent from the household, at least one
foreign-born parent of recent immigration, low family income, and no employed parent. The report indicates that for nearly every indicator of risk, children living in central cities have much higher levels of the risk factors than do children in either the suburbs or in nonmetropolitan areas. This consistently high occurrence of risk factors for children in central cities may mean that their lives are far more volatile than their peers in other geographic areas and results in greater challenges for the urban school district trying to meet their needs.

Urban school systems tend to have specific structural challenges that impede their ability to effectively educate the most at-risk students. While these structural challenges may be seen in all types of educational contexts, they are most potent in urban settings. These challenges include: persistently low student achievement; a lack of instructional coherence; inexperienced teaching staff; poorly functioning business operations; and low expectations of students (Kincheloe, 2010). The budgetary and resource challenges facing urban districts results in the lack of effective or utilized data management systems (Manpower Demonstration Research Corporation, 2002), making it difficult for them to identify student needs and monitor student progress.

Urban schools are bombarded with so many instructional initiatives and approaches that they can become fragmented or even contradict each other. Given the diversity of their student populations’ needs, urban school districts require a variety of initiatives, but these need to target specific and identified needs that are aligned within a broader vision of student success and academic standards (Ahram, Stembridge, Fergus, & Noguera, 2012). Initiatives should be chosen with attention to what is already being
implemented with the school district and should utilize expertise within the schools for coaching and program building.

The challenges facing urban school districts are also framed in terms of urban school personnel. The issue of teacher quality is considered central to growing efforts to understand and reduce performance gaps in achievement between students of color and their Caucasian and Asian peers (Ferguson, 1998). Urban schools are more likely to be staffed by academically under-prepared and inexperienced teachers and to experience a higher teacher turnover (Chester, Offenberg, & Xu, 2001). After more than a decade of calls to increase the quality of teachers in urban schools, there is a consistent decrease in the percentage of certified teachers in urban schools (Shen & Poppink, 2003). Not only are urban teachers less likely to be prepared in their content areas, but these teachers also score lower on literacy skills measures on teacher certification examinations (Ferguson, 1998) and rank classroom management as one of their main challenges (Weiner, 2003). Furthermore, urban teachers have a high level of absenteeism and are more likely to transfer out of their positions (Maxson, Wright, Houck, Lynn, & Fowler 2000). Teachers are drawn to schools with low concentrations of poverty, low minority populations, and high levels of student achievement, thus illustrating the problem of teacher quality as one related to teacher mobility (Boyd, Lankford, Loeb, & Wyckoff, 2005).

Urban schools often fail to provide environments of high academic expectations (Noguera, 2003; Valencia, 2000). Case studies by Manpower Demonstration Research Corporation (MDRC) have shown that teachers in urban school districts can feel overwhelmed by what they consider to be the high needs of their students, and thus lower
their own expectations for student performance (MDRC, 2002). This is also evidenced in the absence of demanding and high level courses and programs such as advanced placement courses and gifted programs (Fine, 1991).

A 1999 report by the U.S. Department of Education concludes that the condition of the physical environment and resources of a school building are vital to academic success in high-poverty areas (Lewis & Sugai, 1999). Yet even with the comparatively greater academic and social needs of urban students, urban schools typically receive substantially less funding per student than those of their surrounding suburban districts (Council of the Great City Schools, 1998). Despite funding intended to reduce the economic inequities stemming from a low tax base in urban communities, high-poverty and high-minority population schools receive an average of $900 per student less than lower-poverty and lower-minority schools (The Education Trust, 2002). This lack of funding results in substandard buildings and inadequate equipment and supplies (Kozol, 1991). According to the National Center for Educational Statistics (NCES) (2005), high-poverty schools are lacking in the basic instructional technology that might serve to reduce the achievement gap. These schools have a significantly higher ratio of students to computers than more economically affluent schools (Parsad & Jones, 2005). Additionally, urban teachers describe their classrooms as overcrowded and bemoan the increasing standards students are expected to meet with declining material resources (Maxson, Wright, Houck, Lynn & Fowler, 2000). This overcrowding is believed to impact the instructional techniques teachers are able to use, the level of student concentration in class, and classroom management.
The No Child Left Behind Act of 2001 was designed to ensure “all children have a fair, equal, and significant opportunity to obtain a high-quality education” (U.S. Department of Education, 2002). However, unless the myriad of issues related to teaching and learning in urban schools are addressed from a student-centered and sociocultural perspective, positive student outcomes will address only surface issues, such as test scores and school grading, which are merely symptoms of the problem of underachievement rather than causes (Gay, 2000). The reality of the matter is that many students in urban areas have been left behind and will continue to be left behind as a result of poor educational experiences and the effects of poverty (Townsend, 2000).

**Milwaukee Public Schools**

By the late 1980’s, Milwaukee became one of the most hyper-segregated urban cities in the North, more racially and socioeconomically segregated than New York, Philadelphia, and Los Angeles (Massey & Denton, 1993). Between 1980 and 1990, the poverty rate among African Americans doubled increasing from 25.2% to 54.8%. Additionally, Milwaukee had one of the largest increases in concentrated poverty where predominantly African American census tracts experienced 40% of residents living below the poverty line (Jargowsky, 1997). Milwaukee’s drastic social and economic deterioration combined with the vestiges of unequal learning opportunities in its schools have created even greater challenges for the community.

A “majority minority” school system exists in Milwaukee even though the African American community is only 27% of the city’s total population (U.S. Census Bureau, 2012). African American students in Milwaukee Public Schools not only attend
highly segregated schools, but also highly impoverished schools due to the growing areas of concentrated poverty in the community (Levine & Zipp, 1993). The number of Milwaukee Public Schools students listed as being in poverty increased significantly from just over half of all students (55.8%) in 1982 to a large majority (82%) of students in 2012. Some predominantly African American school communities have extensive concentrated poverty with over 80% of enrolled students qualifying for free or reduced lunch (MPS District Report Card, 2011). The demographics of Milwaukee Public Schools are substantially less favorable than those of the United States at large and suggest some of the possible challenges to achievement of desired levels of student learning.

Table 1: Socio-demographic Characteristics of the MPS and U.S. Populations

<table>
<thead>
<tr>
<th>Demographic Characteristic</th>
<th>MPS</th>
<th>United States</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-white residents</td>
<td>55%</td>
<td>25%</td>
</tr>
<tr>
<td>Families with children under 18 living below poverty</td>
<td>41%</td>
<td>19%</td>
</tr>
<tr>
<td>Households receiving cash public assistance or food</td>
<td>29%</td>
<td>16%</td>
</tr>
<tr>
<td>Residents speaking languages other than English</td>
<td>19%</td>
<td>21%</td>
</tr>
<tr>
<td>Families with children under 18 and only parent</td>
<td>59%</td>
<td>34%</td>
</tr>
<tr>
<td>Adults with less than a high school diploma</td>
<td>19%</td>
<td>14%</td>
</tr>
</tbody>
</table>

*U.S. Bureau of the Census/American Community Survey, 2010*

The Milwaukee Public Schools, the 38th largest district in the country, has established a wide array of school types and grade structures to meet the academic and social needs of their students. There are currently 166 schools in the district including 113 elementary schools (kindergarten through 8th grade), 8 schools serving grades 6
through 12, 4 traditional middle schools, 23 high schools, and 18 alternative schools. These schools are a mix of traditional, language immersion, arts, International Baccalaureate, and Montessori.

During the 2010-2011 school year, the district employed approximately 9,800 full-time staff members, providing a staff-to-student ratio of 15.1%. This is a five percent reduction from five years earlier due to the district decreasing their staffing to align with the shrinking student population. Over 73% of the staff has at least five years of district experience and 35% of the staff has a master’s degree or higher, a relatively low percentage when compared to 55% of all Wisconsin educators. Based on the highly qualified criteria from No Child Left Behind, 92.4% of full-time teachers were highly qualified with 4.5% possessing an Emergency License and another 3.1% having no license for their current assignment.

The district serves a diverse cultural and social population, including those who have traditionally been under-represented based upon race, language, ability or socio-economic status. There are approximately 80,000 students in MPS, an enrollment that has declined by 18% over the last eight years. The largest decline in enrollment is across the high school grades, which can be explained by a high school dropout rate of 7.5% during the 2009-2010 school year.

Milwaukee is now considered the nation’s fourth poorest U.S. city of its size, which is reflected in the MPS student population with 82% of all students eligible for free or reduced lunch. More than half of the students are African-American though the proportion of Hispanic students has been rising significantly while the percentage of
White students has been shrinking. Students with disabilities represent a growing percentage of students in the district and accounts for about 21% of all students. Eleven percent of the students are English-Language Learners, another growing sub-population.

**Student Demographics of MPS**

![Student Demographics of MPS](image)

*Figure 1. Student Demographics of Milwaukee Public Schools*

The geographic movement of families in the city has accelerated in recent years, particularly in lower-income financially distressed neighborhoods. Fifteen percent of all students in MPS change schools during the school year creating great challenges for the new schools serving them. The overall attendance rate is holding steady at 90%, and the graduation rate is a dismal 67% even though the number of graduates has risen by 15% since 2000 (Milwaukee Public Schools, 2012).

The Milwaukee Public School district, like many of its big-city counterparts across the country, continues to suffer from poor student performance. Student test scores and dropout rates are at deplorable levels, both in comparison with the rest of
Wisconsin and the rest of the nation’s largest school districts. In 2011 MPS participated in the NAEP (National Assessment of Educational Progress) Trial Urban District Assessment to allow comparison of district student performance with other large participating districts in the subjects of reading and mathematics at grades 4 and 8. When compared with 20 other large urban school districts, MPS was fourth lowest at grade 4 and third lowest at grade 8 in mathematics assessment scores. Overall, MPS scored below the urban district average in reading and mathematics at both grades 4 and 8.

A primary district achievement measure is the Wisconsin Knowledge and Comprehension Examination, a criterion referenced test administered in grades 3-8 and at grade 10. In 2010-2011, students at all grades performed below Wisconsin’s annual measurable objective of 68.5% in mathematics with only 48% of all students scoring proficient or above. Mathematics proficiency levels decreased across the grade levels with only 30% of 10th graders scoring proficient or above. Given the poor performance of MPS tenth graders, it is not surprising to find that many of them do not make it to graduation.

Achievement gaps remain a pressing issue for Milwaukee Public Schools. The mathematics achievement gap between White students and their African American peers generally widens from lower to higher grades with a gap of 31% in grade 8 and 35% in grade 10. There is also a significant achievement gap for students with disabilities and general education students with an average gap of 30% in the tested grades of 4 and 8. Another substantial achievement gap of 26% in grade 4 and 22% in grade 8 exists between students receiving free or reduced lunch and those students who do not.
Under No Child Left Behind each state was required to develop an accountability system to measure school and district performance. Wisconsin’s accountability plan has the major components of test participation, attendance and graduation rate, and achievement scores in reading and in mathematics. A school and/or district must fail to meet Adequate Yearly Progress for two years in a row in one of the components before it is defined as a School or District Identified for Improvement. Over 50% of all district schools missed Adequate Yearly Process in 2010-2011 with a third of all district schools labeled as Schools Identified for Improvement (SIFI). Milwaukee Public Schools deplorable achievement scores and graduation rate have resulted in the district failing to
make Adequate Yearly Progress for the last seven years making it a Level 5 District Identified for Improvement. This status has resulted in the state requiring the district to apply an array of improvement strategies, including more support for lower performing students in reading and math, a corrective action plan in attendance and other programs, initiatives to improve teacher quality and various academic and financial oversight actions.

**Transformational Leadership in Effecting Change**

We are currently facing a critical point in public education when effective and sustained change is necessary for a successful future for our current generation of school-age children. Innovative leaders must pilot the transformation required of our public school system with a future-oriented, results-driven vision supported by all organization members. Michael Fullan spoke of this sense of urgency, “Status quo is not acceptable, and only through a change orientation can leaders realize true effective results” (Fullan, 2005).

The significant role of educational leaders on creating and sustaining change is more evident than ever before. Marzano (2003) states, “leadership could be considered the single most important aspect of effective school reform.” Today’s school leadership is the critical key to school improvement. Hess and Kelly state, “school principals are the front-line managers, the small business executives, the team leaders charged with leading their faculty to new levels of effectiveness. In this new era of educational accountability, where school leaders are expected to demonstrate bottom-line results, the skill and knowledge of principals matter more than ever” (2007).
Transformational leadership has been a vital component of successful businesses and non-profit organizations for several decades. These organizations put in place transformational leaders that were future-oriented, open-minded, dynamic, and concerned about planning (Harris, 1985). These leaders renewed employee commitment to the organization by redefining organizational mission and vision (Roberts, 1985). Transformational leaders expected employees to think beyond themselves and to become high performers and leaders themselves (Bass, 1995). They used charisma, individualized consideration, inspiration, and intellectual stimulation to stimulate creativity and enhance employees’ capacity to innovate. Transformational leaders strove to unite employees and encourage them to make the organization’s vision a reality (Bryman, 1992).

Burns (1978) is attributed with developing the concept of transformational leadership that is grounded in a process-centered theory rather than a leader-centered theory. Burns established much of the framework for the constructs of the transactions and transformational leadership paradigm and noted a decided difference between those leaders whose exchanges with followers were transactional and those whose interactions with followers were transformational. Burns (1978) viewed transformational leadership as potentially the more powerful of the two approaches since it occurs when one or more persons engage with others in such a way that leaders and followers raise one another to higher levels of motivation and mortality. While transactional leaders focused on the exchanges between leader and followers, transformational leaders appealed to higher order needs, thus engaging the follower across every dimension (Burns, 1978). A noted
difference between the models is that transactional leaders operate within the framework of the interests of their followers as opposed to transformational leaders who seek to change the framework altogether (Bass, 1990, Sashkin & Burke, 1990).

However, even though Burns’ model of transformational leadership provides many new dimensions to the study of leadership theory, it remains leader-focused and is hierarchical in nature. Building on the early work of Burns, Bass helped bridge the gap between transactional and transformational leadership (Sashkin & Rosenbach, 1998). Bass’s work emphasized that transactional and transformational leadership models were not incompatible. In fact, leaders typically use both approaches although transformational leadership is often more powerful in its effect (Avolio & Bass, 1999).

Progressing into the decade of the 1980’s, scholars of educational leadership termed the definition of “instructional leadership” as the means for improving our schools. However, the instructional leadership model represented a unitary style of management leadership, with minimal focus on specific leadership behavioral characteristics (Hallinger, 2005). Borrowing from the success of the corporate world, the model of transformational leadership has become an extremely popular image of ideal practice in schools at the present time. Collins (2001) found that transformational leaders have a deeper and more lasting influence on organizations and provide more comprehensive leadership if their focus extends beyond maintaining high standards. Like the business leader, the principal of the future must be attuned to the big picture, a sophisticated conceptual thinker who transforms the organization through people and teams (Fullan, 2001).
Building on early researchers of the transformational framework, Leithwood (1992) was inspirational in developing the transformational model of school leadership based on the four I’s (individual consideration, intellectual stimulation, inspirational motivation and idealized influenced). These four characteristics are necessary skills for school principals if they are to meet the challenges of the 21\textsuperscript{st} century (Marzano, Waters, & McNulty, 2005). Transforming leaders convert followers to disciples; they develop followers into leaders. They elevate the concerns of followers from needs of safety and security to needs for achievement and self-actualization, increase their awareness and consciousness of what is really important, and move them to go beyond their own self-interest for the good of the larger entities to which they belong. The transforming leader provides followers with a cause around which they can rally (Bass, 1995).

In the educational setting, transformational leadership attempts to influence the conditions that directly impact the quality of curriculum and instruction delivered to students in the classroom and targets variables in the change process while using strategies as encouraging continuous learning among staff, sharing learning throughout the organization, and working with the community toward achieving broader organizational goals (Hallinger, 2003). Transformational leaders seek new ways of working, seek opportunities in the face of risk, prefer effective answers to efficient answers, and are less likely to support the status quo (Avolio, Bass, & Jung, 1999). Transformational leaders do not merely react to environmental circumstances; they attempt to shape and create them.
A key focus of transformational leadership is on organization and followership with the goal of increasing the organization’s capacity to innovate by elevating the follower’s interest and motivation to a higher level (Hallinger & Heck, 1998). Leithwood (1992) found that principal effects are achieved through fostering group goals, modeling desired behavior for others, and providing intellectual stimulation and individualized support. These objectives of transformational leadership foster motivation in team members to do more than they originally thought possible. Thus, team members’ perceptions of self-efficacy as well as their developmental potential are enhanced through the transformational leadership process (Avolio, Bass, & Jung, 1999).

Fostering the developmental potential of all team members is critical in sustaining change. “It has become increasingly clear that leadership at all levels of the system is the key lever for reform, especially leaders who focus on capacity building and on the development of other leaders who can carry on” (Fullan, 2006). This model of distributed or collaborative leadership is seen as a sustainable means of building the type of learning-focused climate that characterizes high-performing schools (Day, Gronn, & Salas, 2006). In order to maintain the reform movement, transformational leaders must create changes that are embraced and owned by the teachers who are responsible for implementation in the classrooms. Additionally, with the increase in work expectations and responsibilities of building administrators, principals must be able to rely on their team members to work towards the shared vision of the school. The process of transforming team members does not merely empower them or delegate to them the responsibility of fulfilling a goal; rather, it develops their capability to determine their
own course of action. In essence, team members become leaders, and leaders become exemplary team members (Onorato, 2013).

Research by Avolio & Bass (2004) summarizes characteristics of a transformational leader as:

- Transformational leaders become a source of inspiration to others through their commitment to those who work with them, their perseverance to a mission, their willingness to take risks, and their strong desire to achieve.
- Transformational leaders diagnose, meet, and elevate the needs of each of their team members through individual consideration. They believe in promoting continuous people improvement.
- Transformational leaders stimulate their team members to view the world from new perspectives, angles, and informational sources. They question even the most successful strategies to improve them over time.
- Team members trust their transformational leaders to overcome any obstacle, because of their hard work, their willingness to sacrifice their self-interest, and their prior successes.

Educational leadership researchers Leithwood and Hallinger subscribe to a transformational leadership framework that can ultimately change and elevate performance beyond expectations. While research generally supports the conclusion that school leadership exerts a measurable, albeit, indirect, effect on student learning (Hallinger & Heck, 1998), these effects appear to be achieved through strategic actions
that focus on the transformation of sociocultural, structural, and academic processes (Leithwood & Jantzi, 2006).

Improved student learning is the central focus for today’s school districts and leadership is second only to teacher quality as the defining difference between schools that achieve high student performance and those that do not (Seashore-Louis, Leithwood, Wahlstrom & Anderson, 2010). The Wallace Foundation (2012) synthesized more than seventy research reports on educational leadership and found five key functions performed by effective principals:

- Visions of academic success: Narrowing the achievement gap can be accomplished only if a principal establishes a vision of student success and commitment to high standards that is shared and supported by members of the school community (Knapp, Copeland, Honig, Plecki, & Portin, 2010). This shared vision of academic success is essential for the overall achievement of all students (Porter, Murphy, Goldring, Elliott, Polikoff, & May, 2008).

- Hospitable learning climate: Effective learning and teaching requires a school community characterized as an upbeat, welcoming, solution-oriented, no-blame, professional environment (Portin, Knapp, Dareff, Feldman, Russell, Samuelson, & Yeh, 2009). The caring and trusting atmosphere makes learning the central focus for adults and children.

- Cultivating leadership: Collective leadership allows shared decision making by principals, teachers, and community members and maintains a focus on student achievement expectations and goals (Seashore-Louis, Leithwood,
Wahlstrom, & Anderson, 2010). Relational trust created through collective leadership enhances teacher collaboration and profession development, which in turn generates higher student achievement.

