EVALUATING THE EFFECTIVENESS OF MATHEMATICS, SCIENCE, AND TECHNOLOGY TEACHER PREPARATION ACADEMIES IN TEXAS

A Dissertation

by

DANIELLE BAIRRINGTON BROWN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2011

Major Subject: Curriculum and Instruction

Evaluating the Effectiveness of Mathematics, Science, and Technology Teacher

Preparation Academies in Texas

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Approved by:

Co-Chairs of Committee,	Hersh Waxman
	Timothy Scott
Committee Members,	Larry Kelly
	Carol Stuessy
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ABSTRACT

Evaluating the Effectiveness of Mathematics, Science,

and Technology Teacher Preparation Academies in Texas. (May 2011)

Danielle Bairrington Brown, B.S., Texas A&M University

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Chairs of Advisory Committee: Dr. Hersh Waxman
Dr. Timothy Scott

The purpose of this mixed-methods study was to evaluate the effectiveness of 14 Mathematics, Science, Technology Teacher Preparation (MSTTP) Academies located across the state of Texas. The aim of the academies was to increase the number of highly qualified mathematics, science, and technology teachers, while also improving the quality of certified teachers in these areas by focusing on seven established goals. The researcher examined best practices for professional development and teacher preparation utilized by the academies, as well as strengths and weaknesses. Additionally, the extent to which the participants perceived the academy had improved their content knowledge and pedagogical skills was examined. Finally, the extent to which the seven goals were associated with participants' perceived content knowledge and pedagogical knowledge was analyzed. The study used secondary data from a larger evaluation of the MSTTP Academies. A mixed-methods design utilizing triangulation to analyze both quantitative and qualitative data was employed for the study.

The results of the current study revealed that the14 MSTTP academies demonstrated the following key strengths: (a) a focus on strengthening content knowledge; (b) a willingness for developing professionally committed teachers; and (c) providing funding for participants. In regard to weaknesses, the degree of program effectiveness revealed that none of the academies had fully implemented all seven goals. All 14 academies, however, struggled to accomplish two of the goals: (a) the integration of the areas of science technology and mathematics; and (b) the infusion of technology into curriculum. Additionally, the findings indicate that participants felt as though the academies had improved their content knowledge and pedagogical skills. The findings also reveal that all academies exhibited three features of effective professional development: (a) a focus on content; (b) active learning opportunities; and (c) intensive and sustained over time. Only one academy exhibited the remaining two features, collective participation and coherence. Finally, the study revealed that only the goal of strengthening content knowledge was a good predictor for participants' content qualifications, while strengthening content knowledge and strengthening pedagogical skills were good predictors of participants' pedagogical qualifications. This research study contributes to the to fields of teacher preparation and professional development.

DEDICATION

To Marlin,

All my love, Little Rhino

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I am so thankful to Dr. Hersh Waxman whose encouragement and support throughout the process has enabled me to develop as an academic and a researcher. I'd also like to thank my co-chair, Dr. Timothy Scott, and my committee members, Dr. Larry Kelly and Dr. Carol Stuessy. I genuinely appreciate all of your support.

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CHAPTER I

INTRODUCTION

In recent years, science, technology, engineering, and mathematics (STEM) education has become a national concern, as both domestic and world economies become more dependent on science and engineering (National Research Council [NRC], 2007). As our society develops into a more knowledge-based society, it has become even more critical that individual possess science, technology, and mathematics skills in order to fully benefit from, or contribute to it (NRC, 2007). Most individuals, however, do not understand the importance of these skills for future opportunities (NRC, 2007). The National Academy of Sciences report, *Rising Above the Gathering Storm* (2007), stipulates that the United States faces four challenges in the area of STEM education: (1) K-12 student preparation in science and mathematics; (2) limited undergraduate interest in science and engineering majors; (3) significant student attrition among science and engineering undergraduate and graduate students; and (4) science and engineering education that inadequately prepares students to work outside university settings.

On various international assessments measuring students' mathematics and science preparation, American students traditionally score below the United States's international competitors. The results of such assessments demonstrate the United States's lack of scientific and mathematics literacy. For the 2007 administration of the

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This dissertation follows the style of *American Educational Research Journal*.

Trends in International Mathematics and Science Study (TIMSS), 36 countries participated at grade four, while 48 countries participated at grade eight (National Center for Education Statistics [NCES], 2009). Findings revealed that American students scored above the average for the participating countries for both fourth- and eighth-grade mathematics and science, but still ranked below countries in Europe and Asia (NCES, 2009). With regard to scores in the mathematics domain, the United States scored higher than 23 countries at grade four (lower than eight countries in Europe and Asia) and 37 countries at grade eight (lower than five countries in Asia). Additionally, United States students scored higher than 25 countries at grade four (lower than four in Asia) and 35 countries (lower than nine in Asia or Europe) in science (NCES, 2009).

The national results were recently released from the 2009 National Assessment of Educational Progress (NAEP) science assessment (NCES, 2011). Previous NAEP assessments could be compared year to year, but the most recent assessment was changed to update the science content; therefore, these most recent results only provide a snapshot of the science skills of fourth-, eighth-, and twelfth-grade students. The national goal is for all students to perform at the *proficient* level, demonstrating solid academic science performance. In 2009, only 34% of fourth-grade students, 30% of eighth-grade students, and 21% of twelfth-grade students scored within or above the proficient range. These results demonstrate that the majority of students in the United States lack a solid scientific foundation. With regard to Texas, the scores of fourth- and eighth-grade students did not significantly differ from the national average.

Another international assessment, the Program for International Student Assessment (PISA), specifically focused on assessing scientific literacy at an in-depth level during the 2006 administration (NCES, 2007). The Organization for Economic Cooperation and Development (OECD), an international intergovernmental organization promoting policies to improve the economic and social well-being of people around the world, sponsors the assessment. During 2006, 30 OECD countries and 27 non-OECD countries participated in the PISA. Results from this assessment indicated that students in the United States scored lower on scientific and mathematics literacy than the average score of the 56 participating countries in the content area of science (NCES, 2007). With regard to scores in the scientific literacy domain, students in the United States scored lower than 22 countries (16 OECD countries and six non-OECD countries). In terms of mathematics literacy, students in the United States scored lower than 31 countries (23 OECD countries and eight non-OECD countries). Furthermore, between 2003 and 2006 the United States did not experience a measurable change in mathematics literacy scores or change positions when compared to the OECD average (NCES, 2007).

According to a series of studies conducted by Stanford University researchers, countries that perform well on PISA have demonstrated higher increases in Gross Domestic Product (GDP) than countries that do not (Hanushek, Jamison, Jamison, & Woessmann, 2008). This series of studies suggests that higher cognitive skills play a role in explaining the differences of economic growth internationally. Additionally, Hanushek, et al. explain that, in order for the United States to remain economically competitive, United States citizens needs to increase the skills measured on international assessments such as PISA (Hanushek, et al., 2008).

The skills measured on PISA are commonly referred to as 21st century skills. In their book, *21st Century Skills: Learning for Life in Our Times,* Trilling and Fadel (2009) present a framework for 21st century learning and the skills students need to survive in a complex society. They categorize 21st century skills into three areas: (a) learning and innovation skills; (b) information, media, and technology skills; and (c) life and career skills (Trilling & Fadel, 2009). The most commonly cited of these areas is learning and innovation skills. Research recognizes these skills as attributes of students who are prepared for a more complex life and work environment (American Association of Colleges of Teacher Education [AACTE] & Partnership for 21st Century Skills [P21], 2010). Well-prepared students demonstrate critical thinking and problem solving skills; effective oral and written communication skills; ability to collaborate with diverse teams; and creativity and innovativeness (Trilling & Fadel, 2009).

These assessments and other national reports suggest that American students lack crucial skills needed for the 21st century and, consequently, the United States will be facing a global achievement gap in the future (Wagner, 2008). Addressing the global achievement gap is imperative, as these 21st century skills are vital to the future economic competitiveness of the United States (NRC, 2007). To ensure that students can compete in the global economy, the federal government has stated the need for improving K-12 STEM education and thus increasing student achievement (Office of the Press Secretary, 2010). A key factor in improving K-12 STEM education and ensuring that students receive a 21st century education is improving teacher quality, as it is firmly linked to student achievement (NRC, 2007). Although a growing body of research indicates that teacher quality is one of the most critical factors affecting student achievement, there is little consensus on the attributes (e.g., certification), behaviors (e.g., classroom instruction), or knowledge (e.g., content) that contribute most to student achievement or adequately define teacher quality (Darling-Hammond, Holtzman, Gatlin, & Heilig, 2005; Goe, 2007; Heck, 2007; Rice, 2003; Wilson & Floden 2003).

The No Child Left Behind Act (NCLB) of 2001 and its definition of “highly qualified” indicates a focus on content area degrees and certification, yet research suggests that the importance of these attributes varies across subject matter and grade level (Bolyard & Moyer-Packenham, 2008; Goldhaber, 2002). Researchers have often relied on test scores and teaching experience as indicators of teacher quality because these variables are easier to measure (National Science Board [NSB], 2010). On the other hand, many educators would argue that teacher quality is more complex and may need to be defined differently for different purposes (Goe, 2007).

Inequitable Access to Teacher Quality

In response to research findings relating teacher quality to student achievement, schools have attempted to staff their classrooms with “highly qualified” teachers as defined by NCLB. Despite these efforts, inequitable access to high-quality teachers remains a serious problem. Students from groups, such as English language learners (ELLs) and those living in high poverty communities, are disproportionately taught by teachers with the least experience and preparation, even though these are the very students that most need teachers with high levels of expertise (California Education Policy Convening, 2007; Murnane & Steele, 2007). Inequitable distribution of high-quality teachers is especially acute at the secondary level and in hard-to-fill subject areas such as mathematics and science (Brown & Wynn, 2007; Education Trust, 2008).

In Texas, the issue of inequitable access to teacher quality is increasingly important as the student population continues to grow and diversify. A recent enrollment report from the Texas Education Agency (2010), for example, documents a 45.9% increase in the number of economically disadvantaged students, and a 47.1% increase in the number of students identified as limited English proficient (LEP) between the 1999-2000 and 2009-2010 school years. Additionally, the report notes increasing concentrations of Texas students enrolling in urban, high-poverty schools. In other words, the sub-groups that are expanding most rapidly in Texas are the very students that tend to be disproportionately assigned to under-qualified, uncertified, and inexperienced teachers (California Education Policy Convening, 2007; Murnane & Steele, 2007).

Fuller, Carpenter, and Fuller (2008) recently examined the distribution of teacher quality in Texas secondary schools by documenting differences on a variety of teacher quality indicators (e.g., certification status, turnover, etc.) in schools with the lowest and highest concentrations of economically disadvantaged students and minority students and the schools with the lowest and highest percentages of students passing all Texas Assessment of Knowledge and Skills (TAKS) exams. They found significant differences across the sets of schools on nearly every teacher quality indicator, with low-poverty, low-minority, and high-performing schools employing teachers with significantly higher levels of quality indicators than high-poverty, high-minority, and low-performing schools. For the 2007 school year, for example, the percentage of high school English, mathematics, and science teachers assigned out-of-field in high-poverty schools was twice the percentage as in low-poverty schools. The differences in teacher quality across the sets of schools were most pronounced in mathematics and science courses. While nearly 20% of science teachers in the highest-performing high schools were teaching outside of their field, more than double that percentage were teaching outside their field in the lowest-performing high schools.

With the implementation of the new Texas 4x4 curriculum (requiring all students to complete four years of both mathematics and science in high school) and a student population in Texas growing faster than the national rate, inequitable access to and lack of highly qualified mathematics and science teachers may likely worsen. Thus, the issue of recruiting and preparing more highly qualified teachers while also retaining and improving the quality of existing teachers has become one of the most important issues in education (Fuller, 2009).

Overview of Present Study

To address the issue of teacher quality, the 80th Texas Legislature (2007) created a statute enabling the Texas Higher Education Coordinating Board (THECB) to establish teacher academies at institutions of higher education. The purpose of these academies was to prepare more highly qualified mathematics and science teachers, as well as improve the quality of certified teachers. The long-term effect of preparing more highly qualified teachers is to increase the percentage of students who are college-ready in mathematics and science (THECB, 2009). The academy goals set forth include: (a) a focus on strengthening teacher subject matter and pedagogical knowledge; (b) utilize methods based on research in the fields of teacher preparation and professional development; (c) integrate the areas of science, technology, and mathematics; (d) highlight problem-based learning that offers a real-world context; (e) implement a comprehensive mentoring/induction program; and (f) infuse technology into academy curriculum (THECB, 2009).

THECB funded the Mathematics, Science, and Technology Teacher Preparation (MSTTP) Academies at public institutions in the state of Texas through a competitive grant application. At the time of the current study, awards for three cycles of MSTTP academies had been announced. During Cycle 1, THECB awarded two public universities in the state of Texas a MSTTP academy. In Cycle 2, THECB extended the funding for Cycle 1 universities, while also establishing three additional academies. Finally, in Cycle 3, THECB awarded nine more academies, bringing the grand total of academies to 14.

The present study evaluated the effectiveness of the 14 MSTTP Academies located across the state of Texas. Academies were established with the goal of increasing the number of highly qualified mathematics, science, and technology teachers, while also improving the quality of certified teachers in these areas. This study focused on the seven goals set forth by the THECB. In addition, the researcher examined best practices for professional development and teacher preparation used by the academies to increase teacher quality, and strengths and weaknesses of the academies as identified by both academy directors and participants. Finally, the extent to which the seven goals of the academies are associated with participants' perceived subject matter knowledge and pedagogical knowledge was analyzed. These procedures are used to examine the extent that the seven goals of the academy predict participants' perceived subject matter knowledge and pedagogical knowledge.