- Improved instruction: Effective principals understand that quality instruction is essential for improved student learning, (Portin, Knapp, Dareff, Feldman, Russell, Samuelson, & Yeh, 2009) and regularly visit classrooms to observe teaching and monitor student learning. These formative assessments inform principals about the school’s progress in achievement of established goals. This intense focus on teaching and learning assures quality instruction yields high achieving learning.

- Management of resources: Effective principals are effective managers of people, data, and processes within the schools they serve (Portin, Schneider, DeArmond, & Gundlach, 2003). They hire staff members and provide support to them while taking appropriate action to replace under-performing staff members.

The overwhelming principle emerging from the research is that school leaders make a clear and demonstrable impact on student achievement through several avenues of influence.

**Administrator Support for Implementing Change**

Education research has made important advances in defining practices that are effective, or evidence-based, in improving students’ academic and social outcomes (Slavin, Cheung, & Holmes, 2013). Although the content of the evidence-based practice
or innovation is critical, it is insufficient to ensure academic success (Datnow, 2005). The implementation process of the innovation is an under-emphasized component necessary for transforming the promise of an effective innovation into the outcome of improved student achievement (Buzhardt, Greenwood, Abbott, & Tapia, 2006). While researchers have described a number of factors that affect the sustainability of evidence-based practices in schools including contextual relevance, staff buy-in, professional development and on-going technical support, data-based decision making, and a shared vision of expectations and desired outcomes among school personnel (Baker, Gersten, Dimino, & Griffiths, 2004), school personnel perceive the role of the building administrator as singularly important to the sustained implementation of effective programs and practices (McIntosh, Predy, Upreti, Hume, Turri, & Matthews, 2014). The building administrator serves as the key stakeholder in spearheading the implementation process and affecting the potential for student success.

Administrative support is the feature of sustainability most strongly emphasized in the literature (Elliott & Mihalic, 2004) and has been linked to successful teaching and learning outcomes (O’Donnell & White, 2005). Although different levels of administrators play a role in sustaining innovations in the school, the principal is seen as the most critical player. Implementation and sustainability research have demonstrated that leadership is the base upon which a sustainable program is built (Benz, Lindstrom, Unruh, & Waintrup, 2004) and has a direct relationship to the quality of implementation (Kam, Greenberg, & Walls, 2003). Leaders provide direction and motivation for the innovation by sheltering teachers from other pressures, demonstrating that the innovation
is part of the central mission of the school, and communicating positively about the innovation with staff (Sindelar, Shearer, Yendol-Hoppey, & Liebert, 2005).

Building administrators are in a unique position to improve the likelihood of sustained implementation because they can do the following (Adelman & Taylor, 1998; Blasé & Fixsen, 2004; Fullan, 2002; Kam, Greenberg, & Walls, 2003):

- Play a key role in creating a school culture in which staff members share common values and work together to achieve common goals.
- Orient staff to new ways of doing business.
- Provide clear staff expectations.
- Ensure accountability by routinely asking staff to report on the progress of implementation and the types of support they need.
- Creatively allocate limited resources to help ensure that personnel have access to necessary supports such as data systems needed for decision-making and time available to meet regularly.

By implementing these strategies, administrators can thereby help ensure the high levels of fidelity of implementation that are associated with sustained success (Bambara, Goh, Kern, & Caskie, 2012; Adelman & Taylor, 1998; Fullan, 2002).

According to Mitchell (2005), the school principal’s role is crucial in building school culture and motivating teachers. Principals need to provide moral support for the teachers in their building. Moral support from administrators can provide reassurance in a climate of uncertainty and instability which may accompany instructional reform and
can bolster the efforts of teachers, particularly in the initial stages of implementation (Hobbs, 1989).

Additionally, administrators must schedule frequent observations of classrooms to ensure fidelity of the program implementation. Teacher evaluation is an important aspect of a school’s professional culture, and must convey respect for teachers and high expectations of performance (Danielson, 2002). It is vital for principals to make frequent classroom visits so they can assess the current professional development needs of the teacher as well as assure that all students are being held to the same rigorous standards.

Research shows that a resistance to instructional reform can be expected to occur when there is an intensified demand on support materials and equipment (Guskey, 1986). In order to successfully implement an innovation, it is vital that administrators allocate the resources necessary for materials and equipment as well as the professional development for the teachers. Effective professional development is an on-going sustainable process that builds collaboration, generates and shares professional knowledge, uses current research, and informs the daily work of teachers and leaders (Darling-Hammond, 1997). With this understanding of the professional development, it is crucial for administrators to plan for the supports necessary to ensure continuing support throughout the school year.

Principals carry with them several different forms of capital (social, cultural, and political) that has strong influence in specific socially constructed situations. The advantages of appropriate use of social capital include better group communications, more efficient collective action, better access to resources, and enhanced use of the
organization’s intellectual capital that leads to improved instruction in classrooms (Leana & Pil, 2006). When schools begin to rethink their current instructional design to meet the demands of the 21st century, or to retool their teachers’ knowledge base in terms of using appropriate technology instructional practices, the principal remains the standard bearer for leading and sustaining the change efforts (Taylor, Pearson, Peterson, & Rodriguez, 2005).

The task of successfully implementing a systemic reform program relies upon the effort of all stakeholders involved including district-level and building-level administrators. The perceived lack of support from administrators is one of the reasons most frequently cited by districts for the failure of reform movements. Administrators need to foster synergy in the entire school environment where the physical features of the school, the characteristics of the people, the social interactions, the communication and decision-making patterns, the hierarchical relationships between administrators and teachers provide an effective school culture leading to student success (Donaldson, 2001). Effective leaders cannot depend on just a few strategies for promoting a new idea; instead they need to develop moral purpose, build relationships, bring fresh knowledge to the work, and establish coherence in a school’s programs (Fullan, 1999).

Effective school leaders are fundamental to large-scale, sustainable education reform (Fullan, 2002). Newman, King, and Youngs (2000) found that school capacity is the crucial variable affecting instructional quality and corresponding student achievement, and at the heart of school capacity are principals focused on the
development of teachers’ knowledge and skills, professional community, program coherence, and technical resources.

**Teacher Professional Development in Effecting Student Achievement**

Little (1987) defined professional development as “any activity that is intended partly or primarily to prepare paid staff members for improved performance in present or future roles in the school districts.” Teacher professional development is critical to educational reform (Desimone, 2009; Wayne, Yoon, Zhu, Cronen & Garet, 2008) and is a key mechanism for improving classroom instruction and student achievement (Ball & Cohen, 1999; Cohen & Hill, 2000). Professional development for teachers has been deemed the necessary approach to improving teacher quality, both pedagogical content knowledge and pedagogical practices. Essentially, professional development has been adopted as a policy solution to improving the number of highly qualified teachers as well as helping all students to achieve high academic standards (Colbert, Brown, Choi, & Thomas, 2008).

The goal of teacher professional development is to increase student achievement, and teachers generally embrace professional development programs because they believe such programs will help them become better teachers to that end (Guskey, 2003). Desimone (2009) notes a trend in teachers’ professional development to connect it to student learning with an ultimate goal of closing achievement gaps among student groups. It takes extended time to implement changes in practice and classroom culture (Supovitz & Turner, 2000), but improvement is possible by making professional development efforts align and by including job-embedded time.
Professional development affects student achievement through three steps. First, professional development enhances teacher content knowledge and pedagogical skills. Second, better knowledge and skills improve teachers’ instructional practices. Third, improved instruction results in improved academic achievement for students (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). This construct focuses on increasing pedagogical content knowledge, the knowledge of ways to represent and formulate the subject matter that make it comprehensible to students. Pedagogical content knowledge includes an understanding of what makes the learning of specific topics easy or difficult, the conceptions and misconceptions that students may have, and the strategies most likely to be effective in reorganizing the understanding of students (Shulman, 1986). It is essential that professional development embed both content and pedagogical knowledge. Conclusively then, the factors of professional development, teacher change and instructional practice are interlinked, and the combination is the engine behind student achievement (Jenkins & Agamba, 2013).

Further evidence in the research literature indicates that teachers who receive substantial professional development (an average of 49 hours) can boost their students’ academic achievement by approximately 21 percentile products (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). On the other hand, one-shot or disjointed workshops lasting 14 hours or less are relatively superficial and show no statistically significant effect on student learning (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). This training model of professional development is often fragmented, relying on a collection of workshops and/or course offerings, as opposed to a continuous and ongoing program of
professional development for teachers (Miller, Lord, & Dorney, 1994). Instead of thinking about professional development as a quick effort, we need to consider it as a learning opportunity and realize that it takes time for learning to occur (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Having continual support while teachers are making changes, either in the form of a series of workshops or in-classroom coaching, or both, is essential. Research shows the more intense, long-term professional development teachers have, the greater the achievement gains posted by their students during the following year (Corcoran, McVay, & Riordan, 2003).

According to a study by Yoon, Duncan, Lee, Scarloss, & Shapley (2007), professional development is most effective if it is characterized by coherence, active learning, sufficient duration, collective participation, a focus on content knowledge, and a reform rather than traditional approach. Effective professional development focuses on improving instructional practice by giving teachers new knowledge and techniques for assessing learning with the ultimate goal of improving the learning of students (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Research has shown the need for an integrated professional development approach that touches all aspects of instruction and includes the time necessary to have a lasting impact and result in changes. A study by Yoon, Duncan, Lee, Scarloss, & Shapley (2007) indicates that if a teacher fails to apply new ideas from professional development to classroom instruction or arguably has limited opportunity to fully implement those new ideas, improved student learning cannot be expected.
Professional development that is of an extended duration, focuses on content and classroom practice, and provides opportunities for teachers to learn from one another has been linked to increased teacher knowledge and improvements in classroom instruction (Desimone, Porter, Garet, Yoon, & Birman 2002). Cohen & Ball (2000) found that in order for professional development to lead to substantial instructional changes and improvements in student learning it must address teachers, students, and instructional materials, be implemented in a highly aligned manner, and include time for teachers to collaborate during the change process. Effective professional development programs are job-embedded and provide teachers with five crucial elements: (Darling-Hammond, McLaughlin, 2011):

- Collaborative learning by providing teachers with opportunities to learn in a supportive community that organizes curriculum across grade levels and subjects.
- Links between curriculum, assessment, and professional-learning decisions in the context of teaching specific content by emphasizing the importance of developing content knowledge as well as pedagogical techniques
- Active learning by allowing teachers to apply new knowledge and to receive feedback based on ongoing data on how teaching practices influence student learning over time.
- Deeper knowledge of content and how to teach it
- Sustained and intensive learning, supported by modeling, coaching, and problem solving around specific problems of practice.
When these elements are included in intensive professional development, especially when it includes applications of knowledge to teachers’ planning and instruction, it has a greater chance of influencing teaching practices and, in turn, leading to gains in student learning (Knapp, 2003; Desimone, Porter, Garet, Yoon, & Birman, 2002).

One-time professional development workshops are often outside of the context of the school, not typically aligned with ongoing practice, and do not reliably lead to changes in classroom teaching (Loucks-Horsley & Matsumoto, 1999). It is vital for professional development to occur in context of the classroom-learning environment. While particular students interact with particular teachers over particular content in particular circumstances, teachers need to learn “in and from practice” (Ball & Cohen, 1999). Learning in and from practice allows other important components of effective professional development to occur. First, it gives teachers time to collaborate with other teachers and school colleagues. Second, it allows more sustained learning and professional development to occur since it becomes part of the work rather than an additional piece of work. Finally, it allows work to be well integrated in a very meaningful, concrete way that addresses specific problems teachers are having in their own classroom. The importance of grounding teacher training and learning in ongoing practice is a necessary component in developing teachers’ expertise (Putnam & Borko, 2000).

A key component to the success of professional development opportunities is coaching, “a non-evaluative, learning relationship between a professional developer and a teacher, both of whom share the expressed goal of learning together, thereby improving
instruction and student achievement” (Koh & Neuman, 2006). Content-Focused Coaching is a professional development model designed to promote student learning and achievement by having a coach and teacher work jointly in specific settings, guided by conceptual tools (Staub, 1999). Coach and teacher collaboratively plan, enact, and reflect on specific lessons, acting as resources for each other. To be most effective, Content-Focused Coaching has to be seen in relation to and coordinated with other elements of professional development (West & Staub, 2003). Research supports the importance of coaching in fostering and supporting the transfer of training to classroom practice. Several comparison-group studies have found that teachers who receive coaching are more likely to enact the desired teaching practices and apply them more appropriately than are teachers receiving more traditional professional development (Showers & Joyce, 1996; Neufeld & Roper, 2003).

The National Council of Teachers of Mathematics (NCTM) established standards for the professional development of mathematics teachers. The Council contended that professional development should focus on five standards: knowing mathematics content and school mathematics, knowing students as learners of mathematics, knowing mathematics pedagogy, and developing as a mathematics teacher (Martin, 2007). These standards stress the importance of examining and revising teachers’ assumptions about the nature of mathematics, how it should be taught, how students learn mathematics, and the analysis of their teaching effectiveness (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003). Professional development should be designed to enhance middle school mathematics teachers’ knowledge of mathematics and their ability to effectively teach
mathematics to culturally and socially diverse students (Stevens, Harris, Aquirre-Munoz, & Cobbs, 2009). As in all professional development, the context of teacher professional development is important and should include students, standards, student learning needs, practices regarding curriculum, instruction, and assessment, and national, state and local policies (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

Superintendents, principals, and others in positions of authority in school systems are instrumental in providing the vision, time, and resources to support continual professional learning, a positive school climate, and success for all students (Leithwood, Seashore-Louis, Anderson, & Wahlstrom, 2004). Professional development should bring teachers, administrators, staff members and professional development providers together in a co-development process to create a culture with dispositions for continuous professional learning. Having administrator support is essential for adoption of new teaching practices and continued implementation. It is widely accepted that strong administrative leadership is critical to a school’s growth and success (Waters, Marzano, & McNulty, 2003). Great leaders focus on developing people’s capacities rather than their limitations (Leithwood, Seashore-Louis, Anderson, & Wahlstrom, 2004); thus, the principal’s predominant role is to enhance the skills and knowledge of people in the organization and to create a common culture around the use of those skills and knowledge (Elmore, 2000). It is critical for principals to work with staff members to create the culture, structures, and dispositions for continuous professional learning and create pressure and support to help teachers continuously improve by better
understanding students’ learning needs, making data-driven decisions regarding content and pedagogy, and assessing students’ learning within a framework of high expectations.

**Instructional Quality in Effecting Student Achievement**

Despite conventional wisdom that school inputs make little difference in student learning, a growing body of research suggests that schools can make a difference, and a substantial portion of that difference is attributable to teachers. Recent studies of teacher effects at the classroom level have found that differential teacher effectiveness is a strong determinant of differences in student learning, far outweighing the effects of differences in class size and heterogeneity (Sanders & Rivers, 1996; Wright, Horn, & Sanders, 1997). Students who are assigned to several ineffective teachers in a row have significantly lower achievement and gains in achievement than those who are assigned to several highly effective teachers in sequence (Sanders & Rivers, 1996). Teacher effects appear to be additive and cumulative, and generally not compensatory. Similar studies also show that teacher effects have an impact on student mathematics achievement (Nye, Konstantopoulos, & Hedges, 2004; Lockwood, McCaffrey, Hamilton, Stecher, Lee, & Martinez, 2007).

Today’s mathematics educators are engaged in a substantial effort of reform that leads to differences in instructional practices of teachers. This is evidenced, in part, by the many recommendations being made by professional organizations for standards in mathematics and science teaching. The contemporary reform movement is often conducted under the label of “constructivism” (von Glasersfeld, 1989) and is characterized by the assumption that “knowledge is not transmitted directly from one
knower to another, but is actively built up by the learner” (Driver, Asako, Leach, Mortimer, & Scott, 1994).

The National Council of Teachers of Mathematics (NCTM) is at the forefront of the current standards-based reform movement in mathematics education. NCTM published the Principles and Standards for School Mathematics in 2000, setting forth recommendations for mathematics educators and forming a national vision for improved mathematics curricula, teaching, and assessment. The Principles for school mathematics reflect basic reform perspectives on which educators should base decisions that affect school mathematics. These six Principles describe a comprehensive picture of mathematics reform and establish a foundation for school mathematics programs by considering the broad issues of equity, curriculum, teaching, learning, assessment, and technology (NCTM, 2000):

- The Equity Principle acknowledges and honors the vast array of culturally, socially, ethically, racially, and cognitively diverse experiences, which students necessarily bring with them wherever they go. These differences are not simply tolerated; they are a valuable resource that powers and empowers the reformed teacher and student.

- The Curriculum Principle effectively integrates fundamental mathematical concepts so that the student can build and extend ideas through establishing connections with other mathematical ideas as well as interpretations that draw upon concepts from science and other domains including the richness and nuance of everyday phenomena.
• The Teaching Principle includes understanding big mathematical ideas in different representational modes, sensing when student thinking might be tapping alternate modes, and taking the risk of pursuing such possibilities as part of a teaching strategy.

• The Learning Principle describes understanding the current knowledge base of students on which to build, including ideas developed in prior instruction and those acquired through everyday experience. Furthermore, learning with understanding can be enhanced through classroom discourse in which students propose mathematical ideas and conjectures, evaluate their own thinking as well as that of others, and revise or refine their thoughts.

• The Assessment Principle integrates assessment into instructional and learning experiences, often times using a self-reflective process to engage students in a natural critique and verification of their own thinking either alone or in the setting of other students engaged in similar reflection.

• The Technology Principle supports the view that students can learn mathematics more deeply when technology is used appropriately to enrich the range and quality of investigations by providing a means of viewing mathematical ideas from multiple perspectives.

In addition to these six Principles, NCTM also describes five Standards that should be integrated into quality instructional practices. These include: Problem Solving, Reasoning and Proof, Communication, Connections, and Representation (NCTM, 2000).
These Principles and Standards provide a vision of an exemplary learning environment where students confidently engage in complex mathematical tasks chosen purposefully by teachers. Students draw on knowledge from a variety of mathematical topics, sometimes approaching the same problem from different mathematical perspectives or representing the mathematics in different ways until they find methods that enable them to make progress. Teachers help students to make, refine, and explore conjectures on the basis of evidence and to use a variety of reasoning and proof techniques to confirm or disprove them. Alone or in groups and with access to technology, students work productively and reflectively, communicating their ideas and results effectively (NCTM, 2000).

A strong system of support is needed at both the local and national levels in order to make the vision of Principles and Standards a reality. Teachers must continually update their professional knowledge, both of mathematical content and of pedagogy. Teacher-leaders must strive to shift the conversation among their colleagues from just “activities that work” to a critical analysis of their instructional practices. School and district administrators must establish effective structures that support students’ learning and teachers’ professional growth. By implementing these Principles and Standards into instructional practice, teachers can provide the quality of instruction that will result in increasing student achievement.

Factors Effecting Mathematics Achievement

While research has noted that a myriad of factors affect student achievement, studies show disparity in describing the effects of specific student demographics on
mathematics achievement. The three most common student factors that are examined are gender, ethnicity, and socioeconomic status (SES). While SES is a complex measurement of parental education, level of poverty in the family’s neighborhood, and family income (Clements & Sarama, 2008), it is usually measured as eligibility for free or reduced lunch. The study will examine these student-level variables as moderating factors that could provide explanations of observed (or not observed) effects.

The inclusion of gender as a moderating factor of student achievement is supported by existing research. Research is divergent on the differences in mathematics achievement between males and females. The research on gender-related mathematics achievement differences has found instances where no difference exists, where differences favor males, and also instances where differences favor females. However, over the past decade, results from the NAEP have shown small, but persistent math gender disparities favoring males at fourth, eighth, and twelfth grades, with gaps of roughly 0.1 standard deviations, or the equivalent of a few months of schooling (McGraw, Lubienski, & Stutchens, 2006). Overall, there is agreement that the gender gap in mathematics has been decreasing in recent decades and is now quite small (Gray, 1996; Hanna, 2003). The research of Leahey & Guo (2001) supports this theory showing the difference on the ACT mathematics subtest declining from 2.3 points in 1967 to 1.2 points in 1996.

The appearance of gender differences in elementary school has been studied with mixed results. In a study of gifted students in first through fifth grades, Sprigler and Alsup (2003) found no gender differences in the mathematical reasoning of the students.
These results echoed previous work by Fennema and Sherman (1977) that showed no
differences in achievement for elementary school children. These reports are
contradicted by 1996 NAEP data which show males outscore females in the
Measurement, Geometry and Spatial Sense, and Number Sense and Operations content
strands in grade four (Ansell & Doerr, 2000).

Once students reach the middle grades, achievement differences in mathematics
although small tend to favor males (Leahey & Guo, 2001; Marsh & Yeung, 1998). However, more recent NAEP results indicate that the differences have disappeared with
no statistically significant differences in any of the five mathematical content strands
(National Center for Education Statistics, 2012). Similar results are found at the high
school level with males having higher scores on tests measuring mathematical concepts
and problem solving (Marsh & Young, 1989) and on tests of advanced mathematics
(Schreiber, 2002). However, Ansell and Doerr (2000) report that NAEP data show no
statistically significant difference between the overall scores of males and females,
although males did outscore females significantly in the content strands of Measurement
and Geometry/Spatial Sense.

One of the largest-scale studies was the Trends in International Mathematics and
Science Study (TIMSS). This study in 1995 included a nationally representative sample
of more than 20,000 students from 200 schools across the United States. The study
showed that although, on average, males occasionally outperformed girls in specific
content areas, there was no overall significant difference between the mean mathematics
achievement of males and females at the fourth, eighth, and twelfth grades (Mullis,
Martin, Beaton, Gonzalez, Gregory, Garden, & Murphy, 2000). In conclusion, even though the effect of gender on mathematics achievement has received considerable attention, the results are varied.

Research has consistently shown that African-American and Latino students are more likely to have lower standardized test scores than Caucasian students (Delgado-Gaitan, 1992; Lareau, 2003; McCarthy, 1990; Stanton-Salazar, 2001). Even though significant progress over the past twenty-five years has been made by African-American and Latino students in closing the minority-nonminority achievement gap, the gaps are still large. (Campbell, Hombo, & Mazzeo, 2000; Cook & Evans, 2000). As of 2012, the white-black and white-Hispanic achievement gaps were 30-40% smaller than they were in the 1970s due to blacks and Hispanic students’ scores rising faster than those of white students (National Center for Education Statistics, 2012).

The mathematics achievement gap between ethnic groups is a national concern. In nearly all of the nation’s states there is a thirty to fifty percentage-point difference between Caucasian students and the largest minority group in the percentage of students scoring at the basic level on the eighth grade NAEP exam (Blank & Langesen, 1999). Even though all ethnic subgroups have shown improvement since 1990, the 2012 NAEP scores show that Caucasian students and Asian students continue to outperform African-American, Hispanic, and American Indian native students at every grade level (National Center for Education Statistics, 2012).

When combining both gender and ethnicity, the research signs a bright light on the plight of African-American males. The gap between their performance and that of
their peers is perceptible in kindergarten, and only widens thereafter. In the 2008 NAEP assessment, only 46% of African-American males in eighth grade demonstrated “basic” or higher grade-level skills, compared with 82% of Caucasian males (Rampey, Dion, & Donahue, 2009). On the National Education Longitudinal Survey, 54% of sixteen year-old African-American males scored below the 20th percentile, compared with 24% of Caucasian males. This survey also highlighted the low achievement of Hispanic males with only 42% scoring below the 20th percentile (Rampey, Dion, & Donahue, 1989).

Even though the gaps have narrowed, the average achievement gaps between different ethnic groups remain large. While achievement gaps vary across tests, grades, and subject areas, the average achievement gap between African-American and Caucasian students in national data often ranges between 0.75 and 0.90 of a standard deviation on nationally representative tests (Berends, Lucas, & Sullivan, 2001; Nowell & Hedges, 1998). Similarly, the achievement gap between Latino and Caucasian students is 0.60 of a standard deviation (Berends & Koretz, 1996). These results illustrate the strong correlation between ethnicity and mathematics achievement.

There is no greater challenge for those committed to the high school reform goal of making “all students college ready” than the gap between low-income students’ prior mathematics preparation and the requirements of a college preparatory math sequence (Levin & Belfield, 2007). In studies of academic achievement, family income and parent socioeconomic status are often incorporated into a composite defined as socioeconomic status (SES), but when income is examined as a separate variable, it tends to be positively related to student achievement scores. Socioeconomic disadvantage has a notable impact
on student performance with 15% of the variation in student performance explained by students’ socioeconomic status (OECD, 2012). Hill and O’Neill (1994) found an increase of $10,000 per year is associated with an increase of scores of 2.4 percentile points.

The relationship between family SES and academic achievement is referred to as a socioeconomic gradient because it is gradual and increases across the range of SES (Adler et al., 1994). As low SES children get older, their academic achievement gap worsens. Some studies suggest that SES is the strongest predictor of student achievement (Jencks & Phillips, 1998; Lee, Bryk, & Smith, 1993). On the most recent administration of the twelfth grade NAEP, only four percent of high school seniors eligible for free or reduced-price lunch scored at or above proficiency in mathematics (Rampey, Dion, & Donahue, 2009).

These findings are supported by a study by Hanusheck (1997) who found that students from families of higher socioeconomic status tend to score higher on mathematics assessments. Other studies have suggested that parents of higher socioeconomic status are more involved in their children’s education than are parents of lower socioeconomic status and that greater involvement fosters more positive attitudes toward school, improves homework habits, reduces absenteeism and dropping out, and enhances academic achievement (Epstein, 1996; Lareau, 2003).

Many low-income families live in urban areas and attend high-poverty middle schools where their mathematics achievement continues to lag behind their counterparts. Data from the U.S. Department of Education (2002) reveal disparities of middle school
students in achievement levels and course enrollments based on socioeconomic status. Furthermore, Berry (2003) asserts that although there have been some gains in the mathematics achievement of low-income students at the middle school level, the improvement occurred only in the area of basic skills competence as opposed to more complex skills such as contextualized problem solving.

The three demographic factors of gender, ethnicity, and socioeconomic status are considered as likely to mediate the relationship to student mathematics achievement. While research studies are not conclusive as to the degree of correlation between each of these variables and student mathematics achievement, research does generally state that each of these variables affect student achievement.

**Texas Instruments MathForward Program**

The Texas Instruments MathForward program is a systemic mathematics reform initiative aimed at improving achievement in middle school mathematics and algebra. The catalyst for reform has been the introduction of the TI-Navigator Classroom Learning System and the TI-84 graphing calculators, which are intended to increase student participation and engagement in significant mathematics content and to inform both teachers and students about what they know and can do. In addition to the introduction of technology to enhance teaching and learning in the classroom, the MathForward program calls for strong administrator involvement and support, intensive and on-going professional development, the integration of a rigorous mathematics curriculum including formative, summative and diagnostic assessments, increased
learning time for mathematics, regularly scheduled common planning time for teachers, and increased mathematical content knowledge for teachers.

The core components of the program draw on scientific research that has addressed how best to meet the goals of MathForward classroom network technologies like the TI-Navigator Classroom Learning System have shown the potential for increasing students’ participation in class and their conceptual learning (Penuel, Roschelle, & Abrahamson, 2005). Professional development that is of an extended duration, focuses on content and classroom practice, and provides opportunities for teachers to learn from one another has been linked to increased teacher knowledge and improvements in classroom instruction (Desimone, Porter, Garet, Yoon, & Birman, 2002). When students spend more time working on complex assignments in mathematics, they learn more (Rowan, Correnti, & Miller, 2002). Likewise, heightened teacher expectations for students and teachers’ perceptions of greater administrative support have been linked to successful teaching and learning outcomes (Jussim & Eccles, 1992; O’Donnell & White, 2005; Rowan, Chiang, & Miller, 1997).

Three components of the MathForward program make it a systemic reform program with potential for broad impact. First, the program promotes alignment of professional development, curriculum, and assessment, a core feature of systemic reform (Knapp, 1997; Spillane & Jennings, 1997). Second, the program targets whole districts and schools for participation rather than individual teachers. Third, MathForward calls for changes not only inside the classroom, but also in how schools are organized to
support mathematics learning. In these respects, MathForward is like certain states’ efforts to promote systemic reform in mathematics.

The MathForward program is grounded in four bodies of research-based theory and replicates evidence-based practices from a range of school improvement and mathematics improvement projects. It is based on an established theoretical structure for school improvement, which emphasizes multi-component systemic interventions, and it benefits from lessons learned from research on improvement of secondary mathematics instruction, as well as the Comprehensive School Reform (CSR) programs, and more general multidisciplinary implementation research. The program draws conclusions from the research on the high failure rate in Algebra I and its root causes in middle school mathematics. The integration of technology, a vital component of the program, is supported in the extensive research on effective use of graphing calculators in the teaching of secondary mathematics as well as the recent research of classroom networking systems in the interactive mathematics classroom.

In the late 1990’s, Douglas Carnine at the University of Oregon proposed a synthesis of the literature on effective implementation of innovations in education and the literature on implementation on mathematics reform. The synthesis includes the following ten components of effective mathematics innovation, which were validated in a multi-state correlational study relating these implementation factors to state test performance programs (Toenjes, Lewis, Winick, 2004).

1. Sound Administrative Practices – includes communicating achievement expectations for all students, providing support for instruction rather than
enforcing compliance, taking action to ensure adequate student progress and monitoring, and creating an environment conducive to instruction and success

2. Aligned Curriculum – curriculum aligned to state standards, instructional materials, and assessments

3. Ongoing Assessment and Planning – frequent assessment of student learning with instruction adjusted based on results

4. Immediate Intervention for Students Experiencing Difficulty Mastering Concepts – identification of struggling students with immediate, intensive interventions designed to remediate their deficiencies

5. Increased and Effective Use of Instructional Time – provide time for daily mathematics instruction to ensure high levels of student achievement in mathematics

6. Teacher Knowledge of Mathematics Content – teachers possess high-levels of mathematics content understanding

7. Instructional Materials and Teaching Techniques – on grade-level instructional materials are structured and integrated with instruction to meet individual learning needs of students

8. Differentiated Instruction – classrooms are organized into flexible skill groups of students with similar instructional needs

9. Focused Professional Development – on-going professional development is focused on student learning needs derived from assessment results
10. End-of-Year Analysis of Student Performance – includes the analysis of assessment data from a variety of sources at both the beginning and end of the school year, comparison of campus performances to set expectations, communication of conceptual learning needs from elementary to middle and high schools (Carnine, 2000)

From Carnine’s synthesis, the eight coordinated components of MathForward were derived (Carnine, 2000):

1. Improved Teacher Content Knowledge: In-depth learning opportunities through online courses with a mathematician are provided to educators to strengthen their content knowledge enabling them to relate content back to the topics that are required within the district curriculum and to understand students’ misconceptions and thought patterns and address them appropriately.

2. Increased Instructional Time: Extended learning time is used to enhance students’ abilities to solve complex problems using research-based teaching methods. By integrating technology, assessments, and effective teaching strategies that promote multiple representations, students are provided opportunities to enhance their problem solving, analysis, and communication skills as promoted by NCTM.

3. Use of Common Assessments: Both formative and summative assessments are administered to inform teachers about students’ content and procedural knowledge. The instantaneous analysis allows teachers to identify struggling
students and restructure lessons and/or the pace of the lesson to align with the students’ learning needs.

4. Intensive and On-going Professional Development: In addition to frequent trainings on the integration of technology and research-based instructional strategies, a MathForward Implementation Specialist works directly with each teacher in their classroom following a content-focused coaching model. The Specialist collaborates with teachers on planning lessons, modeling best practices in the classroom, and reflecting on instruction.

5. Increased Administrative Support: The MathForward Supervisor works directly with administrators on designing an effective implementation plan based on the constraints of both the school and the district. Administrators are trained on strategies for a successful program implementation and are provided with classroom observation tools to monitor the implementation.

6. Appropriate Use of Technology to Increase Motivation and Learning: Teachers use technology daily to enhance district lessons, assess student understanding, provide students feedback about their learning, and reinforce mathematical content. Not only does the technology increase student engagement, but also provides multiple representations of challenging mathematical concepts.

7. Common Planning Times: Regularly scheduled planning times for teachers provide them the opportunity to critique, inquire, and investigate their classroom instruction. The focus of the collaborative time follows a cycle of
planning, teaching and reflection that builds on the abilities and experiences of
the teachers and incorporates the strategies during the MathForward trainings.

8. Use of Curriculum At and Above Grade Level for All Students: The
supplemental curriculum of MathForward enriches and augments the current
curriculum of the school. The rigorous curriculum follows the recommended
shift in mathematics education to teaching practices that allow learners to
actively explore mathematical concepts in the context of meaningful problems
in order to build structures of understanding.

Successive research confirms the importance of systemic interventions to improve
mathematics instruction. In 2009, an empirical research study on improvement of high-
poverty high schools concluded that the mathematics classroom is best modeled as a
system with the five subsystems of organizational and social climate,
curriculum/materials, teacher expectations/knowledge, intensification strategy, and
pedagogy/instructional approach (Means, 2009). The eight components of MathForward
are aligned to these five dimensions of an effective secondary mathematics intervention
program. Penuel (2008) points out that the theoretical structure of the program is also
consistent with other recent research syntheses on effective strategies for school
improvement. Thus, MathForward is directly and explicitly based on current research on
effective systemic interventions for improvement of mathematics instruction, especially
in schools with diverse and challenging student populations.

MathForward began in the 2005-2006 school year with a pilot study in the
Richardson Independent School District in the Dallas, Texas metropolitan area. The
program was applied to middle school students who had previously failed the mathematics section of the Texas Assessment of Knowledge and Skills (TAKS). Results showed that these students had a 33% pass rate as compared to a 19% pass rate of a comparison group from a similar campus (Winick & Lewis, 2006). Average scores of MathForward students increased at a time when comparison groups and the district as a whole experienced a decline in scores. Gains in the 2006-2007 school year were similarly strong, with 46% of MathForward students who had previously failed the TAKS receiving passing scores. In Algebra I classrooms, the pass rate for MathForward students was 57% as compared to a control group of students with a pass rate of 34% (Winick & Lewis, 2007; Stroup, Pham, & Alexander, 2007).

Since 2007, MathForward has been implemented in over 60 districts across the United States. Quantitative studies have been conducted in a few of these districts and have shown a positive impact on student mathematics achievement. The Charlotte-Mecklenburg School District implemented the MathForward program during the 2008-2009 school year. District averages for Title I students showed improvement from 63% of students demonstrating proficiency on the North Carolina state assessment as seventh grade students to nearly 80% of those same students reaching proficient levels as eighth graders (Texas Instruments, 2009).

In the San Antonio Independent School District, the MathForward program was implemented in the sixth, seventh, and eighth grades in five Title 1 middle schools serving a total of 823 students during the 2010-2011 school year. Prior to MathForward implementation, 17% of these students attained a proficient or above score on the TAKS,
the state of Texas achievement assessment. After one year of MathForward implementation, 44% of these same students attained a proficient or above score on the TAKS (Texas Instruments, 2011).

Improvement in learning occurs when the educational materials and practices used in the classroom encourage a positive interaction between teachers and students. Independent researchers from Winick & Lewis (2006) and the University of Texas (2006) have verified that when the components of TI’s MathForward program are implemented with a high level of fidelity, students are engaged and demonstrate increased understanding and achievement in mathematics. Articulation must be in place across levels and sites to enable sharing of successful practices, continuity of learning, and equitable performance standards for all students. This result is achieved with the commitment and support of administrators, teachers, and MathForward Instructional Specialists.

**MathForward Instructional Technology**

The implementation of the TI-Navigator system along with the TI-84 graphing calculators is an integral component of the MathForward program. The use of this technology can be used to effectively enhance students’ conceptual understanding while also increasing student motivation and engagement. The combination of these factors leads to an increase in student achievement.

Research has shown that when teachers frequently incorporate graphing calculators into their instruction, student achievement was higher both on state assessments and on district benchmark assessments (Heller, Curtis, Jaffe, &
Verboncoeur, 2005). The increase in achievement was evident in conceptual, problem solving, and operational skill areas. These results were further documented in a peer-reviewed meta-analysis of 54 research studies on graphing calculators by Ellington (2003). The conclusion of the research is that graphing calculators have their greatest impact when used to build conceptual understanding and high-level problem solving skills through instructional strategies involving multiple representations of mathematical concepts.

Algebra I serves as a gateway to higher-level mathematics courses and is required for high school graduation in most states. Research shows that the use of graphing calculators can have a positive impact both on general skill and understanding of algebra concepts and, more specifically, on student comprehension of functions (Thompson & Senk, 2001). Graphing calculators improve students’ skills in creating algebraic representations of complex problems. The capabilities of the graphing calculator enable teachers to spend more time on presentations and explanations of graphs and tables and on complex application problems.

The TI-Navigator system connects students and educators by networking each student’s graphing calculator to the teacher’s computer. This network enables teachers to track the progress of individual students in real time, view student coursework and check problem solving techniques, and use instant feedback to create a dynamic learning environment. The MathForward program uses the TI-Navigator system daily to enhance instruction and to provide instant feedback about the progress of students’ understanding.
Research studies have documented student improvement in the areas of conceptual understanding, classroom interactions, quantity and quality of student responses, and time on learning (Dougherty, Akana, Cho, Fernandez & Song, 2005). The TI-Navigator system engages all students in frequent formative assessments that provide immediate feedback to teachers and students about the students’ learning. Rich classroom discussions can be led around error-analysis and the variety of problem solving strategies employed by the students. A study by Hartline (1997) indicated that classrooms implementing a classroom networking system had an increase in the ease with which teachers engaged students in frequent formative assessment and instantaneous feedback. The study found a significant connection between the use of formative assessments and teachers’ questioning strategies to an increase in students’ higher-order thinking skills.

Use of the TI-Navigator system prompts students to engage in classroom activities, remain focused and participate in productive collaborative group interactions. Another research study indicated that classroom networking systems have significantly affected both the quality of student discussions and what students learn from the discussions (VanDeGrift, Wolfman, Yasuhara, & Anderson, 2002). Through the TI-Navigator system, students engage in discussion points around mathematical concepts, which lead enhanced student interaction and collaboration. These discussions enable teachers to extend the classroom topics to more complex, authentic problem situations where students can apply their mathematical knowledge.
CHAPTER III

METHODOLOGY

Introduction

This study examined the effect of the Texas Instruments MathForward program on student mathematics achievement after the teachers had achieved two years of program implementation experience by measuring the change in students’ mathematics scores over a period of one year. Previous research studies have studied the effects of the program using a quasi-experimental design with supplemental regression discontinuity analysis. These studies used state mathematics assessments to compare the scores of students in the MathForward classrooms with students who were not in the program. Since most state assessments are criterion-referenced tests, scores from year to year cannot be compared. Thus, previous studies converted state assessment scores to Normal Curve Equivalents to allow comparison.