Conceptual Framework on Teacher Change

The process of improving teacher quality typically requires a shift in practice or implementation of a professional program. In the present study, the professional development program implemented was the enrollment of inservice or preserivce teachers' in a MSTTP academy. The academies aimed to provide professional development or offer a teacher preparation program that: (a) focused on strengthening teacher subject matter, knowledge, and pedagogical skills; (b) integrated the areas of science, mathematics, and technology; (c) included problem-based learning in the classroom; and (d) instructed teachers on how to infuse technology into their lessons. The goal of the academies was to ultimately improve student outcomes by changing teachers' classroom practices.

The process by which teacher change occurs is a complex one, involving the alteration of teachers' classroom practices, as well as their beliefs and attitudes. Guskey (2002; 1986) provided a simplified model by which the process of teacher change occurs. He acknowledged that numerous factors could influence the process; thus, he offered a general model by which teacher change occurs. Guskey's model indicates that professional development can lead to a change in teachers' classroom practices, which ultimately improves student learning outcomes. Guskey (1986) broadly defined student learning outcomes as "higher levels of achievement, becoming more involved in instruction, or expressing greater confidence in themselves or their ability to learn" (p. 7). According to Guskey (1986), only after teachers saw a change in student learning outcomes did their beliefs and attitudes change. He stated that the most influential factor in changing teachers' beliefs and attitudes was their experiences in the classroom.

Figure 1 displays the conceptual model by which teacher change could occur for participants in a MSTTP academy. MSTTP Academy participants are engaged in a teacher preparation program or professional development program that is designed to change or improve their classroom instructional practices. Ideally, teachers engaged in the academies will increase in their classrooms; the use of problem-based learning, the infusion of technology, and integration of science, mathematics, and technology. These changes in teachers' classroom practices are hypothesized to improve student learning outcomes such as: scores on standardized achievement tests, acquisition of higher-order thinking skills, and engagement in mathematics and science. Once teachers see these changes in student learning outcomes have occurred, their beliefs and attitudes regarding effective instruction should change. In summary, the present study is guided by the concept that preservice or inservice teacher enrollment in a MSSTP academy will change their classroom practices leading to improved student learning outcomes, subsequently impacting their beliefs and attitudes.

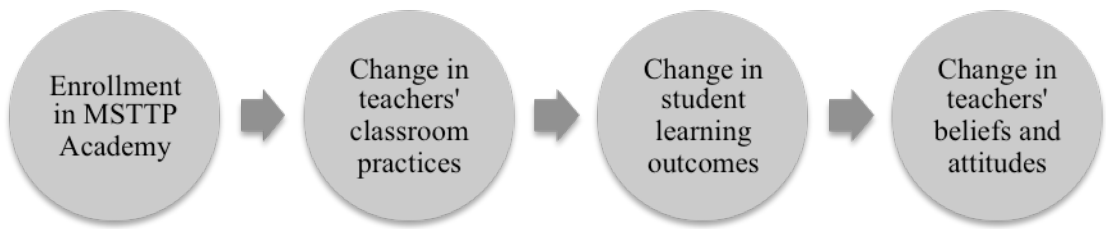

Figure 1. **Process of teacher change.**
Note. Adapted from "Staff Development and the Process of Teacher Change," by T.R. Guskey, 1986.

Purpose of the Present Study

The purpose of the present study was to evaluate the impact on teacher quality of 14 Mathematics, Science, and Technology Teacher Preparation (MSTTP) Academies located across the state of Texas. These academies were established between fall 2008 and fall 2009 with the aim of increasing the number of highly qualified mathematics, science, and technology teachers, while also improving the quality of certified teachers in these areas. This study determined the extent to which these academies are addressing the issue of teacher quality and seek to make recommendations related to best practices for future academies. The present study addressed the following questions:

1. What are the strengths (i.e., beneficial aspects) of the teacher preparation academies?

2. What are the weaknesses of the teacher preparation academies?
3. To what extent do participants feel qualified to teach in their content area as a result of participation in the academy?
4. To what extent do participants perceive that the academies have improved their pedagogical skills?
5. What are the best professional development practices utilized by the academies to increase teacher quality?
6. To what extent does the implementation of the seven goals of the academies relate to teachers' perceptions of subject matter knowledge and pedagogical knowledge?

Significance of the Study

The current study is clearly supported by the review of research that addresses teacher quality in STEM education. The present study differed from the previous research in five important ways. First, it evaluated 14 different programs using the same research methods, in order to make comparisons across the programs. These academies were established under the same grant with the same goals, but were given autonomy to make decisions that best suited the needs of their participants. Consequently, the modes or approaches of delivering professional development differ from site to site. Second, unlike other studies, the present study examined the relative effectiveness of these different modes or approaches to professional development. Third, the current study utilized mixed methods in order to give a better overall understanding, whereas previous studies have primarily relied on quantitative methods to determine effectiveness. Fourth, this study focused on seven research-based goals for improving teacher quality. Previous studies have only focused primarily on one or two of these areas. Finally, the present study utilized a framework of best practices for improving teacher quality and developing students' 21st century skills to evaluate the programs.

CHAPTER II

REVIEW OF RESEARCH

This chapter reviews research on increasing teacher quality and its subsequent effects on student achievement. As previously discussed, there are many aspects of teacher quality. Recent research on teacher quality has focused on teacher characteristics, such as: general ability, experience, pedagogical knowledge, subject matter knowledge, certification status, and teacher behaviors, practices, and beliefs (Cochran-Smith & Zeichner, 2005; Darling-Hammond, 2000; Goe, 2007; Rice, 2003; Wayne & Youngs, 2003; Wilson & Floden, 2003). In the present review of research, I focus on two teacher quality characteristics, *subject matter knowledge* and *pedagogical knowledge* – both goals of the MSTTP academy. This chapter reviews research related to the other five goals of the MSTTP academy: (a) teacher preparation and professional development; (b) integration of the areas of science, technology, and mathematics; (c) problem-based learning that offers a real-world context; (d) comprehensive mentoring/induction programs; and (e) infusion of technology into curriculum. Finally, I reviewed previous evaluations of programs that focused on increasing teacher quality in the areas of mathematics and science.

The review of research is presented in eight sections; each reflects one of the academy goals. Studies included were chosen because they were either meta-analyses, reviews of the research, or seminal studies that focused on student achievement outcomes. Each section includes a table that lists the reviews or studies in alphabetical order and displays methodology and key findings. These 29 reviews included over 2,200 studies that focused on these topics.

Subject Matter Knowledge

Teacher subject matter knowledge has been a focus of research studies for over 20 years. Although studies investigating the impact of teachers' subject matter knowledge on student achievement have been conducted in all content areas, the majority has been in the areas of mathematics and science. The amount of coursework taken in a particular area or a subject-specific degree are the most commonly used variables to define a teacher's subject matter knowledge. Another less frequently used measure is grade point average. While researchers continue to believe in the importance of subject matter knowledge, the results of these studies are often mixed and appear to be content and grade specific (Wilson & Floden, 2003).

The impact of teachers' subject-specific coursework in mathematics at the secondary level is clear. High school students learn more in a classroom with a teacher who has completed more mathematics-related courses or obtained a mathematics degree (Bolyard & Moyer-Packenham, 2008; Darling-Hammond & Youngs, 2002; Goe, 2007; Rice, 2003; Wilson & Floden, 2003; Wilson, Floden, & Ferrini-Mundy, 2001). Yet, Rice

(2003) found that the impact of content coursework might diminish after a certain point (e.g., after taking five courses for high school mathematics teachers). At the elementary level, however, the results for content expertise are inconclusive. Goe (2007) found that there is a positive relationship between subject matter knowledge and student achievement at all grade levels. Wayne and Youngs (2003), however, state that findings at the elementary level are unclear and require more research. Ahn and Choi (2004) found only a small positive effect size in a meta-analysis of 16 studies examining the relationship between teacher subject matter knowledge and student achievement. In summary, the research suggests a positive relationship between student achievement and mathematics subject matter knowledge at the secondary level and an unclear relationship at the elementary level.

In the area of science, the impact of subject matter knowledge is less clear. Bolyard and Moyer-Packenham (2008) found a positive correlation between subject matter knowledge and student achievement in the area of physical science, but not in life science. The findings from Wayne and Youngs' (2003) review, however, contradict these findings indicating that the results for both areas are inconclusive. Therefore, in order to establish a stronger relationship between student outcomes and science subject matter, more research needs to be conducted.

In their review of research, Wilson, Floden, and Ferrini-Mundy (2001) concluded that there is not adequate evidence to determine how much and what kind of subject matter knowledge is needed. Wilson and Floden (2003) noted that the major weakness of the studies included in their review was that there was not an adequate measure for subject matter knowledge. The number of courses or a subject-specific degree does not sufficiently determine whether a teacher has a comprehensive understanding of the subject. In addition, Wayne and Youngs (2003) indicate that more refined data collection strategies should be developed for future research relating teacher subject matter knowledge and student achievement in science. Since the findings from all seven of the research reviews vary, more research on the impact of subject matter knowledge on student achievement needs to be conducted.

Table 1 summarizes seven research reviews that focused on subject matter knowledge as a key component. Each research review established its own set of criteria for including studies; however, many of the same key studies are included in several of the reviews. The studies included in the research reviews focused on studies conducted in the United States with a few exceptions. Finally, three of the seven research reviews limited their search to only studies that included student outcomes.

Table 1

Research Reviews on Subject Matter Knowledge

Study	Methodology, Sample Size & Variables	Findings
Bolyard & Moyer-Packenham (2008)	Comprehensive Literature Review Studies included in the review were empirical, meta-analyses, and literature reviews that were peer-reviewed documents on teacher quality. Only studies including measures of mathematics and science student outcomes were included. Approximately 150 documents were included in the review.	Results from studies exploring the relationship between subject-specific degrees and student achievement differ. However, studies examining mathematics are generally positive especially at the secondary level. When examining subject-specific coursework, the results also vary. Some studies indicate that more coursework in mathematics yields higher achievement while others indicate it is only for advanced mathematics courses. In science, the positive impact of coursework has been demonstrated in physical science. The effect is not the same in life sciences.
Ahn and Choi (2004)	Meta-Analysis of 16 studies examining the relationship between teacher subject matter knowledge and student achievement	Researchers found a very small effect size of 0.12 between knowing mathematics and student achievement.
Darling-Hammond & Youngs (2002)	Review of Research	Research studies reviewed indicate that subject matter knowledge is positively linked to student achievement especially in the content area of mathematics.

Table 1 (continued)

Study	Methodology, Sample Size & Variables	Findings
Goe (2007)	Research Synthesis on Teacher Quality Only studies that used standardized student achievement test scores as an outcome measure were included in the synthesis in order to make some comparisons across studies.	More research relating subject matter knowledge and student achievement has been conducted in mathematics than science. The research synthesis indicates that licensing for mathematics and a degree in mathematics is positively related to mathematics achievement at all grades but particularly at the secondary level.
Rice (2003)	Literature Review on Teacher Quality and Qualifications All studies included are empirical but represent a variety of methodologies, measure of teacher effectiveness, and specific teacher characteristics. Additionally, most studies are from peer-reviewed journals and focus on education in the United States.	Content area coursework is positively related to student achievement in studies (primarily mathematics and science) of middle and high school education. The importance of this coursework is greater at the secondary level. At some point the effect of content coursework may lessen (e.g. after five courses for high school math teachers).

Table 1 (continued)

Study	Methodology, Sample Size & Variables	Findings
	Systematic Literature Review Authors chose articles based on 4 criteria: (1) studies must observe teachers' characteristics as well as the standardized test scores of their students; (2) scope of the search was limited to studies focusing on student achievement in the United States; (3) study designs account for prior student achievement; and (4) study designs account for student socioeconomic status.	Findings related to science are inconclusive. Research relating coursework and degree to science achievement needs more refined data collection strategies. Findings related to mathematics student achievement were positive but are grade-level dependent. All findings related to high school mathematics achievement indicate that students learn more from a teacher with more mathematics related coursework and degrees. The results for elementary mathematics achievement are unclear and require more evidence.
Wilson & Floden (2003)	Literature Review Reviewed research met the following criteria: directly relevant to the 11 questions, be focused on teacher preparation in the United States, be empirical, be original research not literature reviews, and be rigorous. 64 reports were included in the addendum.	Research findings related to the relationship between degree and coursework and student achievement differ. However, students who have teachers with mathematics or mathematics education degrees have higher levels of achievement. The results appear to be grade level and content specific. The weakness of studies in this area is there is not a satisfying measure of teacher subject matter knowledge.

Table 1 (continued)

Study	Methodology, Sample Size & Variables	Findings
Wilson, Floden, & Ferrini-Mundy (2001)	Research Review The studies included in the review met the following criteria: directly relevant to the five questions posed by the U.S. Department of Education, published in a scientific journal, published within the last two decades, studies focused on United States' teacher education and finally were empirical and rigorous. A total of 57 studies were included in the review.	Findings indicate a positive connection between subject matter preparation and teachers' impact in the classroom. There is little conclusive evidence of the kinds or amount of subject matter preparation needed. More research needs to be conducted to draw stronger conclusions.

Pedagogical Knowledge

Pedagogical knowledge is the knowledge a teacher possesses about instruction. Prior researchers have used degrees and coursework in education as well as scores on pedagogical knowledge exams (e.g., Pedagogy and Professional Responsibilities Exam) as measures of teachers' pedagogical knowledge. In several reviews of the research, pedagogical coursework was positively related to student achievement at all grade levels (Rice, 2003; Willson & Floden, 2003; Wilson, Floden, & Ferrini-Mundy, 2001). Bolyard and Moyer-Packenham (2008) (in a review limited to the areas of mathematics and science), found that when coursework in education was used as a measure of a teacher's pedagogical knowledge, there was a significant positive association between student achievement and teacher's pedagogical knowledge, particularly at the secondary level. The same review, however, found contradictory findings when the unit of measure was completion of degrees of education. A positive correlation was found at the elementary level and little to no correlation at the secondary level. These findings suggest that the impact of teachers' education degrees on student outcomes may be related to students' grade level.