This study utilized the Measures of Academic Progress (MAP) assessment to measure the change in students’ mathematics scores. The assessment is a norm-referenced assessment that uses a stable, empirically derived RIT scale so that longitudinal data can be used to analyze program impact. This measurement tool allowed a more accurate analysis of the effect of the MathForward program on student mathematics achievement over a one school year period of time.

The MathForward program is based on an established theoretical structure for school improvement, which emphasizes multi-component systemic interventions. The
program consists of eight coordinated components that research suggests are elements of successful school improvement projects. While the implementation of all eight components is vital to the success of the program in promoting student mathematics achievement, this study targeted the effect of two of these components on student mathematics achievement: the amount of teachers’ professional development, both in-service trainings and in-classroom coaching sessions, and the level of perceived administrative support from building principals. Additionally, the study also took into account the quality of instruction using the Reformed Teaching Observation Protocol. This allowed an accurate analysis of how closely the MathForward teachers were implementing the MathForward pedagogy.

**Research Questions**

- Do students in MathForward classrooms have higher mathematics achievement gains than students in non-MathForward classrooms as quantified by the Measure of Academic Progress (MAP) assessment after the teachers have received two years of program support?
- Does gender, ethnicity, socioeconomic status determined by free or reduced lunch status or the type of curriculum materials (Glencoe or Connected Mathematics Project) affect differences in mathematics achievement gains in MathForward classrooms compared to non-MathForward classrooms?
- Does the amount of professional development, both in-service trainings and in-classroom coaching sessions, perceived level of administrator support, or quality of classroom instruction affect student mathematics achievement gains after two
years of MathForward program implementation as measured by in-service training attendance and coaching records, online teacher surveys, and the RTOP (Reformed Teaching Observation Protocol)?

**Participants**

Eighteen teachers participated in the MathForward program during both the 2011-2012 and 2012-2013 school years with five teaching sixth grade, four teaching seventh grade, eight teaching eighth grade, and one teaching a seventh-eighth grade split. These teachers represented nine schools in the Milwaukee Public School District.

The MathForward program contains supporting instructional materials to integrate with the district mathematics courses of study for sixth, seventh, and eighth grades. These materials include short daily assessments allowing for a spiral review of key mathematics concepts and activities aligned to mathematical standards using Texas Instruments technology as instructional tools. While all middle school mathematics teachers follow the district mathematics program of study, individual schools may choose from two district-approved sources of instructional resources, the Glencoe Mathematics series and the Connected Mathematics Project. Ten of the MathForward teachers utilized the Glencoe Mathematics series in their classroom, which is based on a more traditional, teacher-led approach to mathematics instruction. The other eight MathForward teachers implemented the Connected Mathematics Project, which focuses on inquiry and investigation of mathematical concepts using a problem-centered instructional approach. All MathForward teachers, regardless of their classroom curriculum materials, received the same package of supporting instructional materials from the MathForward program.
Prior to the implementation of the MathForward program, all middle school teachers received the same professional development provided by the district. These district trainings focused on the use of assessments to drive instruction and on the deconstruction of Wisconsin state standards. Teachers from both the MathForward group and the control group were homogenous in their professional development until the MathForward teachers began their program training from Texas Instruments.

The majority of the MathForward teachers were females with only four male teachers participating in the program. The diversity of the Milwaukee community was reflected in the varied ethnicities of the MathForward teachers. Nine of the teachers were Caucasian, five were African-American, and the remaining four were Hispanic. All of the teachers possessed between ten and twenty-four years of experience.

The specific characteristics of each of the teachers participating in the MathForward program are detailed in the following tables:

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th># of Classes</th>
<th>Race</th>
<th>Gender</th>
<th>Yrs Exp</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1-G</td>
<td>6,7,8</td>
<td>1/1/2</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Carver</td>
</tr>
<tr>
<td>Teacher 2-G</td>
<td>7</td>
<td>2</td>
<td>W</td>
<td>F</td>
<td>20-24</td>
<td>Fairview</td>
</tr>
<tr>
<td>Teacher 3-G</td>
<td>8</td>
<td>2</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Fairview</td>
</tr>
<tr>
<td>Teacher 4-G</td>
<td>7</td>
<td>6</td>
<td>W</td>
<td>F</td>
<td>15-19</td>
<td>Morse Marshall</td>
</tr>
<tr>
<td>Teacher 5-G</td>
<td>8</td>
<td>4</td>
<td>A</td>
<td>M</td>
<td>20-24</td>
<td>Morse Marshall</td>
</tr>
<tr>
<td>Teacher 6-G</td>
<td>6</td>
<td>4</td>
<td>A</td>
<td>F</td>
<td>15-19</td>
<td>Morse Marshall</td>
</tr>
<tr>
<td>Teacher 7-G</td>
<td>6</td>
<td>2</td>
<td>H</td>
<td>F</td>
<td>15-19</td>
<td>Lincoln</td>
</tr>
<tr>
<td>Teacher 8-G</td>
<td>8</td>
<td>2</td>
<td>H</td>
<td>M</td>
<td>15-19</td>
<td>Lincoln</td>
</tr>
<tr>
<td>Teacher 9-G</td>
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<td>1</td>
<td>A</td>
<td>M</td>
<td>20-24</td>
<td>MLK</td>
</tr>
<tr>
<td>Teacher 10-G</td>
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<td>1</td>
<td>A</td>
<td>F</td>
<td>15-19</td>
<td>MLK</td>
</tr>
</tbody>
</table>

* G represents the Glencoe curriculum
Table 3: Demographics of MathForward Teachers Using CMP Curriculum

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th># of Classes</th>
<th>Race</th>
<th>Gender</th>
<th>Yrs Exp</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1-CMP</td>
<td>7,8</td>
<td>2/2</td>
<td>W</td>
<td>F</td>
<td>20-24</td>
<td>Fernwood</td>
</tr>
<tr>
<td>Teacher 2-CMP</td>
<td>6</td>
<td>1</td>
<td>H</td>
<td>F</td>
<td>10-14</td>
<td>Greenfield</td>
</tr>
<tr>
<td>Teacher 3-CMP</td>
<td>6</td>
<td>1</td>
<td>A</td>
<td>F</td>
<td>10-14</td>
<td>Greenfield</td>
</tr>
<tr>
<td>Teacher 4-CMP</td>
<td>8</td>
<td>1</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Greenfield</td>
</tr>
<tr>
<td>Teacher 5-CMP</td>
<td>6,7</td>
<td>2</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Manitoba</td>
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<td>Teacher 6-CMP</td>
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<td>2</td>
<td>H</td>
<td>F</td>
<td>20-24</td>
<td>Wedgewood</td>
</tr>
<tr>
<td>Teacher 7-CMP</td>
<td>8</td>
<td>3</td>
<td>W</td>
<td>M</td>
<td>20-24</td>
<td>Wedgewood</td>
</tr>
<tr>
<td>Teacher 8-CMP</td>
<td>8</td>
<td>4</td>
<td>W</td>
<td>F</td>
<td>20-24</td>
<td>Wedgewood</td>
</tr>
</tbody>
</table>

* CMP represents the Connected Mathematics Project curriculum

For this study each classroom of students was linked to a specific MathForward teacher at one of the nine schools implementing the program. The existing student demographic data are school-wide data from the 2011-2012 school report cards from the nine participating schools.

Almost 1,200 sixth, seventh, and eighth grade students in nine schools in the Milwaukee Public School District participated in the MathForward program during the 2012-2013 school year. These schools included six kindergarten through eighth grade schools, two sixth through twelfth grade schools, and one sixth through eighth grade school. One of the schools was a Montessori school while the other schools followed a traditional education approach. The student populations in these schools represented the diverse, urban population of Milwaukee with the student demographics reflecting the unique neighborhood of each school. Five of the schools had a predominantly African-American student population while two of the schools served a majority of Hispanic students. Each school supported a similar percentage of special education students, and
two of the schools served a substantial English-language learner population. Six of the schools included a significant low socio-economic population of students as dictated by free or reduced lunch status while the Montessori school had only one-fourth of its students receiving free or reduced lunch.

Four of the schools implementing the MathForward program failed to meet Adequate Yearly Progress (AYP) for at least two years in a row and were classified as Schools Identified for Improvement (SIFI). Three of these schools had less than half of their sixth, seventh, and eighth grade students scoring proficient or higher as measured by the state criterion-referenced achievement test, the Wisconsin Knowledge and Comprehension Examination. The fourth SIFI school made substantial gains in student achievement during the 2012-2013 school year and was hopeful to be moved out of the SIFI designation for the 2013-2014 school year.

The control group of students for this study was chosen based on matching the characteristics of the teachers participating in the MathForward program with teachers at schools with similar student demographics that had no access to any component of the MathForward program. This created a group of non-MathForward students with similar demographics as the students involved in the MathForward program and a heterogeneous grouping of teachers. The control group used the same district-approved curriculum materials, either Glencoe or the Connected Mathematics Project curriculum, as the treatment group, but without supplemental instructional materials, technology, professional development and in-classroom coaching support provided by the
MathForward program. The amount of instructional time for the comparison group was the same as for the treatment group.

The specific characteristics of each of the teachers in the control group are detailed in the following tables:

**Table 4: Demographics of Control Teachers using Glencoe Curriculum**

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th># of Classes</th>
<th>Race</th>
<th>Gender</th>
<th>Yrs Exp</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1-G</td>
<td>6,7,8</td>
<td>1</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Thoreau</td>
</tr>
<tr>
<td>Teacher 2-G</td>
<td>7</td>
<td>2</td>
<td>W</td>
<td>F</td>
<td>20-24</td>
<td>Alcott</td>
</tr>
<tr>
<td>Teacher 3-G</td>
<td>8</td>
<td>2</td>
<td>W</td>
<td>F</td>
<td>15-19</td>
<td>Burdick</td>
</tr>
<tr>
<td>Teacher 4-G</td>
<td>7</td>
<td>3</td>
<td>W</td>
<td>F</td>
<td>15-19</td>
<td>River Trail</td>
</tr>
<tr>
<td>Teacher 5-G</td>
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<td>3</td>
<td>A</td>
<td>M</td>
<td>15-19</td>
<td>River Trail</td>
</tr>
<tr>
<td>Teacher 6-G</td>
<td>6</td>
<td>3</td>
<td>A</td>
<td>F</td>
<td>15-19</td>
<td>River Trail</td>
</tr>
<tr>
<td>Teacher 7-G</td>
<td>6</td>
<td>2</td>
<td>H</td>
<td>F</td>
<td>15-19</td>
<td>Mitchell</td>
</tr>
<tr>
<td>Teacher 8-G</td>
<td>8</td>
<td>2</td>
<td>H</td>
<td>M</td>
<td>10-14</td>
<td>Mitchell</td>
</tr>
<tr>
<td>Teacher 9-G</td>
<td>7</td>
<td>2</td>
<td>A</td>
<td>M</td>
<td>20-24</td>
<td>LaFollette</td>
</tr>
<tr>
<td>Teacher 10-G</td>
<td>6</td>
<td>1</td>
<td>A</td>
<td>F</td>
<td>20-24</td>
<td>Gaenslen</td>
</tr>
</tbody>
</table>

* G represents the Glencoe curriculum

**Table 5: Demographics of Control Teachers using CMP Curriculum**

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Grade</th>
<th># of Classes</th>
<th>Race</th>
<th>Gender</th>
<th>Yrs Exp</th>
<th>School</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher 1-CMP</td>
<td>7,8</td>
<td>1/1</td>
<td>W</td>
<td>F</td>
<td>0-9</td>
<td>Craig</td>
</tr>
<tr>
<td>Teacher 2-CMP</td>
<td>6</td>
<td>1</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Auer</td>
</tr>
<tr>
<td>Teacher 3-CMP</td>
<td>6</td>
<td>1</td>
<td>A</td>
<td>F</td>
<td>10-14</td>
<td>Starms</td>
</tr>
<tr>
<td>Teacher 4-CMP</td>
<td>8</td>
<td>1</td>
<td>W</td>
<td>F</td>
<td>20-24</td>
<td>School of Languages</td>
</tr>
<tr>
<td>Teacher 5-CMP</td>
<td>6,7</td>
<td>1</td>
<td>W</td>
<td>M</td>
<td>10-14</td>
<td>Clement</td>
</tr>
<tr>
<td>Teacher 6-CMP</td>
<td>8</td>
<td>2</td>
<td>H</td>
<td>F</td>
<td>10-14</td>
<td>Meir</td>
</tr>
<tr>
<td>Teacher 7-CMP</td>
<td>6,7,8</td>
<td>3</td>
<td>W</td>
<td>F</td>
<td>10-14</td>
<td>Auer</td>
</tr>
<tr>
<td>Teacher 8-CMP</td>
<td>8</td>
<td>3</td>
<td>A</td>
<td>M</td>
<td>15-19</td>
<td>Hartford</td>
</tr>
</tbody>
</table>

* CMP represents the Connected Mathematics Project curriculum
To help ensure experimental validity and prevent experimental contamination, all MathForward teachers were asked to refrain from discussing the MathForward program and the professional development with non-MathForward teachers. While the MathForward program is highly dependent on access to classroom technology, graphing calculators and the Texas Instruments Navigator system, certain elements of the program such as an inquiry-based learning environment can be transferred to some extent without the technology.

Table 6: Demographics of the Schools Implementing the MathForward program

<table>
<thead>
<tr>
<th>School</th>
<th>Grades</th>
<th>Served</th>
<th>% Other</th>
<th>% African American</th>
<th>% Hispanic</th>
<th>% White</th>
<th>% Special Education</th>
<th>% English Language Learner</th>
<th>% Free-Reduced Lunch</th>
<th>Years of SIFI</th>
<th>WFCE % Proficient Gr 6</th>
<th>WFCE % Proficient Gr 7</th>
<th>WFCE % Proficient Gr 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carver Academy</td>
<td>3-8</td>
<td></td>
<td>0.2%</td>
<td>98.2%</td>
<td>3.8%</td>
<td>2.7%</td>
<td>22.3%</td>
<td>0%</td>
<td>97.4%</td>
<td>2</td>
<td>37%</td>
<td>29%</td>
<td>54%</td>
</tr>
<tr>
<td>Fairview School</td>
<td>3-8</td>
<td></td>
<td>3.1%</td>
<td>7.6%</td>
<td>23.6%</td>
<td>65.7%</td>
<td>26.5%</td>
<td>1.4%</td>
<td>47.4%</td>
<td>0</td>
<td>81%</td>
<td>84%</td>
<td>80%</td>
</tr>
<tr>
<td>Fernwood Montessori</td>
<td>3-8</td>
<td></td>
<td>3.2%</td>
<td>5.6%</td>
<td>16.9%</td>
<td>74.3%</td>
<td>12.0%</td>
<td>0.3%</td>
<td>22.5%</td>
<td>0</td>
<td>83%</td>
<td>90%</td>
<td>88%</td>
</tr>
<tr>
<td>Greenfield School</td>
<td>3-8</td>
<td></td>
<td>1.1%</td>
<td>3.2%</td>
<td>92.1%</td>
<td>3.5%</td>
<td>13.6%</td>
<td>39.9%</td>
<td>95.2%</td>
<td>0</td>
<td>71%</td>
<td>77%</td>
<td>73%</td>
</tr>
<tr>
<td>King Jr. Elementary</td>
<td>3-8</td>
<td></td>
<td>0%</td>
<td>96.6%</td>
<td>0.6%</td>
<td>2.8%</td>
<td>25.9%</td>
<td>0%</td>
<td>97.4%</td>
<td>3</td>
<td>13%</td>
<td>41%</td>
<td>45%</td>
</tr>
<tr>
<td>Lincoln Center of Arts</td>
<td>6-8</td>
<td></td>
<td>2.9%</td>
<td>67.2%</td>
<td>23.9%</td>
<td>0.6%</td>
<td>22.3%</td>
<td>143%</td>
<td>91.3%</td>
<td>4</td>
<td>39%</td>
<td>54%</td>
<td>30%</td>
</tr>
<tr>
<td>Manitoba School</td>
<td>3-8</td>
<td></td>
<td>6.8%</td>
<td>15.9%</td>
<td>46.6%</td>
<td>30.7%</td>
<td>22.5%</td>
<td>2.8%</td>
<td>76.7%</td>
<td>0</td>
<td>60%</td>
<td>59%</td>
<td>75%</td>
</tr>
<tr>
<td>Morse</td>
<td>6-11</td>
<td></td>
<td>9.4%</td>
<td>76.6%</td>
<td>5.5%</td>
<td>8.5%</td>
<td>21.8%</td>
<td>3.7%</td>
<td>79.2%</td>
<td>1</td>
<td>61%</td>
<td>69%</td>
<td>79%</td>
</tr>
<tr>
<td>Marshall</td>
<td>6-8</td>
<td></td>
<td>5.9%</td>
<td>21.6%</td>
<td>48.1%</td>
<td>24.4%</td>
<td>17.9%</td>
<td>23.2%</td>
<td>82.7%</td>
<td>1</td>
<td>76%</td>
<td>74%</td>
<td>65%</td>
</tr>
</tbody>
</table>
Measures of Academic Progress

The Measures of Academic Progress (MAP) is a computerized adaptive assessment designed to measure general knowledge in language arts, reading, and mathematics. As students answer questions correctly, they receive more challenging questions. Should a student answer a question incorrectly, the student will get an easier question. Each MAP assessment draws from a multiple-choice test question pool of over
3,000 questions. It is developed by the Northwest Evaluation Association (NWEA), a non-profit assessment organization based in Portland, Oregon. The assessment is aligned to national and state curricula and standards and provides immediate feedback on student growth and mastery of various subject-area, strand-defined skills. NWEA has conducted scale alignment studies linking the MAP’s RIT scale to proficiency levels from assessments in all fifty states and the District of Columbia that provide evidence of the relationship between the MAP assessments and each state’s assessment (NWEA, 2005). Further studies indicate that MAP assessments sufficiently predict performance on assessments in at least five states (Cronin, Kingsbury, Dahlin, Adkins, & Bowe, 2007).

The MAP is the primary assessment measure of student progress in Milwaukee Public Schools and is administered to all students in mathematics and reading three times a year in October, February, and June. The mathematics portion of the MAP takes approximately 45 minutes, but each student’s time is different because as soon as the computer has determined the student’s RIT level, the test is over. For the purposes of this study, the mathematics portion of the October and June MAP assessments were used as the primary outcome measure for the change in student mathematics scores.

The MAP assessment is computer-adaptive in which the computer chooses the next question for the student from a large test bank of questions according to the way the student answered the previous question (Van Horn, 2003). This creates a differentiated test for each student (Stokes, 2005). Since these questions are selected response, the questions do not require students to use higher order thinking to answer them (Van Horn, 2003). The MAP provides appropriately challenging questions for 97-99% of students by
providing questions that are both lower and higher than grade level, adjusting them to keep the student appropriately challenged (Olson, 2002). Students are started at an average level and the level of questioning moves up or down according to the way the last questions were answered until the computer finally finds the ability level of the student (Stokes, 2005).

The scores from MAP represent a developmental scale and place students on a continuum of learning from pre-grade 3 to grade 10. The assessment provides a measurement of student growth because the test is scored using the Rasch unit (RIT) named for the Danish statistician Georg Rasch who founded the Item Response Theory. The RIT unit is an equal interval unit that does not change, like centimeters on a meter stick. The questions on the test are assigned a RIT level according to their difficulty. RIT scores are stable; after 20 years of using RIT scores, they are still the same (NWEA, 2007b). As a result, the computer-generated RIT score can be compared to the score from the last time the student took the test and growth can be calculated (NWEA, 2007b). RIT scores are independent from the grade level of the student and stable over time. Scores typically range from 150 to 300 on the RIT scale.

Validity of the MAP is based on concurrent validity, a type of criterion-related validity where NWEA compared MAP scores with scores on other established tests. A Pearson correlation coefficient ($r$) is used to calculate concurrent validity. A perfect correlation would be 1.00 while 0.80 is considered to be acceptable (NWEA, 2005). When compared with the Stanford Achievement Test, $r = 0.82 – 0.83$ in grades sixth
through eighth. The Iowa Tests of Basic Skills correlation was 0.79 in seventh grade. Compared with several state assessments, the correlation was between 0.70 and 0.86.

The reliability for the MAP was calculated in two ways, test-retest reliability and marginal reliability. The test was given twice to the same students over a one-year period. Although it was the same test, the questions were different since the computer chose each question from a question bank. The Pearson coefficient was between 0.83 and 0.94 for repeated tests in grades sixth, seventh, and eighth. The marginal reliability coefficient is a measurement of internal reliability and was measured by calculating the measurement error at different points in the test and combining those measurements. The marginal reliability coefficient is between 0.89 and 0.94 for grades sixth, seventh, and eighth and reflects strong internal consistency. The standard errors of measurement are between 2.5 and 3.5 in Rochester Institute of Technology (RIT) scales and indicate adequate measurement precision (NWEA, 2005).

**Teacher Survey**

An online survey was administered to the MathForward teachers in May 2013 to measure the level of administrator support perceived by the teachers. The survey was adapted from an original survey created by SRI International, a nonprofit independent research center hired by Texas Instruments to evaluate the effectiveness of the MathForward program during the research and development stage of the program. SRI International developed teacher questionnaires, classroom observation forms, and teacher interview protocols to analyze the level of implementation quality in districts participating in the pilot program. The qualitative data presented teacher perspectives on
how conditions in their schools and districts influenced their decisions about program implementation.

Six questions on the perception of support from building administrators were included in the survey and addressed specific components of the MathForward program. The survey questions were developed from research on leadership qualities that affect student achievement and the implementation of reform programs, and were created with a high degree of fidelity between the survey questions and the types of administrator support necessary for a successful MathForward program implementation. (See Appendix A for full survey questions.)

The response options used a four point Likert scale from 4 (strongly agree) to 1 (strongly disagree) and assessed the following administrator skills necessary for an effective implementation of the MathForward program:

- Clear expectations for meeting the goals of the MathForward program
- Communication of a clear vision for the MathForward program
- Establishment of high standards for teaching mathematics
- Encouragement of regular communication with parents about MathForward
- Provision of adequate planning time for MathForward teachers
- Encouragement of teachers to attend MathForward professional development offerings

A Cronbach alpha test was used to measure the internal consistency of the questions regarding administrator support. The survey items produced a coefficient of
reliability of 0.772, which indicates a relatively high internal consistency. All six survey items provided a high degree of consistency with the deletion of the question focused on the encouragement of teachers’ attendance at professional development offerings providing only a slight increase in the Cronbach alpha value.

Table 8: Item-Total Statistics from Cronbach Alpha Test from Teacher Survey

<table>
<thead>
<tr>
<th>Scale</th>
<th>Scale Mean if Item Deleted</th>
<th>Scale Variance if Item Deleted</th>
<th>Corrected Item-Total Correlation</th>
<th>Squared Multiple Correlation</th>
<th>Cronbach's Alpha if Item Deleted</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expectations</td>
<td>13.06</td>
<td>7.114</td>
<td>.614</td>
<td>.646</td>
<td>.713</td>
</tr>
<tr>
<td>Standards</td>
<td>12.89</td>
<td>7.869</td>
<td>.369</td>
<td>.461</td>
<td>.776</td>
</tr>
<tr>
<td>Planning</td>
<td>13.72</td>
<td>6.918</td>
<td>.538</td>
<td>.655</td>
<td>.733</td>
</tr>
<tr>
<td>Vision</td>
<td>13.28</td>
<td>6.918</td>
<td>.661</td>
<td>.621</td>
<td>.700</td>
</tr>
<tr>
<td>Communication</td>
<td>13.56</td>
<td>6.967</td>
<td>.738</td>
<td>.575</td>
<td>.686</td>
</tr>
<tr>
<td>Attendance</td>
<td>13.22</td>
<td>8.536</td>
<td>.244</td>
<td>.443</td>
<td>.801</td>
</tr>
</tbody>
</table>

All eighteen of the MathForward teachers participating in the program completed the survey at the May 2013 professional development session. The survey was administered online using Survey Monkey as the online platform.

Reformed Teaching Observation Protocol

Reformed teaching advocates that classes be “taught via the kinds of constructivist, inquiry-based methods advocated by professional organizations and researchers” (MacIsaac & Falconer, 2002). Reform signals a paradigm shift from the traditional teacher-centered lecture-driven class to a student-centered, activity-based learning environment that typically includes multiple opportunities for collaboration among students.
During classroom observations of MathForward teachers, the Implementation Specialists used the Reformed Teaching Observation Protocol (RTOP) developed by the Evaluation Facilitation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers (Sawada & Piburn, 2000). Since the RTOP measures the degree to which constructivist notions are visible in the classroom, it closely correlates to the MathForward program pedagogy. While it is possible to score high on the RTOP without implementing the MathForward program, a MathForward teacher implementing the program with a high degree of fidelity should not score low on the RTOP since both are founded on constructivist theories of instruction.

The RTOP was designed to capture the current reform movement, especially those characteristics that define “reformed” teaching. To do that, the authors of the RTOP relied heavily upon research in mathematics and science education and on the new national standards. The RTOP measures the degree to which current conceptions of constructivism are found in the classroom. A constructivist classroom is characterized as a place where inquiry is conducted, discourse is the primary mode by which participants engage in negotiations of meaning, and a high level of rigor and an accompanying demand for evidence and argument is featured (Bereiter & Scardamalia, 1993).

The RTOP requires a detailed narrative of the mathematics lesson with an accompanying time log, a description of the physical characteristics of the classroom with an emphasis on mathematics and technology materials, and a set of twenty-five items, each to be rated on a scale of 0 (no evidence) to 4 (highly descriptive of the lesson), resulting in a possible total score range between 0 and 100. The RTOP’s rating
section is divided into five subsets: Lesson Design and Implementation, Propositional Knowledge, Procedural Knowledge, Student-teacher classroom interaction, Student-student classroom interaction. The first subset is designed to capture the model for reformed teaching. It describes a lesson that begins with recognition of students’ prior knowledge and preconceptions, that attempts to engage students as members of a learning community, that values a variety of solutions to problems, and that often takes its direction from ideas generated by students. The second subset assesses the quality of the content of the lesson, and the third subset captures the understanding of the process of inquiry. The fourth and fifth subsets are directed at the climate of the classroom and the quality of the interactions between students and between students and the teacher.

It is important for users of an instrument like the RTOP to have standards of performance against which to evaluate the scores achieved by the teachers. Using the norming sample by Sawada, Piburn, Judson, Turley, Falconer, Benford & Bloom (2002), the mean RTOP score for middle school mathematics teachers was determined to be 46.8 with a standard deviation of 19.0.

The RTOP has proven highly worthwhile in the study of mathematics and science classrooms in middle and high schools, colleges, and universities (Sawada & Piburn, 2000). With appropriate training, it is possible to achieve very high inter-rater reliabilities using this instrument. When tested, inter-rater reliability estimates of RTOP subscales were exceptionally high with $R^2$ ranging from 0.90 to 0.95. RTOP scores predict improved student learning in mathematics and science classrooms at all levels. More specifically, predictive validity was tested by correlating instructors’ RTOP scores
with student gains scores in a variety of courses and the correlation coefficients ranged from 0.88 to 0.97. Construct validity was tested by using subscales to predict RTOP total scores and $R^2$ ranged from 0.76 to 0.97 indicating that RTOP is largely a uni-factorial instrument that taps a single construct of inquiry (Sawada & Piburn, 2000).

Both Implementation Specialists were trained to use RTOP during September 2011, prior to the first year of the MathForward program implementation in Milwaukee Public Schools. The RTOP Training Guide provided by the developers of the instrument was used to ensure the reliability of scores from both Implementation Specialists. Following the two-full-day trainings on the RTOP, both Implementation Specialists observed three mathematics classrooms in Milwaukee Public Scores. Scoring the RTOP’s from the classrooms provided an inter-rater reliability score of 0.92.

Each Implementation Specialist was randomly assigned to observe nine of the eighteen MathForward teachers in Milwaukee Public Schools using the RTOP. Due to time constraints, each MathForward teacher was only observed once towards the end of the first year of implementation between April 21, 2012 and May 15, 2012. The scores of the RTOP measured the quality of instruction and helped to ensure the fidelity of program implementation. The RTOP form can be found in the Appendix.

Other Measures

The amount of professional development received by teachers was tracked using attendance sheets from trainings and coaching reports from classroom coaching days. The individual hours from each of these artifacts were compiled for each teacher.
Demographic data were collected from the Milwaukee Public Schools for teachers participating in the MathForward program and teachers who made up the control group. This data included gender, ethnicity, and the number of years of teaching experience.

Existing student demographic data from the Milwaukee Public Schools were used for each student in both the treatment and the control group. This data included gender, ethnicity, and whether the student qualified for free or reduced lunch status.

The data for this study are archival data that were collected prior to the beginning of the research study. The data from the survey, classroom observations, and professional development attendance sheets were gathered during the implementation of the MathForward program. The archival student achievement data was released from Milwaukee Public Schools in December, 2014 once IRB approval had been established.

**Procedure**

Permission to begin the study was obtained from the Milwaukee Public Schools in July, 2010. Institutional Review Board (IRB) approval was received in September, 2014. Final approval for Milwaukee Public Schools to release de-identified formative student assessment data, MAP scores, as well as student demographic data was received in October, 2014. This archival data from the 2012-2013 school year are stored by Milwaukee Public Schools, the primary source of the data. The archival data was sent electronically in December, 2014 and included both October and June MAP scores from the 2012-2013 school year for the students assigned to both the MathForward teachers and the non-MathForward teachers.
The Texas Instruments MathForward program was implemented in two middle schools in Milwaukee Public Schools during the 2010-2011 school year. Nine teachers at the Lincoln Center of the Arts and five teachers at Dr. Martin Luther King Jr. School received nine days of training and thirty days of in-classroom coaching throughout the school year.

The district chose to expand the program to a second cohort of teachers during the 2011-2012 school year. A total of twenty-seven teachers from ten middle schools were broken into two groups dependent on the geographic location of their school. Each group of teachers received nine days of training and fifty-five days of in-classroom coaching. The teachers attended three full days of training prior to the start of the school year followed by one training session each month for the remainder of the school year. The two MathForward Implementation Specialists were assigned to one of the two groups of teachers and were responsible for facilitating the training and providing the in-classroom coaching. Each teacher received at least a half-day of in-classroom coaching each month with additional support provided during collaborative planning times.

For the 2012-2013 school year, Milwaukee Public Schools chose to discontinue the program at two middle schools, Clarke and Metcalfe, which eliminated five teachers from the program. Additionally, four teachers were replaced for the 2012-2013 school year due to teacher turnover, which left a remaining eighteen teachers in the second cohort. These teachers received a total of eight days of training and seventy days of in-classroom coaching. After the initial two full days of training, each training session was split into two four-hour after-school trainings so teachers were not pulled out of the
classroom. The teachers received at least a half-day of in-classroom coaching support each month as well as support during their collaborative planning time. The two MathForward Implementation Specialists rotated leading each month’s training as well as sharing in the in-classroom coaching support. This cadre of eighteen teachers who implemented the MathForward program for both the 2011-2012 and 2012-2013 school years is the focus of this study.

Table 9: MathForward Training Days for 2011-2012 and 2012-2013 School Years

<table>
<thead>
<tr>
<th>2011-2012 Training Days</th>
<th>2012-2013 Training Days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov 15, 2011</td>
<td>Feb 4/5, 2013</td>
</tr>
<tr>
<td>Jan 17, 2012</td>
<td>Mar 12/13, 2013</td>
</tr>
<tr>
<td>Feb 21, 2012</td>
<td>May 8/9, 2013</td>
</tr>
<tr>
<td>Mar 20, 2012</td>
<td></td>
</tr>
</tbody>
</table>

The goal of the MathForward professional development sessions is to hone the teachers’ content knowledge and pedagogy. During the in-classroom coaching visits MathForward Implementation Specialists modeled an inquiry-based learning environment that stressed critical thinking and in-depth learning. The teacher provided the context of the problem and facilitated the student investigations into the mathematical content. Students frequently worked in collaborative teams to explore and formulate their solutions and were encouraged to engage in mathematical discourse to analyze, defend, and evaluate different problem-solving approaches. The in-classroom coaching
provided the teachers with the support necessary to shift from a teacher-centered classroom to a student-centered learning environment.

Teacher participation in professional development was documented throughout the two years of the study. Attendance sheets were verified at each of the professional development trainings, and the MathForward Implementation Specialists completed detailed in-classroom coaching reports for each day of in-classroom support that the teachers received. These forms can be found in the Appendix of the study.

An online survey was used to measure the teachers’ perception of the MathForward program implementation. The survey and a brief demographic inventory were uploaded to Survey Monkey on May 7, 2013. Before making the survey live, the website link was sent to the Milwaukee Public Schools mathematics coordinator to review and provide any suggested revisions. No changes to question content were made, and an email providing a link to the survey was sent to the teachers on May 21, 2013. Twelve of the eighteen teachers completed the survey by June 10, 2013. The remaining six teachers received a reminder email from Cynthia Rodriguez, Milwaukee Public School mathematics coordinator. This email spurred the remaining six teachers to complete the survey by June 20, 2013.

In addition to other questions pertaining to specific components of the MathForward program, teachers were asked to rate their administrator’s level of support for six different statements. These statements were composed by SRI International during the initial development phase of the MathForward program in 2006 and were
constructed from research on leadership qualities that affect student achievement and the implementation of reform programs.

Data from the survey were aggregated in July 2013, and a Cronbach alpha test was used to measure the internal consistency of the questions regarding administrator support. The results of the test indicated a relatively high level of internal consistency, $\alpha = 0.722$. The teachers’ names from the survey were removed and were replaced with their unique teacher code to match their survey results with their achievement data.

The two MathForward Implementation Specialists who served Milwaukee Public Schools were trained on the Reformed Teaching Observation Protocol on September 10th and 11th, 2011. Inter-rater reliability was established by comparing RTOP scores from a sample of three classroom observations at the completion of the two-day training. Each of the MathForward Implementation Specialists administered the Reformed Teaching Observation Protocol in all eighteen MathForward classrooms between April 2, 2013 and May 24, 2013. The RTOP scores for each MathForward teacher were tabulated and linked to their unique teacher code.

**Data**

**MAP (Measures of Academic Progress)**

MAP scores were obtained for students in MathForward classrooms and the control classrooms in Milwaukee Public Schools for the academic year of 2012-2013. Teachers in Milwaukee Public Schools are required to administer the MAP assessment three times a year; October, February, and June. Since this study measured the change in mathematics achievement over the course of an academic year, only MAP scores from
the October and June administrations were obtained. Included in the dataset for the MAP scores were demographics for each student with a state identification number. Thus, the data was de-identified and the basic demographics included in the report such as ethnicity, gender, and free or reduced lunch status was linked to each student. Student demographics were treated as nominal categorical data in the analyses.

MAP scores are based on the RIT scale, a curriculum scale based on Item Response Theory that uses individual item difficulty values to estimate student achievement. An advantage of the RIT scale is that it can relate the numbers on the scale directly to the difficulty of items on the tests. The RIT scale is an equal interval scale, which means the difference between scores is the same regardless of whether a student is at the top, middle, or bottom of the RIT scale. The scores have the same meaning regardless of grade level and can be used to measure growth over time.

The MAP is a norm-referenced assessment allowing scores to determine if students are performing at, above, or below grade level compared to students across the nation. Typically, younger students show more growth in one year than older students, and students who test above grade level typically show less growth. Anticipated growth rates for each student are based on national norms and represent “typical” growth rather than “expected” growth.
Table 10: National Grade Level Scores for MAP Mathematics Assessment

<table>
<thead>
<tr>
<th>Grade Level</th>
<th>Fall Score</th>
<th>Spring Score</th>
<th>Year's Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>164</td>
<td>178</td>
<td>14</td>
</tr>
<tr>
<td>2</td>
<td>179</td>
<td>191</td>
<td>12</td>
</tr>
<tr>
<td>3</td>
<td>192</td>
<td>203</td>
<td>11</td>
</tr>
<tr>
<td>4</td>
<td>203</td>
<td>211</td>
<td>8</td>
</tr>
<tr>
<td>5</td>
<td>212</td>
<td>220</td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>219</td>
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<tr>
<td>7</td>
<td>225</td>
<td>230</td>
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</tr>
<tr>
<td>8</td>
<td>230</td>
<td>234</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>233</td>
<td>236</td>
<td>3</td>
</tr>
</tbody>
</table>

RTOP (Reformed Teaching Observation Protocol)

The Reformed Teaching Observation Protocol provides a standardized means for detecting the degree to which classroom instruction uses student-centered, engaged learning practices (Lawson, Benford, Bloom, Carlson, Falconer, Hestenes, Judson, Piburn, Sawada, Turley, Wyckoff, 2002). RTOP classroom observations are made in five categories: Lesson Design and Implementation, Propositional Knowledge, Procedural Knowledge, Student-teacher classroom interaction, and Student-student classroom interaction, each with five items for a total of twenty-five items. Each item is scored on a Likert scale from 0 (not observed) to 4 (very descriptive) of the classroom lesson for a total maximum score possible of 100.

Likert scaling is a bipolar scaling method, measuring either positive or negative evaluation for each observation item. The RTOP score is a composite of the observation items scored on a Likert scale. These scores were treated as continuous interval data measuring the latent variable, quality of instruction.
Teacher Survey on Perceived Level of Administrator Support

An online survey was administered to all eighteen MathForward teachers to evaluate the effectiveness of the MathForward program in improving the quality of classroom instruction. One section of the survey focused on the perception of support from building administrators. The response options to the six statements on administrator support used a four point Likert scale from 4 (strongly agree) to 1 (strongly disagree). This created a forced choice since the middle option of “neither agree nor disagree” was not available.

As with the Reformed Teaching Observation Protocol, the responses for each of the six statements were combined for a single composite score. These scores were treated as continuous interval data measuring the latent variable, the perceived teachers’ level of administrator support.

Amount of Professional Development

Compiling the total hours each teacher attended MathForward trainings as well as compiling the total hours each teacher received in-classroom coaching by one of the two Implementation Specialists over the two school years of program implementation in Milwaukee Public Schools measured the amount of professional development. Training attendance sheets and MathForward daily coaching reports completed by the Implementation Specialists documented the amount of professional development. The total hours of professional development, both for in-service trainings and in-classroom coaching sessions were treated as continuous interval data.
Statistical Analyses

Different analytical methods were used to address the study’s objectives. Independent t-tests and a one-way ANOVA were used to answer the following research questions:

1. Do MathForward classrooms have higher mathematics achievement gains than non-MathForward classrooms as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?

2. Are there differences in mathematics achievement gains between males and females as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?

3. Are there differences in mathematics achievement gains between students receiving free or reduced lunch and students not receiving free or reduced lunch as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?