Additionally, researchers have examined the impact of subject-specific pedagogy on student achievement. Goe (2007) found that subject-specific pedagogical knowledge was positively related to mathematics student achievement at all levels. Bolyard and Moyer-Packenham reported similar results but limited the findings to secondary student achievement especially in mathematics.

Rice's (2003) review of research also indicated that the effect of pedagogical coursework does not diminish as the number of courses increases and that these effects of the courses might outweigh the effect of content area coursework. However, she does note the positive association between content area coursework and student achievement. These findings indicate that a mixture of content courses and subject-specific pedagogy courses may have the largest impact on student achievement.

The main critiques of the studies examining pedagogical coursework are the weak measures of pedagogical preparation (Wilson & Floden, 2003; Wilson, Floden, & Ferrini-Mundy, 2001). Wilson and Floden (2001) argued that the measures used were actually measures of the teacher preparation program rather than the impact of the pedagogical courses. Additionally, Wilson, Floden, and Ferrini-Mundy (2001) indicated that the measures used did not indicate which aspects of pedagogical preparation were in fact the most important. The five research reviews examining the impact of pedagogical knowledge on student achievement are summarized in Table 2.

Table 2

Research Reviews on Pedagogical Knowledge

Study	Methodology, Sample Size & Variables	Findings
Bolyard & Moyer-Packenham (2008)	Comprehensive Literature Review Studies included in the review were empirical, meta-analyses, and literature reviews that were peer-reviewed documents on teacher quality. Only studies including measures of mathematics and science student outcomes were included. Approximately 150 documents were included in the review.	Findings reveal a positive relationship between student achievement and coursework in education, particularly at the secondary level. Findings demonstrate a positive impact on student achievement of degrees of education at the elementary level; however, there is little or negative impact at the secondary level. However, studies show that coursework taken in subject-specific pedagogy are positively related to secondary student achievement especially in mathematics
Goe (2007)	Research Synthesis on Teacher Quality Only studies that used standardized student achievement test scores as an outcomes measure were included in the synthesis in order to make some comparisons across studies.	At all grade levels, mathematics student achievement is positively related to content-specific pedagogical knowledge.

Table 2 (continued)

Study	Methodology, Sample Size & Variables	Findings
Rice (2003)	Literature Review All studies included are empirical but represent a variety of methodologies, measures of teacher effectiveness, and specific teacher characteristics. Most studies are from peer-reviewed journals and focus on education in the United States.	Pedagogical coursework is positively related to student achievement at all grade levels. Even though the effect of content area coursework diminishes, the effect of pedagogical coursework persists and might outweigh the effects of content area coursework.
Wilson & Floden (2003)	Literature Review Education Commission of States (ECS) solicited the report as addendum to an original work and posed 11 questions and solicited nominations from experts for inclusion Reviewed research with this criteria: relevant to the 11 questions, focused on teacher preparation in the United States, empirical, original research reviews, and rigorous.	Research related to the impact of pedagogical knowledge or preparation is inconclusive. Most research reviewed in this area actually focuses on the impact of teacher education programs, rather than the impact of particular teacher education courses.

Table 2 (continued)

Study	Methodology, Sample Size & Variables	Findings
Wilson, Floden, & Ferrini-Mundy (2001)	Research Review The studies included in the review met the following criteria: directly relevant to the five questions posed by the U.S. Department of Education, published in a scientific journal, published within the last two decades, studies focused on United States' teacher education and finally were empirical and rigorous. A total of 57 studies were included in the review.	Evidence suggests a positive relationship between content methods coursework, teacher effectiveness and student achievement. Many studies examined use measures for pedagogical preparation; therefore, there is little evidence to which aspects of pedagogical preparation is the most important.

Teacher Preparation

Teacher preparation is a widely debated topic, due to the fact that some programs produce stronger teacher candidates than others (Darling-Hammond, 2010). Teachers who graduate from effective teacher preparation programs are more successful in classrooms in which other beginners might struggle, and can make an impact on children when others are struggling to survive (Darling-Hammond, 2006). Despite the importance of teacher education, limited empirical evidence exists about the impact of various aspects of teacher preparation on teacher effectiveness (Walsh, 2006).

The American Educational Research Association (AERA) published the most comprehensive study on teacher education research in 2005 (Cochran-Smith & Zeichner, 2005). Even though the team of authors recognizes the limited evidence to support the methods used to prepare teachers, they do reach some general conclusions based on the existing research. First, professional development schools, which are collaborations between university programs and local school districts, have a positive impact on teacher learning. Second, teacher education programs that have a clear and consistent vision are positively related to teacher quality and student achievement. In addition, under the right conditions, strategies such as case studies or teaching portfolios can result in changes for the better in: students' knowledge and beliefs, ability to identify instructional issues, and in teachers' proficiency to teach. Finally, research suggests that teachers' initial attitudes, knowledge, beliefs, and confidence in teaching culturally diverse learners may be positively related to certain coursework and school and community fieldwork in teacher preparation programs.

Darling-Hammond (2006) examined seven highly successful and long-standing teacher education programs. Each of the seven programs is highly successful at preparing teachers in terms of subject matter and pedagogy as well as serving a diverse student population. Common features of the programs include: (a) a clear vision of good teaching that permeates all coursework; (b) strong core curriculum with sufficient coursework in content and pedagogy; (c) carefully chosen field experiences that directly relate and support coursework; (d) utilize inquiry to connect theory and practice through the use of case studies, application of learning to real-world problems, etc. in order to develop reflective practitioners; (e) established school-university partnerships; and (f) use of performance assessments to evaluate teaching (Darling-Hammond, 2006).

A well-documented model of an effective teacher preparation program is the aggieTEACH program at Texas A&M University (Scott, Milam, Stuessy, Blount, & Bentz, 2006). The program, a collaborative effort between the College of Science and College of Education and Human Development, was established to recruit and prepare the highest quality mathematics and science secondary teachers. Students in the aggieTEACH program can earn a bachelor's degree in mathematics or science in addition to teacher certification without additional hours, which enables students to graduate in 4 years. Students in the program engage in field experiences with master teachers during their first course. This is seen as one of the most powerful tools of the program. In addition, these students have a deep knowledge of their discipline, the ability to engage students in inquiry, and the ability to use new technology to improve student achievement. Over the years, aggieTEACH has seen significant growth in the number of students recruited and retained, an important endeavor as the need for highly qualified mathematics and science teachers continues to increase

Most studies examining teacher preparation programs have been qualitative in nature and have mixed results with regard to the impact on teacher's knowledge (Rice, 2003). Research in this area has been able to demonstrate that students learn skills necessary for the classroom, but have been unable to link this to teacher effectiveness. Studies have also been able to identify several components of effective teacher preparation programs; however, again these studies offer limited evidence of the impact on student achievement. The existing research related to teacher preparation is summarized in Table 3.

Considering the lack of evidence on effective teacher preparation methods, many researchers have recommended a new research agenda for teacher education. In a recent publication by the National Research Council (NRC), authors suggest research related to three critical topics and their impact on student learning (NRC, 2010). First, researchers need to engage in evaluations of teacher education programs in terms of: their selectivity, the timing of training, and components (e.g., field experiences, subject matter instruction, etc.) of teacher preparation. Second, researchers need to evaluate the effectiveness of teacher preparation methods related to classroom management and educating diverse learners. Finally, scholars should evaluate the structure of teacher preparation programs, including elements such as the combination of pedagogical coursework and subject matter coursework and the design of field experiences.

Table 3

Research Reviews on Teacher Preparation

Study	Methodology, Sample Size & Variables	Findings
Cochran-Smith & Zeichner (2005)	Comprehensive study on teacher education research. Specifically, the study examined which aspects of teacher education programs are known to produce successful teachers.	Professional development schools (collaborations between university program and local school districts) have a positive impact on teacher and pupil learning. More research is needed to understand the conditions that enhance desired outcomes. Research does not provide clear evidence to support one type of teacher education program (e.g., 4-year, 5-year, traditional, alternative) over another. Suggests that program components such as clear and consistent vision are related to teacher quality and student achievement. Under the right conditions, strategies (e.g., case studies, teaching portfolios) can result in changes for the better in: students' knowledge and beliefs, ability to identify instructional issues, and in their proficiency to teach. Teachers' initial attitudes, knowledge, beliefs, and confidence in teaching culturally diverse learners may be positively related to certain coursework and school and community fieldwork in teacher preparation programs. In the content are of mathematics, effective teaching and student achievement is positively related to certification in the field.

Table 3 (continued)

Study	Methodology, Sample Size & Variables	Findings
Darling-Hammond (2006)	Qualitative analysis of seven highly effective teacher preparation programs.	Findings reveal seven characteristics of highly successful teacher preparation programs.
Rice (2003)	Literature Review All studies included are empirical but represent a variety of methodologies, measures of teacher effectiveness, and specific teacher characteristics. Most studies are from peer-reviewed journals and focus on education in the United States.	Limited research exists on the relationship between teacher preparation and effective teaching. Research does show that teachers learn knowledge and skills in their teacher preparation programs but provides little evidence to the degree to which these skills contribute to teacher effectiveness.

Professional Development

Effective professional development is essential in helping students to cultivate 21st century skills. Professional learning opportunities for teachers should emphasize classroom instruction that develops higher-order thinking and performance (Darling-Hammond & Richardson, 2009). The previous models of professional development (e.g., the “drive-by” workshop model) are inadequate to change teaching practices (Stein, Smith, & Silver, 1999).

Over the last two decades large and small-scale studies, including evaluations, survey analyses, and case studies, on professional development, teacher learning, and teacher change have emerged, (Garet, Porter, Desimone, Birman, & Yoon, 2001). As this body of work has grown, researchers have reached a general consensus about what constitutes “effective professional development.” Effective professional development has five key features: (a) content-focused; (b) provides active learning opportunities; (c) intensive and sustained over time; (d) emphasizes collective participation; and (e) promotes coherence (Garet, et al., 2001; Goe, 2007). Additionally, other strategies such as school-based coaching and mentoring and induction programs for new teachers may enhance professional learning (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009).

Professional development content appears to be a key to changing teaching practices. Saxe, Gearheart, and Nasir (2001) determined the effect of active, content driven professional development in their study. Students of teachers who participated in a professional development model that was content driven and developed necessary pedagogical skills showed greater gains in conceptual understanding than those in other professional development models. In a national survey, teachers have reported growth in their knowledge and skills and changes in teaching practice when exposed to professional development that involved active learning and focused on content knowledge (Garet et al., 2001). Kennedy's (1998) review of research indicated that programs that focused on teachers' content knowledge or how students learn the subject has a larger impact than those focused on teachers' behaviors. Two additional studies concluded that professional development focused on helping teachers develop pedagogical skills in a specific content area and student learning had strong positive effects on instructional practices (Blank, de las Alas, & Smith, 2007; Wenglinksy, 2000).

Several studies have documented that intensive and sustained professional development is more likely to lead to transformations in teacher practices and student learning. Nine studies reviewed by Yoon, Duncan, Lee, Scarloss, and Shapley (2007) found that professional development opportunities lasting fewer than 14 hours had no effect on student learning, while those with more than 14 hours had a significant positive impact on student learning. The largest effect on student achievement was found in studies that offered between 30 and 100 hours of professional development over six months to one year. Additionally, an evaluation of professional development in inquiry-based science revealed that teachers in an intensive professional development were more likely to use inquiry-based science instruction and that the growth was sustained over a 3-year period (Supovitz & Turner, 2000).

Research has found that professional development that emphasizes collective participation promotes school change beyond a single classroom (Darling-Hammond & McLaughlin, 1995; Knapp, 2003). For example, when whole grade levels, schools, or departments participate, a collaborative and collegial learning environment is established allowing for inquiry, reflection, and risk-taking among teachers (Ball & Cohen, 1999; Bryk, Camburn, & Louis, 1999). Finally, when the professional development is linked to curriculum, assessment, and standards, teachers are more likely to implement what they learned into their classroom (Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Supovitz, Mayer, & Kahle, 2000).

Although researchers agree on features of effective professional development, most teachers in the United States do not have access to it (Wei, Darling-Hammond & Adamson, 2010). Current professional development policies and practices do not align with what research says. According to the 2003-04 national School and Staffing Survey (SASS), teachers reported they were not participating in substantial professional development (about 50 hours) but rather short-term professional development such as conferences or workshops (about 16 hours) (Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Wei, et al. (2009) explained these two-day professional development opportunities typically focused on content of the subject the teacher taught, but did not offer much depth. When comparing the results of 2008 administration of the SASS to the 2003 administration, more teachers in 2008 revealed they had access to professional development focused on content but that the intensity of these professional developments actually decreased. These findings indicate the United States continues to invest in the least effective models of professional development.

Additional findings from the examination of the 2003 SASS reveal teachers were dissatisfied with professional development that was not content-focused, finding such sessions useless (Wei, et al., 2009). Teachers also reported a lack of support or additional funding to participate in professional development. This discouraged teachers from pursuing additional opportunities for professional growth.

Wei, Darling-Hammond, and Adamson (2010) disaggregated the 2008 SASS results by state and ranked each state on 11 professional development indicators. Texas met three of the 11 indicators. Of the three indicators related to induction, Texas did not meet any of the indicators. The study utilized eight indicators for professional development and Texas met three of these indicators: (1) at least 80% of teachers reported professional development on content; (2) at least 67% teachers reported professional development on uses of computers; and (3) at least 51% teachers reported professional development on teaching students with disabilities. Even though 80% of Texas teachers reported professional development on content, Texas did not meet the indicator that at least 51% teachers received 17 or more hours of professional development on content. These findings indicate that the majority of teachers in Texas are not engaged in intensive, content-focused professional development. Table 4 summarizes research studies related to professional development and Table 5 summarizes reviews of research related to professional development.

Table 4

Research on Professional Development

Study	Methodology, Sample Size & Variables	Findings
Garet, Porter, Desimone, Birman &, Yoon (2001)	Survey Data Analysis Data from a Teacher Activity Survey from a national evaluation of the Eisenhower Professional Development Program National probability sample of 1,027 teachers representing 358 districts Variables included 3 structural characteristics of professional development and 3 core features	Provide empirical evidence for "best practices" Indicates that professional development that is content focused with opportunities for active learning, and is integrated into the daily life of the school is more likely to produce enhanced knowledge and skills It is more important to focus on duration, collective participation, and core features Activities that are linked to teachers' experiences, aligned with other efforts, and encourage professional communication support change in teaching practice. Confirm the importance of professional development focused on mathematics and science content.
Porter, Garet, Desimone, Yoon, & Birman (2000)	Longitudinal Study Researchers utilize the Longitudinal Study of Teacher Change from the national Evaluation of the Eisenhower Program. Used 3 surveys related to teaching practices conducted between 1997 and 1999.	Professional development focused on specific, higher-order teaching strategies increases teachers' use of those strategies in the classroom. Effect is stronger when professional development activity is a reform type activity rather than traditional workshop or conference, provides opportunities for active learning, coherent, involves individuals from same subject, grade, or school.

Table 4 (continued)

Study	Methodology, Sample Size & Variables	Findings
Porter, Garet, Desimone, Yoon, & Birman (2000) continued	Purposeful sample of 30 schools in 10 districts, in 5 states. Surveyed all mathematics and science teachers in all 30 schools (*n* = 430). Relied mainly on the 287 teachers who responded to all 3 surveys.	Teachers do not receive high-quality professional development from one year to the next. Therefore, little change in teaching practice. Positive effects of professional development on teaching practice would be increased if teachers were provided more high quality professional development.
Penuel, Fishman, Yamaguchi, & Gallagher (2007)	Survey data analysis of surveys on features of effective professional development from 454 teachers (received initial GLOBE professional development and training within a 2-year period) Analyzed using hierarchal linear modeling.	Teacher learning and program implementation is significantly related to teachers' perceptions of how coherent the professional development is to their district goals for student learning. Researchers also found that teachers who were allowed time to plan for implementation and provided technical support were more likely to promote program implementation.

Table 4 (continued)

Study	Methodology, Sample Size & Variables	Findings
Saxe, Gearhart, & Nasir (2001)	Quasi-Experimental Solicited volunteers who were upper elementary teachers who either had experience with *Seeing Fractions* or *My Travels with Gulliver* or teachers who had committed to teaching traditional texts. Volunteers were assigned to one of 3 groups. Student pre- and posttest gains in achievement to determine changes within groups and across groups.	The IMA group (teachers participated in program designed to enhance teachers' understandings of fractions and students' thinking and motivation) achieved greater adjusted post-test scores on conceptual scale than SUPP group (teachers met regularly to discuss strategies for implementing curriculum) and TRAD group (teachers used textbooks and received no professional development). IMA and TRAD did not differ on computational scale, but TRAD achieved greater adjusted scores than SUPP. Findings indicate that benefits of reform curriculum for students may depend on integrated professional development.
Stein, Smith, & Silver (1999)	Case Study 2 middle schools participating in the QUASAR Project Initial proposals for QUASAR funding, annual reports including previous year's accomplishments and plans for upcoming year, transcripts or summaries of regularly scheduled teacher or resource partners interviews, artifacts from professional development, curricular materials, summary of professional development synthesizing data over 5-year period.	Professional development should move toward the use of multiple strategies to build teacher capacity to understand subject matter, pedagogy, and student thinking. Professional developers need to match strategies for professional development to the group's goals and to the context. Professional developers need to balance interpersonal sensitivity with the need to challenge prevailing practices and beliefs. Additionally, they need to develop teachers as individuals as well as whole communities. Professional developers will need to be held responsible for changing teaching practice and student achievement.

Table 4 (continued)

Study	Methodology, Sample Size & Variables	Findings
Supovitz, Mayer, & Kahle (2000)	Secondary Data Analysis Researchers utilized data from survey collected between 1992 and 1995 as a part of HRI's evaluation of Ohio SSI (*n*=1,475). Data was collected at 4 points to measure change over time. Surveys included questions related to teachers' attitudes, beliefs, and inquiry-based teaching practices in addition to demographic and school information.	Math and science teachers who participated in intensive professional development showed substantial and statistically significant growth from before their training to a year later in their attitudes toward inquiry, their preparation to use inquiry-based pedagogy, and their actual use of inquiry-based teaching practices. Growth was sustained over the 3-year period and growth was independent of individual or school characteristics.
Supovitz & Turner (2000)	Survey Data Analysis Data collected from teachers (*n* = 3464) and principals (*n* = 666) in 24 communities in 1997 as a part of Local Systemic Change project Surveys asked teachers about their attitudes, beliefs, and practices while principals were asked about their support for the reform	Findings reveal that the quantity of professional development is strongly linked with both inquiry-based teaching practice and investigative classroom culture. Also, content preparation has strong influence on teacher practice and classroom culture. School SES status influences practice more than resources or principal supportiveness. High SES schools used more traditional teaching practices.

Table 4 (continued)

Study	Methodology, Sample Size & Variables	Findings
Wei, Darling-Hammond, & Adamson (2010)	Secondary Data Analysis Researchers utilize 3 administrations (2000, 2004, and 2008) of the Schools and Staffing Survey to compare responses on professional development and evaluate progress of professional development efforts in the states.	Study finds that 75% of beginning teachers participate in an induction program and 80% report having a mentor. While this is an increase from the previous report, urban and rural schools and those serving a large proportion of minority or low-income students do not have equal access. Teachers reported they had fewer opportunities for sustained professional development indicating resources are being put towards short-term workshops. About 75% of teachers report having some time to plan collaboratively with teachers; however, this time is limited. Texas ranked at the top for professional development in student discipline and classroom management. In addition, it ranked above other states in teaching students with disabilities and teaching LEP students.
Wei, Darling-Hammond , Andree, Richardson, & Orphanos (2009)	Secondary Data Analysis Researchers utilized the National Center for Educational Statistics' 2003-04 Schools and Staffing Survey to examine the status of professional development available to teachers and across states	Most teachers participate in some professional development. Typically, it focuses on academic subject matter with little depth. Teachers are dissatisfied with their opportunities and receive little funding to participate in additional professional development. The amount of support and participation in varies widely. Few teachers engage in intense collaboration. Beginning teachers are increasingly likely to participate in an induction program but the quality varies.

Table 4 (continued)

Study	Methodology, Sample Size & Variables	Findings
Wenglinsky (2002)	Secondary Data Analysis Researchers utilized NAEP, specifically the 1996 mathematics assessment (*n* = 7,146). The following variables were utilized in the study: student performance, student background, teacher education level, teacher's major/minor, teachers' years of experience, ten measures of professional development, 21 classroom practices utilized, & number of students per class.	Students of teachers who receive professional development in learning how to teach different groups of students substantially outperform students of other teachers. Professional development has a strong influence on teachers' classroom practices. The more professional development teachers receive in hands-on learning or any topic, the more likely they are to use hands-on learning activities in their classrooms.

Table 5

Research Reviews on Professional Development

Study	Methodology	Findings
Blank, de las Alas, & Smith (2008)	Analysis of evaluation studies from 25 professional development programs for teachers of mathematics and science	Seven of the 25 studies reported measurable effects on student outcomes and 10 studies reported measurable effects on increasing teacher content knowledge. Studies that included professional development focused on content knowledge with training and follow-up pedagogical content knowledge showed significant effects. The total time in professional development for these programs was 50 hours or more. Other findings included how future evaluations could be improved.
Goe (2007)	Research Synthesis on Teacher Quality Only studies that used standardized student achievement test scores as an outcomes measure were included in the synthesis in to make some comparisons across studies.	Findings reveal that a positive relationship between mathematics and science school-level achievement, at both elementary and secondary levels, and professional development is that is sustained, aligned with the curriculum, and focused on instruction.

Table 5 (continued)

Study	Methodology	Findings
Kennedy (1998)	Research Review Only included articles on mathematics and science inservice programs with evidence of student learning. Included 12 studies in 4 separate categories.	Findings include programs that focused on teachers' content knowledge or how students learn the subject has a larger impact than those focused on teachers' behaviors. Also did not find a clear relationship between number of contact hours or coherence and student learning.
Timperley, Wilson, Barrar, & Fung (2007)	Meta-analysis of 72 studies assessing the effects of professional development on student outcomes	Overall effect size of professional development on student outcomes was .66 and was high for science (d = .94) and mathematics (d = .50) Researchers used the effect sizes to establish seven themes about what works best in professional development.
Wei, Darling-Hammond, Andree, Richardson, & Orphanos (2009)	Meta-analysis of 1,300 research studies and evaluation reports	Professional development that is intensive and sustained is related to student achievement. School change can be promoted by collaborative professional learning. Professional development should: - Be intense, ongoing, and connected to practice - Be focused on content and student learning - Align with school improvement goals and priorities - Should build strong teacher relationships.

Table 5 (continued)

Study	Methodology	Findings
Wei, Darling-Hammond, Andree, Richardson, & Orphanos (2009) continued		School-based coaching and mentoring and induction programs may enhance professional learning.
Yoon, Duncan, Lee, Scarloss, Shapley (2007)	Research Review Reviewed more than 1,300 studies; 9 that met the What Works Clearinghouse evidence standards All 9 focused on elementary school teachers and their students. 4 studies focused on student achievement in reading/ELA, 2 on mathematics, 2 on mathematics and reading/ELA, 1 on science, and science and reading/ELA 5 were randomized controlled trials, 1 randomized controlled trial with group equivalence problems, and 3 quasi-experimental studies.	Only 1 of 20 effects found across the 9 studies was negative – study of mathematics where traditional instruction showed more positive effects on student achievement than reform model, however not statistically significant Only 1 of 20 effects found to be zero – reading/ELA study where teachers trained to use instructional talk did not demonstrate greater reading achievement than counterparts attending presentation on classroom management Studies that had more than 14 hours of professional development showed positive significant effect on student achievement

Integration of Mathematics, Science, and Technology

The integration of mathematics, science, and technology across the curriculum "more closely resembles how people learn and work in the real world" (Kotar, Guenter, Metzger, & Overhold, 1998). According to Beane (1996), there are four broad dimensions of curriculum integration: (a) the curriculum is organized around the real world; (b) pertinent knowledge is organized without regard to subject area lines; (c) learning is not based on an eventual test, but rather the content; and (d) real application and problem solving are used to connect the content to real world applications. This approach allows students to connect ideas across discipline boundaries and make sense of their education as a whole (Merrill, 2001). This idea of an integrated curriculum is supported by both national and state standards including: National Council of Teachers of Mathematics' (NCTM) Principles and Standards for School Mathematics, National Research Council's National Science Education Standards, and the Texas Essential Knowledge and Skills (TEKS). Few school systems, however, use integrative approaches due to several barriers (Merrill, 2001).

Barriers to integrating mathematics, science, and technology include: standardized testing, teacher-based tests, increased time, coordination of students, and planning for instruction as a team (West, Mireles, & Coker, 2006). In addition, teachers of mathematics and science have had little to no experience in an integrated setting. Furthermore, these teachers might not have adequate content knowledge in all areas to successfully implement this type of curriculum.

Finally, there is little research documenting the impact of integrating the curriculum on student achievement (West, Mireles, & Coker, 2006). Upon review of the literature, only one study focused on integration of mathematics and science with respect to content while three studies focused on integration of mathematics and science with respect to process. Judson and Sawada (2000) found when mathematics was incorporated into science classes, students scored better on a mathematics statistics test, while there was no difference in science performance. In terms of process, Childress (1996) found that students instructed by both a mathematics and science teacher in a technology class using a National Science Foundation (NSF) supported Technology, Science, and Mathematics (TSM) curricula did not score higher on a posttest, but when interviewed the students tended to consciously use science principles to solve problems during an investigation. In contrast, students instructed by only technology teachers tended to rely on what the teacher taught and what other students did. In two other studies focused on processes, the students taught via an integrated curriculum did not demonstrate significantly greater gains than students taught with a traditional curriculum (Merrill, 2001; Westbrook, 1998). Table 6 summarizes studies on integration of mathematics, science, and technology that include student outcome measures.

Table 6

Research on Integrating Mathematics, Science, and Technology

Study	Methodology	Findings
Childress (1996)	Quasi-experimental, non-equivalent control group design to measure the effects of the Technology, Science, Mathematics (TSM) curriculum on problem solving ability. Researchers used a small sample and a sample of convenience for the study. The treatment group was an 8th grade technology class of 17 students and control group was a class of 16 students. Students were given a pretest and posttest.	While both groups problem solving ability improved, there was no significant difference between the control and treatment group.
Judson and Sawada (2000)	Action research The sample included a control class (*n*=26) and an experimental class (*n*=27) that experienced a three-week unit in statistics. The experimental class was enrolled in a science class that integrated content from the statistics unit into the class.	The statistics-unit test grades for the experimental group were statistically higher than the control group indicating that grades are enhanced when mathematics is incorporated into science. It should be noted that science content was not incorporated into the mathematics class.

Table 6 (continued)

Study	Methodology	Findings
Merrill (2001)	Modified quasi-experimental nonequivalent control group design Purposive sample of 71 students who were enrolled in six intact technology education courses Experimental group (three classes) received and integrated hands-on curriculum and the comparison (three classes) received the same curriculum without the integrated, hands-on learning approach Students were given a pretest and posttest	The students engaged in the integrated, hands-on approach did not have significantly higher cognitive learning gains than the comparison group. The students engaged in the integrated, hands-on approach did not identify key terms and/or phrases as completely integrated at the level for statistically significant results. The students engaged in the integrated, hands-on approach did not have statistically significant increases in retention 2-4 weeks after treatment. Modifications such as, developing a tool for assessing student learning and designing a study for long-term integration, for future research are suggested.
Westbrook (1998)	The study was part of a year-long evaluation of the SAM9 (an integrated mathematics and science curriculum). A sample of 26 SAM9 students and 22 Physical Science-only students were included in the study. Researchers examined the nature and types of linkages in concept maps constructed by students.	Concept maps constructed SAM9 students had a greater number of procedural linkages to connect mathematics and science concepts. SAM9 students tended to place the mathematics and science terms on different parts of the page than physics-only students, which contradicted the thinking that they would be able to more integrate the terms.