4. Are there differences in mathematics achievement gains between Caucasian students, African-American students, Hispanic, and Other (Asian, American Indian, and Alaskan Native) students as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?
5. Are there differences in mathematics achievement gains between students using the Glencoe curriculum materials and students using the Connected Mathematics Project curriculum materials as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?

The dependent variable in these analyses was the continuous variable, mathematics achievement score gains (difference between June and October administration) from the Measure of Academic Progress (MAP). The first independent categorical variable, the type of mathematics instruction, contained two levels, MathForward program and non-MathForward program. The second independent categorical variable, gender, also contained two levels, female and male. The third independent categorical variable, ethnicity, contained four levels, Caucasian, African-American, Hispanic, and Other (Asian, American Indian, and Alaska Native). The fourth independent categorical variable, socioeconomic status contained two levels, free or reduced lunch students and non-free or reduced lunch students. The fifth independent categorical variable, type of curriculum materials, contained two levels, Glencoe Mathematics series or Connected Mathematics Project.

An independent $t$-test examined the equality of the differences between the October and June MAP scores between the students in the MathForward classrooms and the students in the non-MathForward classrooms. This analysis was also used to determine if a difference existed in the mean differences in MAP scores in MathForward classrooms across the other factors of gender, socioeconomic status, and type of
curriculum materials since each of these independent factors contained only two levels. A one-way ANOVA was used to determine if there was a variance in the differences in MAP scores based on student ethnicity since this independent variable contained four levels.

Even though there was a large sample size of 2,704 students, the five factors created very small subgroups when using a factorial ANOVA. This severely decreased the power of the study and could have resulted in little significance on the dependent variable. For this reason independent t-tests and a one-way ANOVA was used to analyze if a difference in student achievement growth scores existed for the variety of student sub-groups determined by the independent variables.

There are five null hypotheses resulting from the initial analysis. The null hypotheses for this study are:

1. In the population, the mean differences in the October and June MAP scores are the same for MathForward and non-MathForward students.

2. In the population, the mean difference in the October and June MAP scores are the same for females and males in MathForward classrooms.

3. In the population, the mean difference in the October and June MAP scores are the same for Caucasian, African-American, Hispanic, and Other (Asian, American Indian, and Alaskan Native) students in MathForward classrooms.

4. In the population, the mean difference in the October and June MAP scores are the same for students receiving free or reduced lunch and students not receiving free or reduced lunch in MathForward classrooms.
5. In the population, the mean difference in the October and June MAP scores are the same for students using Glencoe curriculum materials and for students using the Connected Mathematics Project curriculum materials in MathForward classrooms.

Multiple linear regression analysis with independent variables entered into the equation in a stepwise fashion were used to analyze the following research questions:

1. To what extent does the amount of professional development, both in-service trainings and in-classroom coaching sessions, as quantified by hours affect mean student mathematics achievement gains after teachers have achieved two years of MathForward program implementation experience as measured by attendance and coaching records?

2. To what extent does the teachers’ perceived level of administrator support as measured by teachers’ survey responses affect mean student mathematics achievement gains after teachers have achieved two years of MathForward program implementation experience?

3. To what extent does the quality of classroom instruction affect mean student mathematics achievement gains after teachers have achieved two years of MathForward program implementation experience as measured by the RTOP (Reformed Teaching Observation Protocol)?

The dependent variable in this analysis was the continuous variable, the mean difference in mathematics achievement scores from the June and October administration of the Measure of Academic Progress (MAP). The independent variables were the
continuous variables of amount of professional development, both in-service training hours and hours of in-classroom coaching sessions, perceived level of administrator support, and the quality of classroom instruction.

There are three null hypotheses associated with this analysis:

1. In the population, there is no effect of the amount of teacher professional development, neither in-service training hours nor in-classroom coaching hours, on the mean student mathematics achievement scores of MathForward teachers.

2. In the population, there is no effect on the teachers’ perceived level of administrator support on the mean student mathematics achievement scores of MathForward teachers.

3. In the population, there is no effect on the quality of classroom instruction on the mean student mathematics achievement scores of MathForward teachers.

This regression analysis was used to explain any correlational relationships between the dependent and independent variables as well as to provide an equation that could be used for predicting mathematics achievement scores for all members of the population based on the values of the independent variables. The general equation for this analysis is:

\[ y = \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \varepsilon \]

where \( \beta_0 \) is the constant, \( \beta_1 \) is the coefficient of the first predictor variable, \( \beta_2 \) is the coefficient of the second predictor variable, \( \beta_3 \) is the coefficient of the third predictor variable, \( \beta_4 \) is the coefficient of the fourth predictor variable and \( \varepsilon \) is the error term that
cannot be explained by the model. The four predictor variables are the amount of professional development as received by in-service trainings, the amount of professional development as received by in-classroom coaching sessions, the perceived level of administrator support, and the quality of classroom instruction.
CHAPTER IV
RESEARCH FINDINGS

Introduction

In today’s era of increased accountability and the administration of high stakes testing, districts are exploring a vast array of instructional programs in an attempt to increase student achievement, especially in the content areas of English Language Arts and Mathematics. This study examined the effect of one such program, the Texas Instruments MathForward program, on student mathematics achievement gains in Milwaukee Public Schools. Not only did the study analyze the program’s effect on student mathematics achievement gains as well as any difference within specific student subgroups based on ethnicity, gender, and socioeconomic status, but it also examined the effect of the MathForward program within classrooms using two distinct sets of mathematics curriculum materials.

While the MathForward program consists of eight coordinated components that research suggests are elements of successful school improvement projects, this study specifically analyzed the effect of two of these components on student mathematics achievement: the amount of teachers’ professional development, both in-service trainings and in-classroom coaching sessions, and the level of perceived administrative support from building principals. Additionally, the study took into account the quality of instruction and fidelity of program implementation using the Reformed Teaching
Observation Protocol. The results of this specific analysis will assist administrators in determining what specific factors can be put into action during the implementation of an instructional program to strengthen the program’s effectiveness.

The primary research questions addressed in this study are:

1. Do MathForward classrooms have higher mathematics achievement gains than non-MathForward classrooms as quantified by the Measure of Academic Progress (MAP) assessment after the teachers have achieved two years of program implementation experience?

2. To what extent does the amount of professional development, both in-service trainings and in-classroom coaching sessions, as quantified by hours measured through attendance and coaching records affect MathForward teachers’ mean student achievement gains after they have achieved two years of program implementation experience?

3. To what extent does the teachers’ perceived level of administrator support affect MathForward teachers’ mean student achievement gains after they have achieved two years of program implementation experience as measured by teachers’ survey responses?

4. To what extent does the quality of classroom instruction affect MathForward teachers’ mean student achievement gains after they have achieved two years of program implementation experience as measured by the Reformed Teaching Observation Protocol (RTOP)?
To focus directly on the effects of the MathForward program, student
demographic factors of gender, ethnicity, and socioeconomic status determined by free or
reduced lunch status as well as the type of curriculum materials used by the students were
examined as part of the analyses. These factors were addressed by the following
secondary research questions:

1. Are there differences in mathematics achievement gains between males and
   females as quantified by the Measure of Academic Progress (MAP)
   assessment after their teachers have achieved two years of MathForward
   program implementation experience?

2. Are there differences in mathematics achievement gains between students
   receiving free or reduced lunch and students not receiving free or reduced
   lunch as quantified by the Measure of Academic Progress (MAP) assessment
   after their teachers have achieved two years of MathForward program
   implementation experience?

3. Are there differences in mathematics achievement gains between Caucasian
   students, African-American students, Hispanic, and Other (Asian, American
   Indian, and Alaskan Native) students as quantified by the Measure of
   Academic Progress (MAP) assessment after their teachers have achieved two
   years of MathForward program implementation experience?

4. Are there differences in mathematics achievement gains between students
   using Glencoe curriculum materials and students using Connected
Mathematics Project curriculum materials as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

**Participants**

Participants for the experimental group in this study included teachers across the Milwaukee Public School District that had participated in the Texas Instruments MathForward program during the 2011-2012 and 2012-2013 school years. This group consisted of eighteen teachers across nine schools with 28% teaching grade six, 17% teaching grade seven, 39% teaching grade eight, and 17% teaching a multi-grade split. The majority of the MathForward teachers were female (78%) with only 22% being male. Additionally, half of the teachers were Caucasian with the remaining teachers being almost evenly split between African-American (28%) and Hispanic (22%). All of the teachers possessed between ten and twenty-four years of teaching experience.

The control group was constructed by matching the teacher demographics of gender, ethnicity, and years of teaching experience as closely as possible. Additionally, the grade level taught, type of mathematics curriculum materials used, and the demographics of the school were also taken into consideration to establish a control group that was equivalent to the experimental group. Eighteen teachers were chosen across fifteen schools for the control group with 28% teaching sixth grade, 17% teaching seventh grade, 33% teaching eighth grade, and 22% teaching a multi-grade split. As with the experimental group, the majority of the teachers were female (72%) with only 28%
being male. The ethnic breakdown closely matched the experimental group with half the teachers being Caucasian, 33% being African-American, and 17% being Hispanic. One teacher possessed less than nine years of teaching experience with the remaining teachers (17) having between ten and twenty-four years of teaching experience. The teacher demographics of both the experimental and control groups are detailed in the table below.

Table 11: Demographics of All Teachers in the Study

<table>
<thead>
<tr>
<th>Grade Level Assignment</th>
<th>MathForward Teachers</th>
<th>Control Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>Grade 6</td>
<td>5</td>
<td>27.78%</td>
</tr>
<tr>
<td>Grade 7</td>
<td>3</td>
<td>16.67%</td>
</tr>
<tr>
<td>Grade 8</td>
<td>7</td>
<td>38.89%</td>
</tr>
<tr>
<td>Grade 6/7 Split</td>
<td>1</td>
<td>5.56%</td>
</tr>
<tr>
<td>Grade 7/8 Split</td>
<td>1</td>
<td>5.56%</td>
</tr>
<tr>
<td>Grade 6/7/8 Split</td>
<td>1</td>
<td>5.56%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Teaching Experience</th>
<th>MathForward Teachers</th>
<th>Control Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>0 – 9 years</td>
<td>0</td>
<td>0.00%</td>
</tr>
<tr>
<td>10 – 14 years</td>
<td>6</td>
<td>33.33%</td>
</tr>
<tr>
<td>15 – 19 years</td>
<td>5</td>
<td>27.78%</td>
</tr>
<tr>
<td>20 – 24 years</td>
<td>7</td>
<td>38.89%</td>
</tr>
<tr>
<td>25 or more years</td>
<td>0</td>
<td>0.00%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>MathForward Teachers</th>
<th>Control Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>14</td>
<td>13</td>
</tr>
<tr>
<td>Male</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>MathForward Teachers</th>
<th>Control Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>African-American</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Hispanic</td>
<td>4</td>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Curriculum Materials</th>
<th>MathForward Teachers</th>
<th>Control Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glencoe</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>CMP</td>
<td>8</td>
<td>8</td>
</tr>
</tbody>
</table>
While cleaning the original data set it was discovered that there were missing MAP scores from either the October or June administration for some of the middle school students enrolled in a sixth, seventh, or eighth grade mathematics course in Milwaukee Public Schools. A closer analysis of the missing data was completed, and it was determined that the missing data was randomly scattered throughout the data field. The students with missing MAP scores amounted to 15% of the original pool of subjects and were eliminated from the study. The listwise deletion of these students still left a large population of 12,066 students to be chosen for the study.

Of the remaining 12,066 students in the population, 1,656 students were automatically entered into the experimental group based on their teacher receiving two years of MathForward program support. The students taught by the selected non-MathForward teachers from the comparison group equivalent analysis formed the control group of 1,047 students. These two groups of students combined to provide a total of 2,703 students for the study, approximately 23% of the original student population of middle school students in Milwaukee Public Schools.

The experimental group of students taught by the eighteen MathForward teachers was comprised of 30% sixth graders, 25% seventh graders, and 46% eighth graders. The students were almost evenly split between female (48%) and male (52%). Half of the students were African-American with the remaining students consisting of 26% Hispanic, 17% Caucasian, and 7% Asian, American Indian, and Alaska Native. Reflecting the high-poverty rate within the Milwaukee community, 80% of the students received free
and/or reduced lunch. Only 19% of the students were classified as Special Education students.

The control group of teachers taught 1,047 students with 27% of them being in sixth grade, 22% in seventh grade, and 51% in eighth grade. Gender breakdown mirrored that of the experimental group. The majority of the students were African-American (61%) with the remaining students consisting of 21% Caucasian, 13% Hispanic, and 5% Asian, American Indian, and Alaska Native. A slightly smaller percentage of students were eligible for free and/or reduced lunch (74%) when compared to the experimental group. The table below details the demographics for students in both the experimental and the control group.

**Table 12: Demographics of All Students in the Study**

<table>
<thead>
<tr>
<th>Demographic</th>
<th>MathForward Students</th>
<th>Control Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>Percent</td>
</tr>
<tr>
<td>Grade Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grade 6</td>
<td>490</td>
<td>29.59%</td>
</tr>
<tr>
<td>Grade 7</td>
<td>407</td>
<td>24.58%</td>
</tr>
<tr>
<td>Grade 8</td>
<td>759</td>
<td>45.83%</td>
</tr>
<tr>
<td>Free or Reduced Lunch Status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1324</td>
<td>79.95%</td>
</tr>
<tr>
<td>No</td>
<td>332</td>
<td>20.05%</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>803</td>
<td>48.49%</td>
</tr>
<tr>
<td>Male</td>
<td>853</td>
<td>51.51%</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>277</td>
<td>16.73%</td>
</tr>
<tr>
<td>African-American</td>
<td>830</td>
<td>50.12%</td>
</tr>
<tr>
<td>Hispanic</td>
<td>427</td>
<td>25.79%</td>
</tr>
<tr>
<td>Other</td>
<td>122</td>
<td>7.37%</td>
</tr>
</tbody>
</table>
Details of the Analyses

The detailed analyses of the paired-samples *t*-test, independent samples *t*-test, one-way analysis of variance, and multiple linear regression are provided below. These analytical methods were used to investigate each of the eight research questions as well as to determine the correlation between both administrations of the MAP assessment.

MAP Assessment Scores

Prior to analyzing data for my research questions, a paired-samples *t*-test was conducted to compare the October and June MAP assessment scores. The October and June MAP assessment scores from both the experimental and control group of students were paired and analyzed. There was a significant difference in the scores for the October assessment (*M* = 216.42, *SD* = 16.227) and the June assessment (*M* = 221.35, *SD* = 16.586); *t*(2703) = -31.967, *p* = 0.000, *α* = .05. There was also a positive correlation between the October and June MAP scores, *r* = 0.881, *p* = 0.000, *α* = .05. Further, Cohen’s effect size value (*d* = 0.300) suggested a moderate practical significance.

Research Question #1

Do MathForward classrooms have higher mathematics achievement gains than non-MathForward classrooms as quantified by the Measure of Academic Progress (MAP) assessment after the teachers have achieved two years of MathForward program implementation experience?

Hypothesis: In the population, the mean differences in the October and June MAP scores are the same for MathForward and non-MathForward students.
An independent samples $t$-test was conducted to compare the difference in scores from the October and June MAP administration between students in MathForward classrooms and students in non-MathForward classrooms. There was not a significant difference in the scores for the MathForward students ($M = 4.84, SD = 8.072$) and non-MathForward students ($M = 5.07, SD = 7.938$); $t(2254.954) = -0.727, p = 0.467$.

**Research Question #2**

Are there differences in mathematics achievement gains between males and females as quantified by the Measure of Academic Progress (MAP) assessment after the teachers had achieved two years of MathForward program implementation experience?

**Hypothesis:** In the population, the mean difference in the October and June MAP scores are the same for females and males in MathForward classrooms.

An independent samples $t$-test was conducted to compare the difference in scores from the October and June MAP administration between female and male students in MathForward classrooms. There was not a significant difference in the scores for the MathForward female students ($M = 4.92, SD = 7.978$) and MathForward male students ($M = 4.77, SD = 8.164$); $t(1651.681) = 0.375, p = 0.708$.

An additional independent samples $t$-test was conducted to compare the difference in scores from the October and June MAP administration between female and male students in non-MathForward classrooms. There was a significant difference in the scores for the non-MathForward female students ($M = 4.50, SD = 7.503$) and non-MathForward male students ($M = 5.60, SD = 8.292$); $t(1045.427) = -2.245, p = 0.025$. 
Research Question #3

Are there differences in mathematics achievement gains between students receiving free or reduced lunch and students not receiving free or reduced lunch as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

Hypothesis: In the population, the mean difference in the October and June MAP scores are the same for students receiving free or reduced lunch and students not receiving free or reduced lunch in MathForward classrooms.

An independent samples t-test was conducted to compare the difference in scores from the October and June MAP administration between students receiving free and/or reduced lunch and students not receiving free and/or reduced lunch in MathForward classrooms. There was not a significant difference in the scores for the MathForward free and/or reduced lunch students ($M = 4.81$, $SD = 8.245$) and MathForward non-free and/or reduced lunch students ($M = 4.96$, $SD = 7.353$); $t(558.714) = -0.315$, $p = 0.753$.

An additional independent samples t-test was conducted to compare the difference in scores from the October and June MAP administration between students receiving free and/or reduced lunch and students not receiving free and/or reduced lunch in non-MathForward classrooms. There was not a significant difference in the scores for the non-MathForward free and/or reduced lunch students ($M = 5.02$, $SD = 8.300$) and non-MathForward non-free and/or reduced lunch students ($M = 5.21$, $SD = 6.810$); $t(572.467) = -0.359$, $p = 0.720$. 
**Research Question #4**

Are there differences in mathematics achievement gains between Caucasian students, African-American students, Hispanic, and Other (Asian, American Indian, and Alaskan Native) students as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

Hypothesis: In the population, the mean difference in the October and June MAP scores are the same for Caucasian, African-American, Hispanic, and Other (Asian, American Indian, and Alaskan Native) students in MathForward classrooms.

A one-way between subjects ANOVA was conducted to compare the effect of ethnicity on the difference in mathematics achievement gains, using African-American, Hispanic, White, and Other (Asian, American Indian, and Alaskan Native) groupings of MathForward students. There was a significant effect on ethnicity on the difference in mathematics achievement gains at the $p < 0.05$ level for the four groups [$F(3, 1652) = 5.295, p = 0.001$]. Post hoc comparisons using the Tukey HSD test indicated that the mean score for MathForward African-Americans ($M = 4.08, SD = 7.972$) was significantly different than MathForward Hispanics ($M = 5.68, SD = 8.308$) as well as MathForward Others (Asian, American Indian, and Alaskan Native) ($M = 6.10, SD = 7.233$). However, MathForward Whites ($M = 5.28, SD = 8.163$) did not significantly differ from any of the other three groups, MathForward African-American, MathForward
Hispanic, and MathForward Other. MathForward Hispanics also did not significantly differ from MathForward Others.

An additional one-way between subjects ANOVA was conducted to compare the effect of ethnicity on the difference in mathematics achievement gains, using African-American, Hispanic, White, and Other (Asian, American Indian, and Alaskan Native) groupings of non-MathForward students. There was not a significant effect on ethnicity on the difference in mathematics achievement gains at the $p < 0.05$ level for the four groups $[F(3, 1044) = 1.144, p = 0.330]$.

**Research Question #5**

Are there differences in mathematics achievement gains between students using Glencoe curriculum materials and students using Connected Mathematics Project curriculum materials as quantified by the Measure of Academic Progress (MAP) assessment after their teachers have achieved two years of MathForward program implementation experience?

Hypothesis: In the population, the mean difference in the October and June MAP scores are the same for students using Glencoe curriculum materials and for students using the Connected Mathematics Project curriculum materials in MathForward classrooms.