Problem-Based Learning

Problem-based learning (PBL) is an "instructional (and curricular) learner-centered approach that empowers learners to conduct research, integrate theory and practice, and apply knowledge and skills to develop a viable solution to a defined problem" (Savery, 2006, p. 9). PBL originates from medical schools, but its applications can be used effectively in any area. A core model of PBL, as described by Barrows (1996), has six distinguishing characteristics: (1) it is a student-centered learning approach; (2) learning should occur in small groups with the guidance of a facilitator; (3) role of the teacher during PBL is to serve as a facilitator guiding the students; (4) authentic problems are posed to students before any formal teaching has occurred; (5) knowledge and problem solving skills are acquired by working through an authentic problem; and (6) new knowledge is acquired though self-directed learning. At the conclusion of any PBL activity, an appropriate assessment would require students to apply their knowledge to authentic problems (Segers, Dochy, & De Corte, 1999).

Due to PBL's roots in medicine, the earliest meta-analyses examining the impact of PBL only used studies in the medical field. Albanese and Mitchell (1993) found that students engaged in a program utilizing PBL rather than traditional methods enjoyed the program more and performed as well or better on clinical examinations and faculty evaluations. Additionally, the instructors of these programs tended to enjoy teaching more when using PBL. A meta-analysis by Vernon and Blake (1993) supports these findings and also indicates that students engaged in PBL do not score significantly higher on miscellaneous tests of factual knowledge.

As the use of PBL learning expanded to other areas, researchers began to investigate its use across disciplines. Findings from a meta-analysis by Walker and Leary (2009) reveal that students engaged in PBL performed as well or better than students in a lecture-based environment, especially in areas outside of medicine. Additionally, a meta-analysis by Dochy, Segers, Van den Bossche, and Gijbels (2003) concluded that PBL had a moderate positive and practically significant effect ($ES = 0.460$) on the skills (or application of knowledge) of students and a small, not practically significant effect on student knowledge. It is important to note that effect size for student knowledge was strongly influenced with two studies. These findings are consistent with results of other meta-analyses (Gijbels, Dochy, Van den Bossche, & Segers, 2005).

Haas (2005) examined the impact of PBL on student achievement from 1980 to 2002. The results of this meta-analysis indicated that PBL was the second most effective method of teaching secondary-level algebra. There is also evidence that PBL prepares students for further learning. Schwartz and Martin (2004) found that ninth-grade students participating in PBL learned more in a following lecture than students who were in a class where the instructor worked the problem. In summary these findings suggest that PBL has a stronger impact on students' application of knowledge rather than the acquisition of knowledge. This is not surprising, since PBL should emphasize problem-solving skills. Table 7 summarizes six meta-analyses investigating the impact of PBL on student learning outcomes.

Table 7
Research on Problem Based Learning

Study	Methodology	Findings
Albanese & Mitchell (1993)	Meta-analysis of 11 studies from 1972 to 1992 investigating the effects of PBL in medicine.	Findings suggest: (a) PBL is more enjoyable; (b) PBL graduates perform as well or better on clinical examinations and faculty evaluations; (c) PBL graduates are more likely to enter family medicine; and (d) faculty tend to enjoy teaching using PBL.
Dochy, Segers, Van den Bossche, & Gijbels. (2003)	Meta-analysis of 43 articles examining the effects of PBL in tertiary real-life classrooms	PBL had a moderate positive (*ES = 0.460)* and practically significant effect on the skills (or application of knowledge) of students. PBL had a small (*ES = -0.223)* not practically significant effect on student knowledge.
Gijbels, Dochy, Van den Bossche, & Segers (2005)	Meta-analysis of 40 studies looking at the effects of PBL on assessment outcomes	Researchers found zero effects on the learning of concepts (*d* = -0.04) from PBL. Also, found a positive effect on application (*d* = .40) and principals (*d* = .75).
Haas (2005)	Meta-analysis of research studies focusing on impact of teaching methods for secondary-level algebra on student achievement from 1980 to 2002.	PBL ranked second in effect size (a medium effect size) and had a percentile gain of 20% for students.

Table 7 (continued)

Study	Methodology	Findings
Vernon & Blake (1993)	Meta-analysis of 35 studies in the field of medicine from 1970 to 1992 comparing PBL with more traditional methods in education.	Students engaged in a program using PBL had significantly higher attitudes and opinions about their program and scored significantly higher on students' clinical performance. Traditional and PBL students did not differ on miscellaneous tests of factual knowledge and tests of clinical knowledge.
Walker & Leary (2009)	Meta-analysis of 82 studies across a variety of disciplines examining the impact of PBL.	Among almost all of the analyses run, PBL students did as well or better than lecture-based students. This finding was especially true for studies involving content outside of medicine.

Comprehensive Mentoring/Induction Programs

Mentoring and induction programs are essential for first year teachers as this is a critical and problematic time period (Wang, Odell, & Schwille, 2008). As preservice teachers become inservice teachers, a successful induction program should serve as a bridge during the transition (Ingersoll & Smith, 2004). Teacher induction programs are established for a number of different reasons including “support, socialization, adjustment, development, and assessment” (Ingersoll & Kralik, 2004, p. 2). Despite the widespread use of mentoring and induction programs, only a limited amount of evidence exists to support the effect of these programs on the development of teacher practice (Strong, 2009). Furthermore, the effects of mentoring and induction programs are contextual and likely to function as a result of the nature of their preparation program and the school in which they work (Allen, 2005)

Wang, Odell, and Schwille (2008) examined research studies related to mentoring and induction and placed them into one of three categories: (a) assumed effects of teacher induction components using theoretical assumptions; (b) effects of teacher induction identified by beginning teachers; and (c) effects of teacher induction using multiple data sources. Based on theoretical assumptions, researchers identified mentors’ dispositions, behaviors, and processes of mentoring that are useful in shaping mentees’ learning. Examples included co-thinking with mentees, focusing mentees’ attention on issues of instruction, and modeling and analyzing teaching, and discussing subject content with mentees and its relationship to student learning. In the studies reviewed, beginning teachers expected a formally structured mentor relationship and desired lesson observations and lesson-based discussions. Finally, studies using multiple data sources revealed that teacher preparation has a lasting impact on what and how beginning teachers learn to teach. In addition, these studies indicated the need for mentors to possess skills consistent with the kind of teaching and learning that mentees are supposed to learn in an induction program.

Teachers who are provided support through an induction program are more likely to become a high-quality teacher who is better equipped to manage challenges in the classroom and therefore, more likely to stay in the profession (Educational Issues Policy Brief, 2001). Successful induction programs share five main characteristics: (1) all first-year teachers participate regardless of certification status; (2) induction programs should last at least one year; (3) *qualified mentors* be assigned to all beginning teachers; (4) beginning teachers have reduced teaching loads; and (5) successful completion of the program should conclude with a summative review by the mentor (Educational Issues Policy Brief, 2001).

Findings from *Examining the Effects of New Teacher Induction,* suggested that induction programs could be improved by focusing on mentors (Wechsler, et al., 2010). The study indicates that strong induction programs have more control over mentors, held mentors accountable for mentoring, and provide more training and on-going support for beginning teachers. Additionally a five-year study conducted by the National Center for Research on Teacher Learning (NCRTL), revealed four issues to be important to creating successful mentoring programs (NCRTL, 2000). First, mentoring must be associated with a vision of good teaching – one that promotes effective teaching and positive professional norms. Mentors also need to be trained in what novices need to learn and how that learning occurs to create suitable learning experiences. A defined purpose linked to descriptions of specific mentoring practices increases mentor effectiveness by demonstrating it is more than a social role. Finally, an essential component of becoming an effective mentor is time. Mentors not only need time to mentor beginning teachers, but also need time to learn how to be effective mentors.

Research relating mentoring and induction to student achievement is limited. In a review of the research, Goe (2007) only found one study by Frome, Lasater, and Cooney (2005) that investigated the link between the two. This study suggested that the percentage of teachers engaged in an induction program is positively related to school-level achievement in mathematics. However, it is impossible to determine whether participation in induction was responsible for the increase in student achievement since it is a school-level variable. Strong (2009) also examined the impact of induction and mentoring on student achievement and found a possible connection. The limitation of these studies includes the use of value-added models for estimating school and teacher effectiveness or the use of quasi-experimental designs.

In summary, there is little evidence to support the impact of induction and mentoring on teacher practice or student achievement. In addition, the impact of these programs is largely dependent upon the context in which it is situated. This does not mean, however, that these types of programs are not beneficial for teacher retention. Table 8 summarizes the research on mentoring and induction.

Table 8

Research on Mentoring and Induction

Study	Methodology	Findings
Allen (2005)	Review of research aimed at helping policymakers gain a better understanding of the nature of the teaching workforce and encouraging strategies for recruitment and retention.	Research provides limited evidence that mentoring and induction increase teacher retention. The effects of mentoring and induction programs are contextual and likely to function as a result of the nature of their preparation program and the school in which they work.
Goe (2007)	Research Synthesis on Teacher Quality Only studies that used standardized student achievement test scores as an outcomes measure were included in the synthesis in order to make some comparisons across studies.	The amount of existing research does not provide a strong foundation on which to base conclusions related to student achievement and induction programs. Only found one study focused on the impact of mentoring and induction on student achievement. The article by Frome et al. suggested that the percentage of teachers engaged in an induction program is positively related to school-level achievement in mathematics.
NCTRL (2000)	Longitudinal study examining mentoring in the United States, the United Kingdome, China. Specifically the study investigated what mentors do, what novices learn, and how this is shaped by the context.	Findings revealed four issues to be important to creating successful mentoring programs: (a) mentoring must be associated with a vision of good teaching; (b) mentors need to be trained in what novices need to learn and how that learning occurs; (c) a defined purpose; and (d) time to learn how to mentor and time to mentor.

Table 8 (continued)

Study	Methodology	Findings
Strong (2009)	Research review assessing the evidence of the effectiveness of teaching induction and mentoring.	There is limited evidence related to the effect of induction support on development of teaching practice. The existing research indicates induction practices or components of it have an effect on teachers' attitudes to their work or actual classroom practice. There is a possible impact of induction on student achievement but research is limited.
Wang, Odell, & Schwille (2008)	Research review of studies since 1960 related to effects of mentoring and induction. Studies were divided into three categories: (a) assumed effects of teacher induction components using theoretical assumptions; (b) effects of teacher induction identified by beginning teachers; and (c) effects of teacher induction using multiple data sources.	Researchers identified mentors' dispositions, behaviors, and processes of mentoring that are useful in shaping mentees' learning. Mentees view induction programs as supporting classroom management, curriculum resources, and their relationship with students. Beginning teachers expect a formally structured mentoring relationship, including lesson observation and lesson-based discussions. School culture shapes the effects of lesson observation and lesson-based discussions. What mentors and mentees think and know about teaching and learning, plays a role in shaping what and how they are able to learn. Teacher preparation has a lasting impact on what and how beginning teachers learn to teach.

Table 8 (continued)

Study	Methodology	Findings
Wang, Odell, & Schwille (2008) continued		Mentors need the skills consistent with the kind of teaching and learning that mentees are supposed to learn in an induction program.
Wechsler, Caspary, Humphrey, & Matsko (2010)	Study of effectiveness of 39 state-funded new teacher induction in Illinois school districts for the past 4 years. Researchers utilized teacher and mentor surveys, case studies, data on the programs, teacher retention data, and student achievement data.	Overall, there was a positive relationship between teacher effectiveness and participation in an induction program. Mentees in the programs reported that they rarely had opportunities for their mentors to observe their teaching or observe their mentors teaching. School context is the biggest influence on beginning teachers' success. When teachers are engaged in induction focused on instruction, provide a variety of experiences, provide intensive mentoring, and are in a supportive school context, it is positively related to teacher efficacy and improvement in instructional practice. The relationship between induction and teacher retention and student achievement is unclear. Strong induction programs have more control over mentors including making mentors accountable for mentoring and provide more training and on-going support. This finding suggests that induction programs can be improved by focusing on mentoring.

Infusion of Technology

As our society becomes more global, technology plays a greater role in our everyday lives. Subsequently, educators are challenged with teaching technology skills that will enable students “to apply the basics in authentic, integrated ways to solve problems, complete projects, and creatively extend their abilities” (International Society for Technology in Education [ISTE], 2010, “Digital-Age Learning”, para. 1). In order to encourage the integration of technology into instruction, ISTE has developed five National Educational Technology Standards (NETS) for teachers (ISTE, “NETS for Teachers 2008”, 2010): (a) Facilitate and inspire student learning and creativity; (b) Design and develop digital-age learning experiences and assessment; (c) Model digital-age work and learning; (d) Promote and model digital citizenship and responsibility; and (e) Engage in professional growth and leadership.

Beyond the NETS for teachers, research supports the infusion of technology into instruction resultant of its impact on student achievement (Ringstaff & Kelly, 2002; Schacter, 1999; & Waxman, Lin, & Michko, 2002). Three reviews of research have documented the positive association between student achievement and the use of technology (Ringstaff & Kelly, 2002; Schacter, 1999; & Waxman, Lin, & Michko, 2002). One of these research studies also found that the infusion of technology has a slight negative effect on student discipline problems (Waxman, Lin, & Michko, 2002). A recent study conducted by the Texas Center of Educational Research (TCER) (2008) also supports the notion that technology integration has negative effect on student disciplinary problems. This same study also found a significant impact of technology immersion on standardized mathematics scores especially for economically disadvantaged and high-achieving students as well as allowing the students to experience more intellectually demanding work. Additionally, Hopson, Simms, and Knezek (2002) found that technology integration has an effect on the development of higher-order thinking skills. Specifically, the study found a positive relationship between the development of students' evaluation skills (the highest level in Bloom's taxonomy) and engagement in a technology-enriched environment. Finally, Lowther, Inan, Strahl, and Ross (2008) found that classrooms which integrate technology more frequently use commonly accepted best practices (e.g., working in centers, and engaging in research and project-based learning). Notwithstanding the current research that supports the use of technology, additional studies are needed related to the impact of emerging technologies (e.g. interactive whiteboards, student response devices, MP3 players, etc.).

Recently, the National Center for Educational Statistics (NCES) surveyed 4,133 teachers nationwide regarding technology use in classrooms (Gray, Thomas, & Lewis, 2010). Of the teachers surveyed, 40% reported they or their students often used computers in the classroom during instructional time and 29% reported use sometimes. In addition to computers in the classroom, 48% of teachers reported having an LCD or DLP projector and 23% reported having an interactive whiteboard. Almost 75% of teacher who had a projector in their classroom reported using it sometimes or often and more than 50% who had an interactive whiteboard reported using it sometimes or often. Only 34% of teachers indicated participation in 9 or more hours of professional development activities for educational technology in the last 12 months.

In another national survey conducted by Project Tomorrow, participants were surveyed about their perceptions of how technology impacts their students' learning. Fifty-one percent of teachers reported that students were more motivated to learn when technology was infused into the curriculum (Project Tomorrow, 2010). In addition, teachers reported that when using technology, students are more likely to apply knowledge to practical problems (30%) and take ownership of their learning (23%). These same teachers also saw changes in their teaching practice including encouraging students to be self-directed, creating more relevant and interactive lessons, and utilizing more differentiated instruction. Furthermore, roughly 30% of teachers reported that by using technology students were developing 21st century skills including problem solving skills, critical thinking skills, creativity, and collaboration.

Despite these findings, recent studies of technology use in the classrooms indicate that education as a whole, has not reached high levels of effective technology use (Bauer & Kenton, 2005; Project Tomorrow, 2008). In fact, some teachers still rely on the tools from the past instead of 21st century tools (Cuban, 2001). Furthermore, when teachers do use technology in their instruction, it tends to be low-level, teacher directed, or focuses on the development of students' technical skills (Tondeur, van Braak, & Valcke, 2007). Technology is not only for the purpose of making it quicker and easier to teach the same things but also makes it possible to "adopt new and arguably better approaches to instruction and/or change the content or context of learning, instruction, and assessment" (Lawless & Pellegrino, 2007).

In order for teachers to effectively use technology in their classroom, they first need knowledge of the technology itself (Ertmer & Ottenbreit-Leftwich, 2010). While some teachers are digital natives, there are other teachers who have had to learn how use technology through supplementary courses or workshops. However, just *knowing* how to use the technology is not sufficient; teachers need knowledge of how to effectively use the technology in their instruction. In addition, teachers need to feel confident in their ability to use the technology. Suggestions for building this confidence include: allowing teachers to play with the technology; starting small with integration; collaborating with peers; and participating in professional development that incorporates technology (Ertmer & Ottenbreit-Leftwich, 2010). Finally, Ringstaff and Kelly (2002) outline five conditions that are more likely to produce productive outcomes from technology: (a) when it is used as one component in a broad-based reform; (b) when teachers are provided adequate training and when their beliefs about technology integration change; (c) when sufficient resources are provided; (d) when a long-term plan is developed with required support; and (e) when technology is integrated into the curricular and instructional framework.

In terms of teacher education, preservice teachers indicate there is a gap between what they are learning and the technology that teachers are implementing in their classrooms (Project Tomorrow, 2010). The majority of preservice teachers surveyed reported being trained to use word processing or database tools, create multi-media presentations, or find digital resources to incorporate into lessons. When asked what would best prepare them to teach, overwhelmingly they responded with the desire to learn how to use technology to differentiate instruction or create and utilize video and podcasts, among others. A smaller percentage of teachers expressed an interest in learning how to effectively incorporate mobile devices or using social networking (Project Tomorrow, 2010). Table 9 summarizes key studies related to the infusion of technology.

Table 9

Research on Infusing Technology into Instruction

Study	Methodology	Findings
Gray, Thomas, & Lewis (2010)	Teacher survey conducted by NCES related to technology use during the winter and spring of 2009. 2,005 schools provided a full-list sample of full-time teachers and 4,133 teachers were selected to receive the survey. The weighted response rate 79%.	The ratio of students to computers in the classroom every day was 5.3 to 1. 40% of teachers reported that they or their students used computers in the classroom during instructional time often. 29% reported sometimes. The following is the percentage of teachers who indicated the pieces of technology were available in their classrooms: 23% interactive whiteboard and 57% reported they used them sometimes or often, 48% LCD or DLP projectors and 72% reported they were using it sometimes or often. 61% of teachers reported professional development activities prepared them to either a moderate or major extent to make effective use of technology for instruction. 61% indicated training provided by school technology staff and 78% indicated independent learning. 13% of teachers reported spending zero time in professional development activities for educational technology in the last 12 months, 53% indicated 1 to 8 hours, 18% indicated 9 to 16 hours, 9% indicated 17 to 32 hours, and 7% indicated 33 or more hours

Table 9 (continued)

Study	Methodology	Findings
Hopson, Simms, & Knezek (2002)	Quasi-experimental design 5th and 6th grade students in a suburban North Central Texas school district Treatment group was comprised of students accepted to a magnet program that had technology-enriched classrooms. Treatment and control groups were given the Ross Test of Higher Cognitive Processes and the Computer Attitude Questionnaire as a posttest.	Treatment group students in both 5th and 6th grade demonstrated a higher level of evaluation skill as measured by the Ross test and no significant differences on analysis and synthesis. The analysis of 5th grade student scores demonstrated treatment students' scores were significantly higher on subtests measuring importance, motivation, and creativity and no significant differences on enjoyment, study habits, empathy, anxiety, or seclusion.
Lowther, Inan, Strahl, & Ross (2008)	Matched treatment-control quasi-experimental study. The study included findings from the cohort, "Launch" 1, a 3-year program, including 26 schools, 12,420 students, and 927 teachers. The effectiveness of the Tennessee EdTech Launch (TnETL) program was measured using classroom observations, surveys, student performance assessments, focus groups, and student achievement analysis.	Teacher survey results indicated that teachers involved in the program had significantly higher confidence integrating technology and using technology for learning. Observation results indicated that program classrooms more frequently used computers, worked in centers, and engaged in research and project-based learning. Results related to student achievement were mixed.

Table 9 (continued)

Study	Methodology	Findings
Project Tomorrow (2010)	Included survey to 299,677 K-12 students, 26,312 parents, 38,642 teachers, and 3,947 administrators representing 5,757 schools in 1,215 school districts. Survey included questions related to use of the technology, 21st century skills, emerging skills, math instruction, STEM exploration, and challenges with technology integration.	51% of teachers reported that students were more motivated to learn when technology was infused. In addition, teachers reported that when using technology students are more likely to apply knowledge to practical problems (30%) and take ownership of their learning (23%). Teachers indicated changes in their teaching practice including encouraging students to be self-directed, creating more relevant and interactive lessons, and utilizing more differentiated instruction. Approximately, 30% of teachers reported that by using technology students were developing problem solving skills, critical thinking skills, creativity, and collaboration. The majority of preservice teachers surveyed reported being trained to use word processing or database tools, create multi-media presentations, or find digital resources to incorporate into lessons. Preservice teachers indicated they would like to learn how to use technology to differentiate instruction or create and utilize video and podcasts among others. A smaller percentage of teachers expressed an interest in learning how to effectively incorporate mobile devices or using social networking.

Table 9 (continued)

Study	Methodology	Findings
Ringstaff & Kelley (2002)	Review of the research in which the inclusion of studies was limited to those that were the most methodologically sound, longitudinal examining change over time, and those that illuminated the difference between "instruction" and "construction".	Conditions that favor productive outcomes from technology: (a) it is best used as one component in a broad-based reform; (b) teachers need adequate training and changes in their beliefs; (c) resources must be sufficient; (d) effective use requires long-term planning and support; and (e) it should be integrated into the curricular and instructional framework. In terms of learning from computers, computer tutorials can be beneficial for increasing students' scores on standardized achievement and tutoring students on basic scores. Measuring the impact of technology use on student achievement is difficult; however, technology can have a positive effect on student achievement when used for certain purposes under certain circumstances.
Schacter (1999)	Review of Research Analyzed the five largest scale studies of education technology. Studies were selected for their scope, sample, and generalizability. Analyzed two smaller scale studies that point to the promise of newer technologies.	Students with access to computer assisted instruction, integrated learning systems technology, simulations and software that teacher higher order thinking, collaborative networked technologies, or design and programming technologies show positive gains in achievement on researcher conducted tests, standardized tests, and national tests. Some evidence that technology is less effective when learning objectives are unclear.

Table 9 (continued)

Study	Methodology	Findings
TCER (2008)	Quasi-experimental 42 middle schools (grade 6 to 8) (21 treatment, 21 control) from rural, suburban, and urban locations in Texas. Study focused on 3 student cohorts in the third year of the program including over 15,000 students and 1,253 teachers. Researchers conducted classroom observations, distributed teacher and student surveys, collected disciplinary information from schools, and accessed school and student data from publicly available sources.	Treatment teachers altered instructional beliefs at a significantly faster rate and employed actions supporting infusion on technology. Evidence suggests that the use of laptop and digital resources have allowed treatment students to experience slightly more intellectually demanding work. Treatment students had significantly fewer disciplinary actions. Technology immersion had a significant effect on TAKS mathematics achievement, particularly for economically disadvantaged and high achieving students. Effect of technology immersion on students reading and mathematics achievement generally became stronger over time as they became more proficient technology users.

Table 9 (continued)

Study	Methodology	Findings
Waxman, Lin, & Michko (2002)	Meta-analysis including 42 studies from 1997 to 2003. Quantitative, experimental, and quasi-experimental studies were included. Studies included met the following criteria: (a) focus on teaching and learning with technology in K-12 in which the majority of instruction is face-to-face; (b) either a control/treatment group or a pre/posttest design; (c) report statistical data for calculating effect sizes. The studies represent a combined sample of 7,000.	Mean study weighted effect sizes: - Averaging across all outcomes was .410 - 29 studies with cognitive outcomes was .448 - 10 comparisons focused on student affective outcomes was .464 - 3 studies contained behavioral outcomes was .448 Results indicate that when compared to traditional instruction, teaching and learning with technology has a small, positive, significant effect on student outcomes and a small, negative effect on students' behavioral outcomes.

Summary of Research

The review of research provides strong support for a link between the seven goals of the academy and providing a 21st century education for students in the state of Texas. As studies have demonstrated, aspects of teacher quality (e.g., subject matter knowledge, pedagogical knowledge, and opportunities for continuing education) and student achievement are directly linked. Teachers with a deep understanding of subject matter and pedagogical knowledge are more likely to have a positive impact on student achievement. In addition, research suggests that teachers who participate in research-based professional development programs and comprehensive teacher education programs will mature into better teachers. Also, teachers who partake in mentoring and induction programs have more opportunities to develop effective teaching skills. Furthermore, a teacher who integrates mathematics, science, and technology and incorporates problem-based learning provides opportunities for students to experience a curriculum based on real-world problems and increases students' problem-solving and critical-thinking skills. Moreover, studies demonstrate that student motivation and teacher effectiveness both increase when teachers infuse technology into their curriculum. Finally, these goals appear to have a strong research basis and they appear to support learning and innovations skills, information, media and technology skills, and life and career skills.

Previous Evaluations of Programs Focused on Increasing STEM Teacher Quality

The lack of mathematics and science skills among United States's students has led to the development of numerous programs. NSF and state organizations have made large investments directed at increasing not only students' mathematics and science skills, but teachers' skills as well. These programs typically include evaluations to determine the effectiveness of the overall program or specific aspects. Findings from these evaluations can provide useful insight for the design of future programs with similar goals.

Math and Science Partnership Program. The Math and Science Partnership Program (MSP Program) was a legislative mandate for NSF to make awards to partnerships between institutions of higher education and K-12 school districts (Yin, 2010). The mandate did not specify the educational activities in which the partnerships would be involved. Rather, it provided the flexibility for partnerships to design and implement activities from a variety of accepted activities that would meet local needs. The primary purpose of the MSP Program was to strengthen the mathematics and science workforce, which includes K-12 teachers. All MSP Programs were required to engage IHE faculty members from STEM disciplines in active or leadership positions, a key distinction of the program according to NSF.

The bulk of the evaluation of the MSP Programs has focused on 48 awards that undertook mathematics and science education activities (Yin, 2010). The most common activity undertaken in these programs is some kind of professional development for K-12 teachers in the form of: workshops, summer institutes, the establishment of mentoring and support networks or professional development communities, or formal courses offered by IHEs. The evaluation has focused on three educational outcomes (K-12 student achievement, K-12 teacher content knowledge, and STEM discipline faculty involvement) and two process related outcomes (the contribution of new ideas to mathematics and science education and sustainability of the program past program funding).

Results from the evaluation related to K-12 student achievement indicated that schools participating longer in a MSP Program had students with higher proficiency scores (Yin, 2010). In terms of teacher content knowledge, statistically significant gains were found for 63% of mathematics teachers and 78% of science teachers. The evaluation also revealed that STEM discipline faculties were more involved than IHE education faculty members or K-12 school district staff. As a result of the partnerships, 172 articles have been published in peer-reviewed journals and another 69 articles have been published in other journals. Finally, 63 IHEs reported offering 492 courses that were, either new, enhanced, or modified, of which 77% were in the STEM departments.