An independent samples $t$-test was conducted to compare the difference in scores from the October and June MAP administration between students using Glencoe curriculum materials and students using Connected Mathematics Project curriculum
materials in MathForward classrooms. There was a significant difference in the scores for the MathForward students using Glencoe curriculum materials \((M = 4.32, \, SD = 7.971)\) and MathForward students using Connected Mathematics Project curriculum materials \((M = 5.99, \, SD = 8.184)\); \(t(974.16) = -3.868, \, p = 0.00\). Further, Cohen’s effect size value \((d = 0.2067)\) suggested a small practical significance.

An additional independent samples \(t\)-test was conducted to compare the difference in scores from the October and June MAP administration between students using Glencoe curriculum materials and students using Connected Mathematics Project curriculum materials in non-MathForward classrooms. There was not a significant difference in the scores for the non-MathForward students using Glencoe curriculum materials \((M = 4.97, \, SD = 8.343)\) and non-MathForward students using Connected Mathematics Project curriculum materials \((M = 5.15, \, SD = 7.593)\); \(t(967.606) = -0.368, \, p = 0.713\).

The table on the next page summarizes the statistics for each analysis for both the MathForward and the non-MathForward students.
Table 13: *Detailed Statistics for MathForward and non-MathForward Students*

<table>
<thead>
<tr>
<th>Factor</th>
<th>MathForward Students</th>
<th>Non-MathForward Students</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>$\bar{X}$</td>
</tr>
<tr>
<td>Free or Reduced Lunch</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>1324</td>
<td>4.81</td>
</tr>
<tr>
<td>No</td>
<td>332</td>
<td>4.96</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>803</td>
<td>4.92</td>
</tr>
<tr>
<td>Male</td>
<td>853</td>
<td>4.77</td>
</tr>
<tr>
<td>Ethnicity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>African-American</td>
<td>830</td>
<td>4.08*</td>
</tr>
<tr>
<td>Hispanic</td>
<td>427</td>
<td>5.68*</td>
</tr>
<tr>
<td>White</td>
<td>277</td>
<td>5.28</td>
</tr>
<tr>
<td>Other</td>
<td>122</td>
<td>6.10*</td>
</tr>
<tr>
<td>Curriculum Materials</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Glencoe</td>
<td>1139</td>
<td>4.32*</td>
</tr>
<tr>
<td>Connected Math Project</td>
<td>517</td>
<td>5.99*</td>
</tr>
</tbody>
</table>

* The mean difference is significant at the 0.05 level.

**Research Question #6**

To what extent does the amount of professional development, either in-service trainings or in-classroom coaching sessions, as quantified by hours affect MathForward teachers’ mean student mathematics achievement gains after teachers have achieved two years of program implementation experience as measured by attendance and coaching records?
Hypothesis: In the population, there is no effect of the amount of teacher professional development, either in-service trainings or in-classroom coaching sessions, on the mean student mathematics achievement scores of MathForward teachers.

Research Question #7

To what extent does the teachers’ perceived level of administrator support as measured by teachers’ survey responses affect MathForward teachers’ mean student mathematics achievement gains after teachers have achieved two years of program implementation experience?

Hypothesis: In the population, there is no effect on the teachers’ perceived level of administrator support on the mean student mathematics achievement scores of MathForward teachers.

Research Question #8

To what extent does the quality of classroom instruction affect MathForward teachers’ mean student mathematics achievement gains after teachers have achieved two years of program implementation experience as measured by the RTOP (Reformed Teaching Observation Protocol)?

Hypothesis: In the population, there is no effect on the quality of classroom instruction on the mean student mathematics achievement scores of MathForward teachers.

A stepwise multiple linear regression analysis was conducted to evaluate whether the amount of professional development received by the teacher, both total in-service
trainings and total in-classroom coaching sessions, the level of administrative support perceived by the teacher, and the teacher’s Reformed Teaching Observation Protocol score were necessary to predict the mean difference in the June and October mathematics MAP scores for the students of each MathForward teacher.

<table>
<thead>
<tr>
<th>Variable</th>
<th>$M$</th>
<th>$SD$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Difference in MAP Scores</td>
<td>6.124</td>
<td>3.821</td>
</tr>
<tr>
<td>Level of Administrative Support</td>
<td>15.944</td>
<td>3.189</td>
</tr>
<tr>
<td>RTOP Score</td>
<td>66.889</td>
<td>24.088</td>
</tr>
<tr>
<td>Total Coaching Hours</td>
<td>14.940</td>
<td>2.363</td>
</tr>
<tr>
<td>Total Training Hours</td>
<td>11.528</td>
<td>4.516</td>
</tr>
</tbody>
</table>

Each of the predictor variables were entered into the regression equation one at a time based upon statistical criteria from the stepwise multiple linear regression analysis. At Step 1 of the analysis, the total amount of in-classroom coaching hours entered into the regression equation and was significantly related to the MathForward teacher’s mean difference in students MAP scores, $F(1,16) = 4.681, p = 0.046$. The model using only the factor of a MathForward teacher’s total amount of in-classroom coaching hours accounted for approximately 23% of the variance in the mean differences in a MathForward teacher’s student mathematics MAP scores ($R^2 = 0.226$, Adjusted $R^2 = 0.178$). The analysis also found a high degree of correlation between the total amount of in-classroom coaching hours and the combined score from the Reformed Teaching Observation Protocol ($r = 0.513$).
Table 15: Correlations between Variables from Regression Analysis

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean Diff in MAP Scores</th>
<th>Admin Support</th>
<th>RTOP</th>
<th>Coaching Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Admin Support</td>
<td>0.071</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RTOP</td>
<td>0.342</td>
<td>-0.093</td>
<td>0.513</td>
<td></td>
</tr>
<tr>
<td>Coaching Hours</td>
<td>0.476</td>
<td>0.163</td>
<td>0.324</td>
<td>0.234</td>
</tr>
<tr>
<td>Training Hours</td>
<td>0.149</td>
<td>0.082</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The other three factors did not enter into the equation with MathForward teacher’s perceived level of administrator support \((t = -0.030, p = 0.977)\), MathForward teacher’s Reform Teaching Observation Protocol score \((t = 0.133, p = 0.507)\), and MathForward teacher’s total amount of in-service training hours \((t = 0.040, p = 0.866)\). The three factors of perceived level of administrator support, Reformed Teaching Observation Protocol score, and total amount of in-service training hours did not make a statistically significant addition to the analysis, with only the total amount of in-classroom coaching hours having a statistically significant relationship to a MathForward teacher’s mean difference in their students’ mathematics MAP scores. Thus the regression equation for predicting a MathForward teacher’s mean difference in their students’ mathematics MAP scores is:

\[
\text{MathForward Teacher’s Mean Difference in Students Mathematics MAP Scores} = 0.769(\text{total hours of teacher’s in-classroom coaching hours}) - 5.372
\]
Summary

Analysis of the data resulted in accepting a number of null hypotheses. Independent $t$-tests and one-way ANOVA tests were used to analyze the research questions comparing both the MathForward and non-MathForward students, as well as to analyze if there was a difference between any of the student sub-groups within the larger groups. These sub-groups were created by associating students by gender, ethnicity, socio-economic status, and curriculum materials used by them. The only significant differences were found between ethnic groups within the MathForward students and the type of curriculum materials used by the MathForward students. However, several interesting interpretations can be made by comparing the differences between the sub-groups of the MathForward students to the sub-groups of the non-MathForward students.

A multiple linear regression was completed to analyze any correlation between the MathForward teacher factors of perceived level of administrative support, the amount of professional development received, both in-service training and in-classroom coaching sessions, and the Reformed Teaching Observation Protocol score on the mean difference in mathematics MAP scores. The results indicated that only the total amount of in-classroom coaching hours significantly predicted the mean difference in mathematics MAP scores.
CHAPTER V

RESULTS

Introduction

By February 2012, forty-three states including Washington, D.C., have been granted waivers from the stringent Adequate Yearly Progress requirements of the No Child Left Behind Act of 2001 (U.S. Department of Education, 2013). To be approved for a waiver, states needed to demonstrate that they would implement a series of reforms to their academic standards, student assessments, and accountability systems for schools and educators. Many states put into action a comprehensive accountability index. These indexes use multiple measures and classify schools along a rating continuum where accountability determinations are reported annually in a school report card. Most school report cards include scores in four priority areas: student achievement, student growth, closing student achievement gaps, and graduation/attendance rates. School report cards can determine explicit rewards and/or sanctions for performance that exceeds or does not exceed expectations of the state as well as indirect pressures to the school district from the publicized report cards.

The age of accountability that education currently exists in places tremendous pressure on school administrators to not only increase overall student achievement, but to raise lower-performing student groups, specifically certain ethnic groups, economically
disadvantaged students, students with disabilities, and English language learners. Administrators are searching for research-based programs that can improve classroom instruction and strengthen their teachers’ pedagogy.

This study examined the effect of the Texas Instruments MathForward program on student mathematics achievement growth in the Milwaukee Public Schools while also examining the effect of the program on specific student sub-populations based on gender, ethnicity, and socioeconomic status. While it is important for school administrators to make educated decisions on where to spend their limited funding, it is also important for administrators to be aware of strategies that augment the effects of any reform program they chose to implement at their school. With this in mind, the effects of the amount of professional development (both training and in-classroom coaching) and the level of administrator support was also analyzed in this study as well as the quality of classroom instruction.

Summary of Findings

The MathForward Program and Student Achievement Gains

The results of the independent $t$-test indicated that there was no significant difference between the students of teachers implementing the MathForward program for two years and the students of teachers not implementing the MathForward program when comparing the difference in scores from the June and October administration of the mathematics Measures of Academic Progress (MAP) assessment. However, independent $t$-tests did indicate significant differences among some of the student sub-populations.
Although previous research suggests that socio-economic status is the strongest predictor of student achievement (Jencks & Phillips, 1998; Lee, Bryk, & Smith, 1993), this is not substantiated in this study. While students not receiving free and/or reduced lunch had a higher mean difference in MAP assessment scores than students receiving free and/or reduced lunch in both the MathForward group and the non-MathForward group, the difference was not large enough to be statistically significant.

Even though mathematics achievement differences based on gender have received considerable attention in research studies, the results have been varied. These mixed results are duplicated in this study where although males had a slightly higher mean difference in MAP assessment scores than females, it was not statistically significant within the MathForward group. However, in the non-MathForward group, there was a statistically significant difference between males and females with the males outscoring the females. Another striking difference was that while non-MathForward males had a higher mean difference than MathForward males, non-MathForward females underscored their MathForward counterparts. The positive effect of the MathForward program on the mathematics achievement growth for females could be a possible explanation for MathForward females having a higher mean difference in MAP scores than non-MathForward females.

Milwaukee Public Schools is a diverse, urban district with African-Americans accounting for over half of the student population, followed by Hispanics representing 25%. Caucasian students total 15% with all other ethnicities (Asians, American Indians,
and Alaskan Natives) combining for approximately 5%. While previous studies have highlighted the substantial mathematics achievement gap between Caucasians and African-Americans as well as Hispanics (Delgado-Gaitan, 1992; Lareau, 2003; McCarthy, 1990; Stanton-Salazar, 2001), this study had mixed results between these student ethnic groups. There was not a significant difference in MAP scores between Caucasian students and the other three student sub-populations with Caucasian students having the next to least amount of growth, slightly above African-American students, as measured by the difference in MAP scores.

There was however, a statistically significant difference between African-American students and Hispanic students, and African-American students and Asian, American Indian, and Alaskan Native students within the MathForward group. In the MathForward classrooms, both Hispanic students and Asian, American Indian, and Alaskan Native students had a significantly higher mean difference in MAP scores than African-American students with Asians, American Indians, and Alaskan Natives having the highest mean difference of all four ethnic groups. There was not a significant difference between any of the four ethnic groups in the non-MathForward population of students.

While the MathForward program did not bridge the gap between all student ethnic groups, it does appear that the program helps Hispanics and Asians, American Indians, and Alaskan Natives show significant mathematics growth, but African-Americans still lag the furthest behind. This substantiated previous MathForward studies that had found
a marked growth in overall mathematics achievement by Hispanic students (Stroup, Pham, & Alexander, 2007).

In addition to analyzing any differences in mathematics achievement growth between student sub-groups, this study also examined any mean difference in MAP assessment scores between students using two different types of curriculum materials, Glencoe and the Connected Mathematics Project (CMP). Whereas there was no significant difference in scores for students using the two different curriculum materials in non-MathForward classrooms, there was a significant difference in the MathForward classrooms. MathForward students using the CMP curriculum materials had statistically significant higher gains than MathForward students using Glencoe curriculum materials. The mean gain for MathForward students using CMP curriculum materials was also substantially higher than non-MathForward students using the same materials.

The professional development training MathForward teachers received did not incorporate training on any specific curriculum materials, neither Glencoe nor CMP, but aimed at incorporating technology-rich activities developed by Texas Instruments into instruction. Even though the MathForward program did not facilitate the use of any particular curriculum materials, the significant difference could possibly be explained by the similar pedagogy behind CMP and the MathForward program.

MathForward Teacher Effects and Student Achievement Gains

A stepwise multiple linear regression analysis was used to develop a model for predicting the mean difference in students’ mathematics MAP scores for the
MathForward teachers from the total amount of professional development they received, both in-service trainings and in-classroom coaching sessions, their perceived level of administrative support, and their total Reformed Teaching Observation Protocol score. The resulting prediction model contained only one of the four predictors and was reached in one step. The only predictor that was found to account for the variance in the mean differences in a MathForward teacher’s student mathematics MAP scores was the total amount of in-classroom coaching hours that the teacher received. The model only accounted for approximately 23% of the variance in the difference in student MAP scores. The small sample size of eighteen MathForward teachers may be a reason for this small amount of explanation of variance. Another striking observation from the multiple linear regression analysis was the high correlation between the total hours of in-classroom coaching received by each MathForward teacher and their total score from the Reformed Teaching Observation Protocol.

**Discussion of Findings**

**The MathForward Program and Student Achievement Gains**

While previous research studies analyzing the MathForward program showed a marked increase in student achievement scores, they did not analyze the mathematics achievement growth of students over the course of a school year. Studies in the Richardson Independent School District compared the passing percentage of MathForward students on the Texas Assessment of Knowledge (TAKS) on one campus to the passing percentage of non-MathForward students on a different campus. Other
studies compared the passing rate of students on state assessments from the year prior to experiencing MathForward to the year after experiencing MathForward. Whereas these studies used the same group of students, they used different instruments each year to assess the students. None of the previous studies examined the changes within the same group of MathForward students from one time period to another.

Though this study did control for student demographics of gender, ethnicity, and socio-economic status to ensure the experimental and control group possessed similar dynamics, it did not find any significant difference in mathematics achievement growth as measured by the June and October Measures of Academic Progress (MAP) between MathForward students and non-MathForward students. This study also used the Measures of Academic Progress mathematics assessment, a computerized adaptive assessment developed to measure student growth using the Rasch scale rather than state assessments at two different grade levels. While the MAP assessment has been proven reliable and valid, there is concern over the amount of effort students exhibit on the assessment, which may result in their assessment scores not serving as valid indicators of what they know and can do. Students in Seattle Public Schools have stated, “I know students who just go through the motions when taking the test, did it as quickly as possible so that they could do something more useful with their time.” Teachers have echoed these concerns stating that “students do not take the test seriously as they know that it will not directly impact their class grade or graduation status.” (Strauss, 2013).
This study also examined any effect the MathForward program may have had on different student sub-groups as measured by the difference in MAP scores from the June and October administrations. The results provided support to previous studies that indicate the gender gap in mathematics has been decreasing in recent decades and is now quite small (Gray, 1996; Hanna, 2003).

While the results of this study also supported previous studies that highlight an achievement gap between ethnic groups, the anomaly in this study is that the significant difference was between African-Americans, Hispanics, and Asians, American Indians, and Alaskan Natives rather than Caucasians in MathForward classrooms. As in previous studies, the sub-group of Others, which contains Asian students, outperformed the other ethnic groups. However, MathForward Hispanic students had a higher mathematics achievement growth than MathForward Caucasians with MathForward African-American students showing the smallest amount of mathematics achievement growth. This finding is in direct contrast to the 2003 National Assessment of Educational Progress study showing that Caucasian and Asian students outperform African-American and Hispanic students (National Center for Education Statistics, 2003).

The majority of students who speak a language other than English at home are Hispanic. These students may benefit most from the integration of the technology utilized by the MathForward program that enhances visualization of mathematical concepts and principles. Instruction in MathForward classrooms employs the graphing calculators and the Texas Instruments Navigator system. This technology allows students
to visualize in a dynamic way, tough to-learn concepts such as average rate of change and slope: the ability for students to also see slope as a fraction not only in the way it is entered into the calculator, but also in the subsequent answer (Pardo, 2010).

One of the most striking disparities in this study as compared to previous research is the lack of significance between students receiving free and/or reduced lunch and those students who do not receive free and/or reduced lunch. A study by the Organization for Economic Cooperation and Development (2012) found that socioeconomic disadvantage has a notable impact on student performance with 15% of the variation in student performance explained by students’ socioeconomic status. Milwaukee Public Schools is a large, urban district with a large proportion of students of low socioeconomic status. Only 20% of the students in this study did not receive free and/or reduced lunch. This small sample size could contribute to the lack of significance in achievement gains in the study.

Another significant distinction between the differences in students’ mathematics MAP scores was found between the two distinct sets of curriculum materials the MathForward students used in their classrooms. The MathForward students who used the Connected Mathematics Project (CMP) curriculum materials had a significant higher mathematics growth than MathForward students who used the Glencoe curriculum materials. These significant differences were only found between the MathForward students with the non-MathForward students showing no significant differences in scores between the two sets of curriculum materials.
Research indicates that Connected Mathematics Project is a strong inquiry based instructional program where students are given time to delve, discuss and think through problems with small and large group activities allowing for exploration and discovery (Prentice Hall, 2004). Connected Mathematics Project also has a strong staff development component that fosters a better understanding of inquiry based learning versus the direct teaching method where students receive a lecture from the teacher followed by guided practice and homework. This pedagogy is parallel to the research that supports a concentrated effort to reach beyond mere paper and pencil activities and encourage teacher-to-student and student-to-student interactions (National Research Council, 2001).

These same ideologies form the foundation of the MathForward program and are the focus of the professional development provided to the MathForward teachers. The integration of the TI-Navigator system and the graphing calculators in MathForward classroom instruction prompts students to engage in classroom activities, remain focused on the content, and participate in productive collaborate group interactions (VanDeGrift, Wolfman, Yasuhara, & Anderson, 2002). The similar pedagogies between the MathForward program and the Connected Mathematics Project could explain the significantly higher different in students’ MAP scores.

MathForward Teacher Effects and Student Achievement Gains

Douglas Carnine synthesized existing literature on the effective implementation of innovations in education, which included ten components of effective mathematics
innovation (Carnine, 2000). These components were later validated in a multi-state correlational study relating these implementation factors to state test performance (Toenjes, Lewis, Winick, 2004). This study examined the effect of two of these factors, sound administrative practices and focused professional development, on mathematics achievement growth as measured by the difference in the June and October MAP scores.

A multiple linear regression analysis with factors entered in a stepwise fashion resulted in a model containing only the predictor of total amount of in-classroom coaching hours. The remaining three factors of total amount of MathForward training hours, survey score for perceived administrator support, and the total score from the Reformed Teaching Observation Protocol were excluded from the model. The model explained only 23% of the variance in a MathForward teacher’s mean difference in student MAP scores between the June and October administration. This low explanation in variance could be attributed to the small sample size of eighteen MathForward teachers.