California Mathematics & Science Partnership. The intention of the California Mathematics and Science Partnership (CaMSP) was to increase mathematics achievement (grade three through Algebra I) and science achievement (grades three through eight) by increasing classroom teachers' content and pedagogical knowledge (O'Driscoll, et al., 2009). Partnerships between high need local education agencies and IHEs were highly encouraged, as well as partnerships between county offices of education and other organizations associated with mathematics and science education.

The program allowed for flexibility in order to meet local needs. CaMSP programs included five key features: (a) partnership driven; (b) focused on increasing teacher quality; (c) focused on enabling teachers to provide and ensure student success in challenging courses and curricula; (d) program design informed by current research; and (e) ensure institutional change and sustainability.

The most recent evaluation of the CaMSP program included qualitative data collected from Cohorts 3, 4, and 5 and student outcome data from Cohorts 1 and 4 (O'Driscoll, et al., 2009). Evaluation results indicate there is some evidence of a positive relationship between CaMSP and student achievement as measured by California's standardized mathematics and science tests. In addition, some of the later cohorts are more successful than previous ones, indicating improvements in implementation.

Local Systemic Change. Local Systemic Change (LSC) is one of the biggest mathematics, science, and technology teacher professional development initiatives to date (Banilower, Boyd, Pasley, & Weiss, 2006). Over the course of 10 years, LSC funded 88 projects through a grant from NSF with the aim of improving STEM education. A key requirement of these projects was that teachers spend a minimum of 130 hours in professional development. The major successes the LSC initiative included positive impacts on teachers and learning including: improved mathematics and science lessons; elementary teachers increased time spent on science instruction; enhanced quality of content presented to students; more frequent use of investigative practices; and increased likelihood of intellectual rigor and student engagement. The major challenges associated with these programs included: supporting teachers during implementation;

addressing teacher's content needs; and preparing and supporting professional development providers.

Review of Evaluations. In 2005, the Council of Chief State School Officers (CCSSO) commissioned a study reviewing 25 evaluations from teacher professional development programs in mathematics and science nominated by 14 states through a grant from NSF (Blank, de las Alas, & Smith, 2008). These programs were offered through both IHEs and local school districts. Of the studies reviewed, 10 studies reported measurable effects on increasing teacher subject knowledge while four studies reported measurable effects on instructional practices. The researchers found that effective professional development studies spent a total of 50 hours or more in professional development. This professional development included a focus on content knowledge and pedagogical knowledge. An evaluation outcome the researchers found the ability to link teacher knowledge gains to classroom practices to be useful for future evaluations. Only four of the 25 studies reviewed, included observations so that changes in teacher practice could be made.

In summary, the majority of previous evaluations of programs focused on increasing STEM teacher quality documented partnerships between IHEs and local school districts. Another important feature of these programs was the ability to institutionalize changes brought about by the programs and the sustainability once funding ended. The majority of evaluations documented changes in teacher content knowledge and improved instruction. Finally, student achievement was a more difficult outcome to measure; consequently, it was not used in all evaluations.

Summary

The MSTTP funding program resembles programs that have been previously funded by the National Science Foundation or state organizations. Many of these programs include goals similar to those of the MSTTP academies indicating their importance. The current evaluation has many similarities to previous program evaluations. Specifically, the MSTTP evaluation requires partnerships between IHEs and high need districts in Texas. Additionally, the evaluation focuses on improved instruction and teacher content knowledge. Although, the inclusion of student achievement data would have been ideal, the data was not available. Finally, the current evaluation’s design and methodology resembles previous evaluations.

CHAPTER III

METHODS

The present study used secondary data from a larger evaluation of the Mathematics, Science, Technology Teacher Preparation (MSTTP) Academies conducted by the State of Texas Education Research Center at Texas A&M University between summer 2010 and spring 2011. The intent of this study is to evaluate the effectiveness of 14 MSTTP Academies across the state of Texas. The researcher used a mixed-methods design utilizing triangulation to analyze both quantitative and qualitative data. Survey data was used to examine the perceptions of academy participants. At the same time, interview data and academy end-of-year status reports provided more in-depth knowledge of the programs. The reason for collecting both quantitative and qualitative data was to compare and validate results.

Participants

At the time of this study, the Texas Higher Education Coordinating Board (THECB) had established 14 MSTTP Academies. The locations of the academies were: three in the Rio Grande Valley, two on the far western border of the state, one on the southern Gulf Coast, three in the Dallas-Fort Worth metroplex, two in east Texas, one in north Texas, and two in central Texas. Of the 14 academies, only one offered an initial certification program by itself. Six offered initial certification and a master's of education (or another master's degree). Three offered master teacher certification and master's of education (or another master's degree). Four offered a combination of all three. Ten of the academies chose to focus on mathematics and science, while two explicitly focused on integrating technology in mathematics and science. Of the remaining four academies, three were solely focused on mathematics and one on science. In terms of grade level, five academies focused on grades 4-8 and 8-12; four on K-12; three on 6-12; one on 8-12; and one on early childhood-4.

Table 10

Overview of MSTTP Academies

Academy	Region of the State	Program	Subject Focus	Grade Level
A	East Texas	A, B, & C	Mathematics & Science	8-12
B	Rio Grande Valley	A	Mathematics & Science with Integration of Technology	4-12
C	North Texas	A, B, & C	Mathematics & Science	K-12
D	Southern Gulf Coast	A & C	Mathematics & Science	4-8 and 8-12
E	Central Texas	B & C	Mathematics	EC-4
F	Central Texas	A, B, & C	Mathematics	4-8 and 8-12
G	Dallas-Fort Worth Metroplex	A & C	Mathematics	4-8 and 8-12
H	Dallas-Fort Worth Metroplex	A & C	Mathematics & Science	K-12
I	Rio Grande Valley	B & C	Mathematics & Science	K-12
J	Dallas-Fort Worth Metroplex	A & C	Mathematics & Science	K-12
K	Far Western Border	B & C	Mathematics & Science with Integration of Technology	EC-12
L	Far Western Border	A, B & C	Mathematics & Science	4-12
M	Rio Grande Valley	A & C	Mathematics & Science	4-12
N	East Texas	A & C	Mathematics & Science	2-12

Notes. Program A=Initial Certification. Program B=Master Teacher Certification. Program C=Master's Programs.

Preservice and Inservice Teachers. Participants for this study included 649 current students (any student who received funding from an academy during Cycle 2 or 3) of the MSTTP Academies in the state of Texas. Academy participants were either (a) current mathematics or science classroom teachers in a high-needs district with a minimum of two years experience or (b) students participating in a teacher preparation program with an emphasis in STEM related fields. By agreeing to participate in an academy, all students committed to teaching in a Texas high-need public school district for a minimum of two years after completing the program. The academies provided financial incentives for the participants in the form of tuition and textbook reimbursement, and, in some cases, stipends for completing projects. Table 11 shows a breakdown of participants by program for each academy.

Table 11

Academy Participants by Program

Institution	Program A	Program B	Program C	Total
A	5	3	37	45
B	35			35
C	8	8	27	43
D	15		18	32
E[a]	1	38	38	39
F[a]	28	22	30	52
G	10		51	61
H	4		43	47
I		20	24	44
J	28		25	53
K[a]		51	56	56
L	22	26	11	59
M	6		25	31
N	20		34	54

Notes. Program A=Initial Certification. Program B=Master Teacher Certification. Program C=Master's Programs.

[a]Participants in these academies could be enrolled in multiple programs.

Directors. Academy directors were all faculty members at a public university in the state of Texas. These individuals were principal investigators or co-principal investigators for the MSTTP Academies and were housed in a variety of colleges, including the College of Education, College of Science and College of Mathematics at their respective universities. Four of these faculty members were currently serving as deans of their colleges, while the remaining 24 were professors in their respective college. Of the 28 directors, 13 were male and 15 were female.

Data Sources and Collection

For the purpose of this study, data were collected from the following sources: participant and director interviews, participant surveys, and end-of-year academy status reports. Data was collected between June 2010 and December 2010.

Interview Data. In order to collect more in-depth knowledge of the programs, semi-structured interviews of both academy directors and participants were conducted (Appendices A & B). At each academy, directors preselected four preservice or inservice teachers to participate in interviews (*n*=56). Participant interviews consisted of 18 questions related to the MSTTP Academy goals and objectives. In addition, participants were given an opportunity to offer their viewpoints on any topics that might not have been addressed in the interviews. In addition to student interviews, directors from each academy were also interviewed (*n*=28). The director interview consisted of 13 questions related to academy activities, goals, and objectives. Each director was also given the opportunity to offer any other comments relating to their academy.

Researchers affiliated with the State of Texas Education Research Center at Texas A&M University conducted student and director interviews at each of the 14 sites during the summer of 2010. Interviews lasted approximately 30 minutes, in an informal setting at small tables within isolated classrooms or conference rooms to ensure confidentiality. Prior to beginning each interview, participants were informed about the study and then asked to sign an informed consent document. Interviews were transcribed as they occurred.

Survey Data. Researchers also distributed a Mathematics, Science, and Technology Teacher Preparation Academy Participant Survey, to all academy participants (*n*=649) (Appendix C). The survey was an adapted version of the 2000 Survey of Science and Mathematics Education Teacher Questionnaire created by Horizon Research Inc. for the National Science Foundation (NSF) grant # REC-9814246 and the T3 Survey created by the Education Research Center at Texas A&M University (Horizon Research Inc., 2000). The purpose of the survey was to examine the perceptions of academy participants. Specifically, the questions addressed the extent to which participants felt confident in their subject matter and pedagogical knowledge and ability to implement technology into instruction after participating in the academy. The survey also included general demographic information about the participant. At the end of the survey, open-ended questions provided students with the opportunity to elaborate on the strengths and weaknesses of the academies.

In the fall of 2010, students were invited (via e-mail) to take part in an online, voluntary survey regarding their respective MSTTP Academy. A web link for the

"Mathematics, Science, and Technology Teacher Preparation Academy Participant Survey" was distributed to Academy participants directly. The email informed students that the survey would take approximately 30 minutes and they would not be able to revisit the survey after starting. At the beginning of the survey, participants were informed about the intent of the research, and were also assured subject confidentiality. Consent to participate in the study was assumed by the willingness to proceed with the survey. The survey was distributed using Qualtrics, an online survey software, which allowed researchers to directly download survey data from the website.

Academy End-of-Year Status Reports. At the end of the 2010 funding year, THECB required each of the 14 MSTTP academies to submit an end-of-year status report. THECB provided an outline for the reports to ensure all academies included the same information. Once the reports were submitted, THECB provided a copy to the State of Texas Education Research Center at Texas A&M University.

Data Analysis

Data analysis of all data sources was conducted in the spring of 2011. Figure 2 displays the data collection and data analysis procedures utilized in this study.

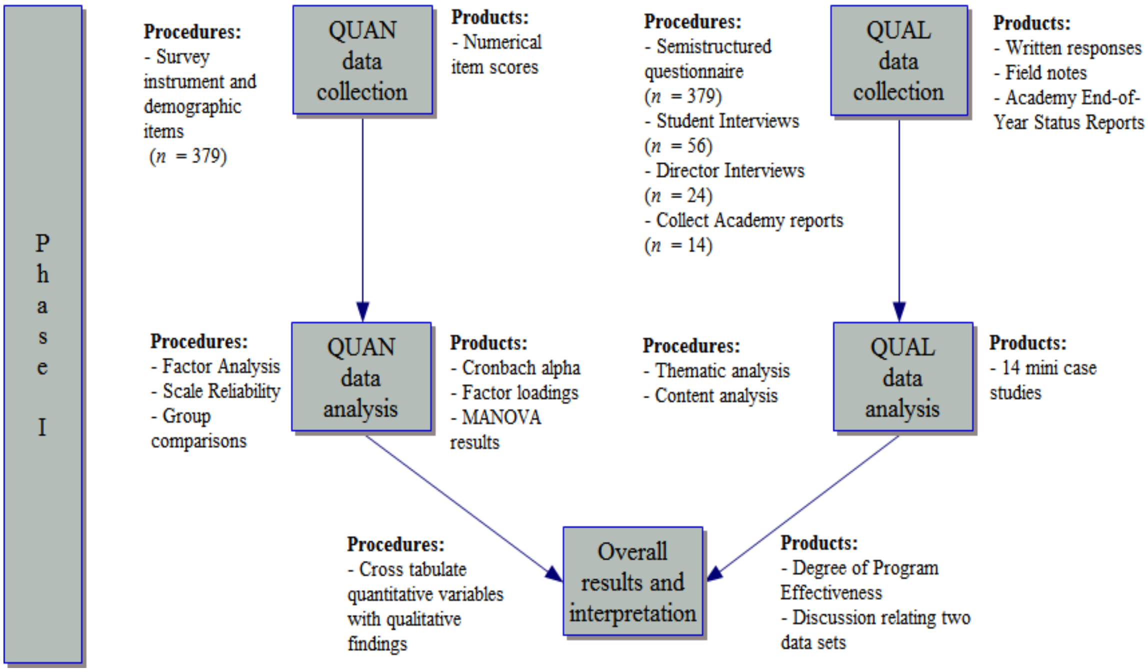

Figure 2. **Visual diagram of data collection and analysis.**
Note. Adapted from “Designing and Conducting Mixed Methods Research” by J.W. Creswell & V.L.P. Clark, 2007.

Survey Data Analysis. Descriptive statistics are reported to ascertain student experiences and perspectives related to the MSTTP Academies. Next, a factor analysis was conducted to examine the construct validity of the survey and group items into factors. The number of factors retained was determined by using eigenvalues greater than 1.00. Cronbach alphas were also calculated to determine factor or scale reliability. Next, I computed Pearson correlation among the scales extracted from the factor analysis to test scale validity. Finally, a MANOVA was conducted to determine if significant differences existed among the 14 academies on the extracted scales.