Sound administrative practices include communicating achievement expectations for all students, providing support for instruction rather than enforcing compliance, taking action to ensure adequate student progress and monitoring, and creating an environment conducive to instruction and success (Toenjes, Lewis, Winick, 2004). These practices were measured by an online survey completed by the MathForward teachers. The survey’s Cronbach alpha test did measure a relatively high internal consistency; however, the results from this study do not find any significant correlation
between the MathForward teachers’ perceived level of administrative support and the average difference in MAP scores for their students. The lack of correlation between perceived administrative support and student mathematics achievement gains could be attributed to the small sample size of eighteen MathForward teachers.

Focused professional development has been found to be the key mechanism for improving classroom instruction and student achievement (Ball & Cohen, 1999; Cohen & Hill, 2000). Professional development enhances teacher content knowledge and pedagogical skills resulting in improved teachers’ instructional practices, which in turn lead to improved academic achievement for students (Yoon, Duncan, Lee, Scarloss, & Shapley, 2007). This study analyzed the effect of two forms of professional development, the total hours of both in-service trainings and in-classroom coaching received by each teacher, on the average difference in MAP scores for their students.

While the results from this study do not find any correlation between the total hours of in-service trainings received by the MathForward teachers and the average difference in MAP scores for their students, there was a significant correlation between total hours of in-classroom coaching and achievement gains. This finding supports previous studies that find little evidence of transfer from conventional staff development to ongoing classroom practice, even after high-quality training that integrates theory and demonstration (Joyce & Showers, 1995). Studies that examined effective staff development noted that it must be ongoing, deeply embedded in teachers’ classroom work with children, specific to grade levels or academic content, and focused on
research-based approaches while also helping to open classroom doors and creating more collaboration and a sense of community among teachers in a school (Russo, 2004). These factors of effective staff development align to the content-focused coaching modeled supported by the MathForward program where Implementation Specialists collaborate with teachers on analyzing student work and planning appropriate lessons, model best practices in the classroom, and lead conversations reflecting on instruction. In support of previous research findings, the model established by the stepwise multiple linear regression analysis in this study contained only the predictor of total hours of in-classroom coaching to predict the mean variance in student mathematics gains and excluded the predictor of total hours of in-service trainings.

Another interesting finding of the multiple linear regression analysis was the high correlation between the total hours of in-classroom coaching received by a MathForward teacher and their combined score from the Reformed Teaching Observation Protocol even though a teacher’s combined RTOP score was excluded from the model established by the stepwise multiple linear regression. The Reformed Teaching Observation Protocol measures the degree to which constructivist notions such as inquiry-based activities and student-led content discussions are visible in the classroom. During coaching sessions, MathForward Implementation Specialists assist teachers in planning their curriculum and coaching them on issues ranging from mathematical standards to pedagogical practices based on the Principles and Standards for School Mathematics (NCTM, 2000). Since the Reformed Teaching Observation Protocol and the MathForward program rely heavily
upon research advocating constructivist, inquiry-based instructional methods, it is reasonable that a teacher’s RTOP score would be highly correlated with the amount of in-classroom coaching that they received from MathForward Implementation Specialists. The small sample size of eighteen MathForward teachers could be a possible reason for the exclusion of this predictor in the model created by the stepwise multiple linear regression analysis.

**Limitations**

This study focused on the effect of the MathForward program in classrooms where teachers were in the second year of MathForward program implementation within the Milwaukee Public School District. The experimental group consisted of a small sample size of eighteen teachers that were chosen by the district to implement the MathForward program. There was no random sampling involved in this study due to the purposeful selection of teachers by the district based on numerous factors such as low achievement scores of the school, agreement of building administrators to implement the program, and funding available to purchase technology required for program implementation. The experimental group of students was selected based on their teachers’ participation in the second year of MathForward program implementation; thus, random sampling of students was not employed. The lack of random sampling prevents the results from being generalizable to the population of middle schools students.

Another limitation to the study was the mortality of subjects due the pre- post-test used to measure the students’ mathematics achievement gains. Over 15% of the
potential subjects for both the experimental and control groups of students were removed due to a missing score from either the June or October administration of the MAP assessment. While statistical analyses determined that the scores were missing at random, deletion of these subjects did decrease the sample size for the study.

Even though there were a total of 2,704 students involved in the study, the large number of independent variables (gender, ethnicity, free and/or reduced lunch, and type of curriculum materials) created very small sub-groups to analyze. For example, there were only 26 white, female students who did not receive free and/or reduced lunch and used the Connected Mathematics Project curriculum materials. These small sample sizes prevented the use of an analysis of variance to examine the between subjects effects and decreased the power of the study.

A potential limitation in the study is the measurement tool chosen to determine the students’ mathematics achievement growth. While the MAP assessment has been proven to be reliable and valid in measuring student growth, there is concern about the extent of effort students put forth when taking the assessment. The growing concern over the reliability of the MAP assessment began in Seattle Public Schools. Seattle teachers have claimed that their students do not take the test seriously as they know that it will not directly impact their class grade or graduation status. They state the students approach the test less and less seriously the more times they take it; therefore, teachers find achievement scores go down after instruction (Strauss, 2013).
With Milwaukee Public Schools administering a variety of state and district assessments each school year, there is some question as to what extent students try their best on the MAP which is considered a low-stakes test without consequences for student performance. If low motivation leads to reduced test scores, it also reduces score validity in the sense that the assessments do not provide an accurate reflection of the mathematics growth of the students. Previous research has found that scores from low-stakes tests may not represent what the student knows; rather, such scores represent what students will demonstrate with minimal effort (O’Neil, Sugrue, & Baker, 1995/1996).

**Suggestions for Future Research**

This study was conducted in the Milwaukee Public Schools, a district predominantly consisting of African-American students with a large majority of students receiving free and/or reduced lunch. Future studies could include other districts with differing student demographics in order to examine the effect of the MathForward program on the general population of middle school students. Since the MathForward program has been implemented in over sixty districts across the country, a large enough sample teacher population exists so that random sampling could be done to construct a sample that is representative of the general population. Not only will this increase the generalizability of the results, but it will also increase the size of student sub-groups so that the effects between subjects can be examined using an analysis of variance.

The results from this study on the achievement growth of students receiving free and/or reduced lunch compared to those students who do not are an anomaly to previous
studies that find socioeconomic disadvantage has a notable impact on student performance with 15% of the variance in student performance explained by students’ socioeconomic status (OECD, 2012). This study found no significant difference between students receiving free and/or reduced lunch and those who do not within both the MathForward group of students and the non-MathForward group of students. The low percentage of students (20%) not receiving free and/or reduced lunch in Milwaukee Public Schools could possibly be a cause for the lack of significance. By increasing the sample size of students across various districts in future studies, more equivalent sized student sub-groups based on socioeconomic status may result in differing findings that are more aligned to the research indicating the significant effect of socioeconomic status on student achievement.

Additionally, findings from this study indicated the significant achievement growth of Hispanic students compared to other ethnic groups when participating in a classroom implementing the MathForward program. Previous studies on the MathForward program have also found significant achievement gains for Hispanic students (Texas Instruments, 2011). These similar results open the door for future studies to examine the effects of specific components of the MathForward program on Hispanic students or other ESL students. The results of these future studies would be beneficial to districts across the country that have a growing Hispanic population, a student subgroup that has shown to be more likely to have lower standardized test scores
than Caucasian students (Delgado-Gaitan, 1992; Lareau, 2003; McCarthy, 1990; Stanton-Salazar, 2001).

Another interesting result from this study that could be examined in greater detail is the interactive effect of different instructional programs and curriculum materials on student achievement. There was a statistically significant difference between MathForward students using Connected Mathematics Project curriculum materials rather than Glencoe whereas there was no difference with non-MathForward students. This finding supports previous research which supports a constructivist theory-based approach to teaching mathematics in which students make personal sense of mathematics content through exploring, reasoning, or problem solving (Draper, 2002). Future studies could explore the specific effects of implementing both instructional programs and curriculum materials created on constructivist teaching techniques.

Another future study that would be interesting is the exploration of the effects of various formats of teacher professional development on student mathematics achievement growth. Several comparison-group studies have found that teachers who receive coaching are more likely to enact the desired teaching practices and apply them more appropriately than are teachers receiving more traditional professional development (Showers & Joyce, 1996; Neufeld & Roper, 2003). This study showed that in-classroom coaching was positively correlated with student achievement growth, while in-service training was not. Future studies could examine the various aspects of both trainings and coaching sessions to determine which key attributes can most improve student
achievement gains or if a blended model of the two is most effective. Another study could examine if there is a significant impact on student achievement due to in-classroom coaching paired with curriculum materials that are of the same philosophical perspective. This information would be helpful to a district designing professional development plans for their teachers as well as districts exploring new curriculum materials for their classrooms.

Furthermore, a qualitative study could provide insight into the specific characteristics of in-classroom coaching that provide the greatest effect on student achievement gains. This study could examine how coaches provide support for the components of technology integration, content knowledge, and pedagogy. Additionally, a qualitative study could explore the factors that assist teachers in making effective changes to their instruction.

Finally, it would be interesting to replicate this study using a different tool to measure student mathematics achievement growth. While the Measures of Academic Progress (MAP) assessments have been popular tools to measure student achievement growth, they are often viewed as non-consequential assessments by both teachers and students. Without consequences for performance, many students will not put forth their best effort on these low-stakes tests resulting in test scores reflecting an underestimate of their level of proficiency. Aggregating these scores across students, as done in this study, may yield a biased picture of student achievement.
With the majority of states adopting new assessments aligned to the Common Core State Standards, these high-stakes tests may provide a more accurate measure of student achievement. Partnership for Assessment of Readiness for College and Careers (PARCC) and the Smarter Balanced Assessment Consortium have designed summative assessments to be administered during the last three months of the school year. These assessments are designed to accurately measure both student achievement and growth of student learning. Since the results of these assessments will be used in most states to evaluate the performance of individual schools and districts, teachers and students will be highly motivated to exhibit greater effort on these assessments than they would on lower-stakes tests. As research evidence suggests that increased motivation leads to an increase in test score validity (O’Neill, Sugure, & Baker, 1995/1996), using the new PARCC and Smarter Balanced assessments to measure student achievement growth may lead to results different from those obtained by using the MAP assessment as the measurement tool.

**Conclusion**

The passage of the No Child Left Behind Act of 2001 expanded the federal role in education and brought about sweeping changes concerning student achievement and assessment. Test-driven accountability has taken center stage in the education landscape, and administrators are struggling to increase the achievement of ALL students as mandated by federal legislation. This study aims at providing building administrators
with knowledge on specific components that can be instilled in their buildings to lead to increased student achievement.

The purpose of this study was to evaluate the effectiveness of the Texas Instruments MathForward program and its effect on specific student sub-groups differentiated by gender, ethnicity, socioeconomic status, and the type of curriculum materials used in their classrooms. Additionally, the study also explored the relationship between the amount of professional development (both in-service trainings and in-classroom coaching sessions) teachers received and their perceived level of administrative support for the MathForward program with student mathematics achievement gains.

The results of this study aim at assisting administrators in making decisions on the implementation of a research-based mathematics program that can potentially impact student achievement, both for the general student population and for specific student sub-groups. Once an instructional program is decided upon, it is vital that administrators are aware of specific factors that increase the effectiveness of the program. With this in mind, this study examined the relationship between the amount of two different forms of professional development, the amount of in-service trainings and the amount of in-classroom coaching sessions received by the teachers, on student mathematics achievement growth. Additionally, the relationships between the perceived level of administrator support and the quality of classroom instruction with student achievement growth was also explored. The coordination of curriculum, instructional materials,
assessment, instruction, professional development, and school organization around the development of mathematical proficiency should direct school improvement efforts (National Research Council, 2001). School administrators are the main driving force responsible for these much needed efforts at improving students’ mathematical learning. The results of this study will provide administrators with information on specific components they can influence that can have a positive effect on student achievement.

While funding for innovative instructional programs to meet the unique learning needs of urban students can be difficult to obtain, it is vital that research-based decisions are made by administrators on how to successfully implement these programs. This study has indicated some potential components of the MathForward program that can have positive impacts on student achievement. Although this study has shown that traditional professional development trainings have little effect on student achievement gains, the implementation of in-classroom coaching founded on the constructivist tenets of NCTM can strengthen classroom instruction and in turn increase student achievement.

Research has proven that leadership is second only to teaching among school-related influences on learning, and the need for effective leadership is most crucial in urban schools which are typically low-performing (Seashore-Louis, 2010). In these schools, educators find themselves in a crucible of diverse and acute learning needs, often diminished resources, limited hope and expectations, and a history of low performance on whatever measures matter in their respective district and state systems (Hess, 1999; Payne, 2008). While strong leadership is needed in all schools, principals in low-
achieving or high poverty, minority schools tend to have a greater impact on student outcomes than principals at less challenging schools (Leithwood, Seashore-Louis, Anderson & Wahlstrom, 2004; Seashore-Louis, Leithwood, Wahlstrom & Anderson, 2010).

Research has shown effective building leaders in challenging schools are typically linked to three actions. First, the foundation for being an effective principal is establishing a school-wide vision and commitment to high standards and success of all students (The Wallace Foundation, 2012). Secondly, the most effective principals share leadership responsibilities with their teachers and other administrators (Seashore-Louis, Leithwood, Wahlstrom & Anderson, 2010). Shared leadership focuses on ensuring that everyone is progressing towards the school’s goals. Finally, effective principals are instructional leaders. A principal’s instructional leadership has about three to four times more impact on student achievement than transformational leadership, where principals focus on motivation and improving the morale of their leaders (Robinson, Lloyd and Rowe, 2008). Principals demonstrate instructional leadership by establishing a culture within the school that supports continual professional learning and by taking explicit steps to support individual teachers (Seashore-Louis, Leithwood, Wahlstrom & Anderson, 2010). Principals provide instructional support by emphasizing the value of research-based strategies and applying them effectively (Seashore-Louis, Leithwood, Wahlstrom & Anderson, 2010); by encouraging teacher collaboration (The Wallace Foundation, 2012); and by providing more time for teacher planning (The Wallace
These leadership factors must be integrated with the implementation of a reform instructional program to have a long-term effect on instructional quality. While the improvement of students’ mathematics achievement is critical for meeting school accountability guidelines, it is vital to our country’s economy. Unfortunately, the gap between the burgeoning business demand for a highly accomplished workforce and a lagging educational system has steadily widened. The importance of reforming classroom learning of mathematics is summarized by Bill Gates, chairman of the Microsoft Corporation, “Unless the schools of the U.S. find the tools to bring students up to the highest level of accomplishment, it places the nation at risk in the international economy of the 21st Century (Washington Post, 2007). The weight of this burden lies heavily on the shoulders of building administrators who must be knowledgeable of successful reform initiatives that can transform the classrooms in their buildings into engaging centers where high quality instruction and learning occur.
APPENDICES
APPENDIX A

PERCEIVED LEVEL OF ADMINISTRATOR SUPPORT SURVEY
Appendix A

Perceived Level of Administrator Support Survey

Please mark the extent to which you agree or disagree with each of the following statements. The principal at my school:

<table>
<thead>
<tr>
<th>Makes clear to the staff his/her expectations for meeting the goals of MathForward</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communicates a clear vision for MathForward in our school</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Sets high standards for teaching mathematics</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Encourages teachers to communicate regularly with parents about MathForward</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Provides adequate common planning time for MathForward teachers</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Encourages all teachers to attend MathForward professional development trainings</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
APPENDIX B

REFORMED TEACHING OBSERVATION PROTOCOL
Appendix B

Reformed Teaching Observation Protocol

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada
External Evaluator

Michael Pihurn
Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)

Technical Report No. 1N00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher

Announced Observation? (yes, no, or maybe)

Location of class

(district, school, room)

Years of Teaching

Teaching Certification

(A or T-12)

Subject observed

Grade level

Observer

Date of observation

Start time

End time

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.
III. LESSON DESIGN AND IMPLEMENTATION

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The instructional strategies and activities respected students' prior knowledge and the misconceptions inherent therein.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>The lesson was designed to engage students as members of a learning community.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>In this lesson, student exploration preceded formal presentation.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>The focus and direction of the lesson was often determined by ideas originating with students.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>

IV. CONTENT

Propositional Knowledge

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>The lesson involved fundamental concepts of the subject.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>The lesson promoted strongly coherent conceptual understanding.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>The teacher had a solid grasp of the subject matter content inherent in the lesson.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Connections with other content disciplines and/or real world phenomena were explored and valued.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>

Procedural Knowledge

<table>
<thead>
<tr>
<th></th>
<th></th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>11</td>
<td>Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Students made predictions, estimations and/or hypotheses and devised means for testing them.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Students were reflective about their learning.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>Intellectual rigor, constructive criticism, and the challenging of ideas were valued.</td>
<td>0 1 2 3 4</td>
<td></td>
</tr>
</tbody>
</table>
### V. CLASSROOM CULTURE

<table>
<thead>
<tr>
<th>Communicative Interactions</th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>16) Students were involved in the communication of their ideas to others using a variety</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>of means and media.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17) The teacher’s questions triggered divergent modes of thinking.</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>18) There was a high proportion of student talk and a significant amount of it occurred</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>between and among students.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19) Student questions and comments often determined the focus and direction of classroom</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>discourse.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20) There was a climate of respect for what others had to say.</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
</tbody>
</table>

### Student/Teacher Relationships

<table>
<thead>
<tr>
<th></th>
<th>Never Occurred</th>
<th>Very Descriptive</th>
</tr>
</thead>
<tbody>
<tr>
<td>21) Active participation of students was encouraged and valued.</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>22) Students were encouraged to generate conjectures, alternative solution strategies,</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>and ways of interpreting evidence.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23) In general the teacher was patient with students.</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>24) The teacher acted as a resource person, working to support and enhance student</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
<tr>
<td>investigations.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25) The metaphor “teacher as listener” was very characteristic of this classroom.</td>
<td>0 1 2 3</td>
<td>4</td>
</tr>
</tbody>
</table>

Additional comments you may wish to make about this lesson.
APPENDIX C

MATHFORWARD COACHING REPORT
Appendix C

MathForward Coaching Report

Texas Instruments MathForward Coach Visit Notes

<table>
<thead>
<tr>
<th>* School:</th>
<th>* Implementation Specialist:</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>* District:</th>
<th>Milwaukee Public Schools</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>* State training performed in:</th>
<th>WI</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>* Start Date of Visit:</th>
<th>01/09/2012</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>* End Date of Visit:</th>
<th>01/10/2012</th>
</tr>
</thead>
</table>

* What was the plan for?
To work in AC with each teacher

* What was accomplished?
worked with 7th and 6th graders with graphing lines and points in AC
used SC to integrate technology into existing CMP lesson
sent LC

* Site Implementation Level

<table>
<thead>
<tr>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
</tr>
</thead>
</table>

* Notes:
all teachers are using the system

* Administrative Support Level:

<table>
<thead>
<tr>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
</tr>
</thead>
</table>

* Notes:
attended meeting

Teacher Implementation Level:

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Implementation Level</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
</tr>
</thead>
</table>

* Notes:

<table>
<thead>
<tr>
<th>Red</th>
<th>Yellow</th>
<th>Green</th>
</tr>
</thead>
</table>

* What needs to happen next?
continue to work with teachers on LC and AC
REFERENCES
REFERENCES


Rowan, B., Correnti, R. & Miller, R.J. (2002). What large-scale survey research tells us about teacher effects on student achievement: Insights from the Prospects study of elementary schools. *Teachers College Record, 104*(8), 1525-1567.