Interview Data Analysis. Analysis of the interview data for this study occurred in three distinct, but overlapping, phases. First, I became familiar with the data by reading and re-reading each interview multiple times, marking any passages deemed interesting or important. I relied on my judgment regarding the significance of selected passages. According to Seidman (1998), the researcher's judgment may be the most important component she or he brings to a qualitative study, and to a great extent, depends on the experience the researcher has in internalizing and interpreting data from interviews.

The second phase of data analysis included the development of mini-case studies for each of the MSTTP academies. The mini-case studies describe the directors' and participants' experiences related to the academies, including strengths, challenges, and possible improvements. When writing the mini-case studies, I began by pulling quotes from the interview transcripts that were deemed meaningful in the first phase of analysis. These quotes served as a framework for developing the mini-case studies and helped to accurately portray the participants' sentiments.

In the final phase of qualitative analysis, a cross-case analysis of the data was performed. I began by reducing the text in order to identify what was of most interest and importance, utilizing a constant comparison method of coding passages. Through an inductive analysis of the data, I identified common themes across the 14 sites. Additionally, important themes, which were prevalent only at one or two schools, were also identified. During this process of reading and identifying passages of interest, I began to look for words or phrases to identify categories into which the marked passages might fit. Data were sorted into categories and coded as a process for developing an organizational framework for the case study reports addressing the effectiveness of the MSTTP Academy prevalent across the 14 sites.

Academy End-of-Year Status Report Analysis. The academy end-of-year status reports were analyzed for evidence supporting the face that academies were meeting the seven goals outlined by THECB in the initial request for proposals. The researcher read each report and marked any statements indicating the academy was meeting one of the seven goals. The data collected from the end-of-year status reports served to verify findings from interviews and survey results.

Degree of Program Effectiveness. In an effort to merge the qualitative and quantitative data, I calculated a degree of program effectiveness measure for the 14 MSTTP academies from three different sources of data: (a) interview data; (b) scale scores from the Math, Science, and Technology Teacher Preparation Academy Participant Survey; and (c) academy end-of-year status reports. Two coders will review all data sources and rate each academy based on seven indicators: (a) strengthening teacher subject matter knowledge; (b) strengthening pedagogical knowledge; (c) based on research in teacher preparation and professional development; (d) integration of science, technology, and mathematics; (e) implementation of a comprehensive mentoring/induction program highlight (f) emphasizing problem-based learning that offers a real-world context; and (g) infusion of technology into academy curriculum. Each of the seven indicators will be assigned a value of 1 to 4 (1 = no sources of evidence; 2 = 1 source of evidence; 3 = 2 sources of evidence; 4 = more than 2 sources of evidence), for a maximum program effectiveness overall rating of 28. Academies were then grouped into one of three categories based on their overall program effectiveness rating: more effective academies, effective academies, and less effective academies. Finally, the extent to which the seven goals of the academies are associated with participants' perceived subject matter knowledge and pedagogical knowledge was analyzed using multiple regression analyses. These procedures will be used to examine the extent that the seven goals of the academy predict participants' perceived subject matter knowledge and pedagogical knowledge.

CHAPTER IV

RESULTS

This chapter reports the results of this study. First, the results from the quantitative analysis from the participant survey will be reported. Second, the qualitative results that include (a) director and student interviews, (b) documentation from academy end-of-year status reports, and (c) open-ended response items included in the participant survey, are reported. Finally, the overall results that describe the degree of program effectiveness are reported.

Quantitative Analysis

Demographics. The Mathematics, Science, and Technology Teacher Preparation Academy Participant Survey was distributed to 651 participants in the 14 academies. The overall response rate for the survey was 59.1%. The academy with the highest response rate was Academy I (86.4%) and the academy with the lowest response rate was Academy J (37.7%). Table 12 displays all participant response rates by academy.

Table 12

Participant Response Rate by Academy

Institution	Participants	Responses	Response rate
I	44	38	86.4%
C	43	34	79.1%
D	32	25	78.1%
A	45	34	75.6%
K	56	38	67.9%
G	61	36	59.0%
M	31	18	58.1%
N	54	31	57.4%
B	35	20	57.1%
E	39	20	51.3%
H	47	22	46.8%
L	59	27	45.8%
F	52	22	42.3%
J	53	20	37.7%
All Academies	**651**	**385**	**59.1%**

Participants were asked on the survey to indicate their status within their respective academy. Table 13 displays participant status by academy. The majority (87.8%) of respondents indicated they were current participants. Only 8.1% of respondents indicated they had either graduated or completed the academy, and the remaining 4.1% of survey participants indicated they were no longer with the academy and did not complete or graduate from the academy. Of the 16 individuals that indicated they were no longer with the academy, seven stated *personal reasons*, 5 stated *they did not like aspects of the academy*, and 4 stated *miscellaneous reasons* for their decision.

Table 13

Participant Status by Academy (*N*=385)

Institution	Current Participant	Graduated/Completed Academy	No longer with academy but did not complete/graduate
A	26	5	3
B	19	0	1
C	34	0	0
D	16	9	0
E	20	0	0
F	21	1	0
G	35	0	1
H	19	3	0
I	35	2	1
J	19	1	0
K	34	1	3
L	14	8	5
M	15	1	2
N	31	0	0
All Academies	**338**	**31**	**16**

For the purpose the present study, only current or graduated/completed academy participants were included (*N*=369). Of the 369 respondents, the overwhelming majority (76.7%) were female. In terms of ethnicity, the majority (53.5%) of participants were Caucasian. The next highest ethnic group was Hispanic/Latino(a) at 34.8%. Table 14 displays the academy participant demographics.

Table 14

Academy Participant Demographics (*n*=369)

Sex	
Female	76.7%
Male	23.3%
Ethnicity	
Caucasian	53.5%
Hispanic/Latino(a)	34.8%
African American	6.0%
Asian	3.8%
Other	1.4%
American Indian/Alaskan Native	0.5%

In addition to demographic information, the survey revealed the mean participant enrollment for all academies ranged from 3.5 semesters to 5.1 semesters with an overall average enrollment of 4.35 semesters. Academy H had the highest mean semester enrollment at 5.1, indicating the average student been participating in the academy for almost 2 years. Academy N had the lowest mean enrollment at 3.5 semesters, signifying an average student in this academy had been participating for a little over 1 year. Table 15 displays the participants' mean number of semesters enrolled by academy.

Table 15

Participant Mean Enrollment by Academy (*n*=364)

Institution	Mean Number of Semesters
H	5.1
A	4.9
M	4.9
J	4.9
E	4.8
K	4.7
C	4.6
G	4.5
F	4.2
D	3.9
L	3.9
I	3.8
B	3.6
N	3.5
All Academies	**4.35**

Note. Metric = semester (e.g., spring, summer, and/or fall).

Participants were asked to indicate in which program they were participating (e.g., initial certification, master teacher certification, and/or a master's program). The majority (83.7%) of participants were enrolled in only one program. The master's degree program had the highest percentage of students (50.4%). Students enrolled in an initial certification and master's degree program comprised the smallest percentage (1.9%) Table 16 displays the participants' program by academy.

Table 16

Participants' Program by Academy (*n*=369)

Institution	Program A	Program B	Program C	Program A&C	Program B&C
A	0	14	8	0	9
B	15	0	4	0	0
C	5	0	26	0	3
D	0	1	19	4	1
E	0	6	8	0	6
F	11	0	4	2	5
G	6	2	27	0	0
H	0	2	20	0	0
I	0	16	13	0	8
J	4	0	15	1	0
K	1	13	3	0	18
L	8	3	10	0	1
M	2	5	9	0	0
N	9	0	20	0	2
All Academies	**61**	**62**	**186**	**7**	**53**

Notes. Program A=Initial Certification. Program B=Master Teacher Certification. Program C=Master's Programs.

In addition to indicating program type, participants were also asked to indicate their content focus in their respective academy (e.g., mathematics, science, and/or technology). The majority (75.1%) of students indicated only one content area focus. The largest content area focus was mathematics with 139 students, followed by science with 125 students. Only 30 students (8.1%) indicated they were focused on all three domains of mathematics, science, and technology. Table 17 displays the content focus of participants by academy.

Table 17

Content Focus of Participants by Academy (*n*=369)

Institution	Math	Science	Tech.	Math & Science	Math, Science, & Tech.	Math & Tech.	Science & Tech.
A	6	24	0	1	0	0	0
B	9	6	0	0	2	1	1
C	15	3	0	12	3	1	0
D	6	12	0	2	2	0	3
E	14	0	0	1	4	0	1
F	10	0	0	5	5	2	0
G	33	1	0	1	0	0	0
H	3	15	0	2	1	0	1
I	0	17	0	1	5	0	14
J	1	17	0	0	1	0	1
K	8	14	12	0	1	0	0
L	9	5	0	6	2	0	0
M	13	1	1	0	1	0	0
N	12	10	0	2	3	1	3
All Academies	**139**	**125**	**13**	**33**	**30**	**5**	**24**

Additionally, academy participants were asked to indicate the grade level taught or planning to teach. The largest percentage (46.6%) of participants indicated they taught or were planning to teach grades 9-12. Individuals who indicated they were teaching or plan to teach K-2 was the smallest group of participants at 4.6%. Of the 28 individuals who selected other, the majority of respondents specified they were teaching grades that spanned more than one of the categories provided. Other individuals who selected this category identified themselves as instructional coaches or administrators. Table 18 displays the grade level taught or plans to teach by academy.

Table 18

Participant Grade Level Taught or Plan to Teach by Academy (*n*=369)

Institution	K-2	3-5	6-8	9-12	Other
A	0	0	6	24	1
B	0	2	0	16	1
C	1	8	15	7	3
D	0	5	7	10	3
E	3	12	0	0	5
F	1	1	5	13	2
G	0	2	10	15	8
H	0	1	6	14	1
I	7	6	14	9	1
J	0	1	4	15	0
K	2	9	12	11	1
L	1	0	6	13	2
M	1	0	4	11	0
N	1	5	11	14	0
All Academies	**17**	**52**	**100**	**172**	**28**

Results of the survey indicated that the majority (81.6%) of respondents were inservice teachers, instructional coaches, or administrators. Only 18.4% of respondents were preservice teachers. Academy B had the largest percentage (78.9%) of respondents indicating they were preservice teachers. Table 19 displays teacher type by academy.

Table 19

Teacher Type by Academy (*n*=369)

Institution	Preservice Teacher	Inservice Teachers/Instructional Coaches/Administrators
A	0	31
B	15	4
C	5	29
D	4	21
E	0	20
F	13	9
G	6	29
H	0	22
I	0	37
J	5	15
K	1	34
L	8	14
M	2	14
N	9	22
All Academies	**68**	**301**

The respondents who indicated they were current classroom teachers (*n*=220) were also asked to indicate their number of years of teaching experience, including the 2010-2011 academic year. The majority (66.4%) of teachers participating in MSTTP academies reported having more than 6 years of experience. Remarkably, 36.4% of inservice teachers reported having 10 or more years of experience. Only 16.8% of teachers indicated they had less than three years of experience. Table 20 displays participants' years of teaching experience by academy.

Table 20

Years of Teaching Experience by Academy (*n*=220)

Institution	1-3	4-5	6-8	9-10	10+
A	0	2	4	4	14
B	9	0	0	0	0
C	4	7	3	2	8
D	5	0	2	1	4
E	0	1	0	3	6
F	1	2	2	0	2
G	1	3	8	1	5
H	1	3	3	3	5
I	3	8	2	3	6
J	0	0	2	1	9
K	3	4	8	0	11
L	6	2	4	1	3
M	0	1	2	2	3
N	4	4	5	0	4
All Academies	**37**	**37**	**45**	**21**	**80**

General Academy Perceptions. In addition to demographic information, all participants were asked a series of 15 questions related to the academy in general. All items were scored on a four-point Likert-type measure: *Strongly Disagree* (1), *Disagree* (2), *Agree* (3), and *Strongly Agree* (4). The 15 questions were factor analyzed using principal component analysis with Varimax rotation. The analysis yielded three factors. The factor loadings of 15 questions ranged from 0.54 to 0.87, and each item had its highest loading fall in the factor. The eigenvalues of the three factors were above 2.87, and the total variance explained by these scales was 72.47%. Factor 1 was labeled Research and Professional Development (RPD), Factor 2 was labeled Incorporation of Technology (IT), and Factor 3 was labeled Learning Academy Seminar (LAS). Table 21 displays the variables and their corresponding factor loadings.

Table 21

Factor Loadings of General Academy Scales

	Factor Loadings		
Variable	RPD	IT	LAS
The mentoring/induction program was beneficial to me in my professional development.	0.54		
The mentoring/induction program supported my learning.	0.59		
The academy created a sense of collegiality among participants.	0.65		
The academy utilized research-based articles related to my field.	0.77		
The academy increased my ability to apply research-based practices to my teaching.	0.80		
The academy increased my awareness of current issues in my field.	0.74		
The academy prepared me to conduct research related to my field.	0.80		
The academy encouraged me to present research I conducted at a professional conference.	0.68		
The academy infused technology into the curriculum.		0.82	
The academy demonstrated how to effectively use technology in the classroom.		0.86	
The academy provided time for participants to practice with new pieces of technology.		0.86	
Mathematics, science, and technology were integrated into all aspects of the academy.		0.79	
The Learning Academy Seminars created a learning community.			0.87
The Learning Academy Seminars supported improved instruction.			0.86
The Learning Academy Seminars improved my understanding of content knowledge.			0.81
Variance	29.85	23.52	19.10
Eigenvalue	4.48	3.53	2.87

Notes. RPD = Research and Professional Development. IT = Incorporation of Technology. LAS = Learning Academy Seminar.

In addition, internal consistency reliability (Cronbach alpha) and inter-scale correlation coefficients (discriminant validity) of each scale were calculated. The internal consistency reliability coefficients of the three scales ranged from 0.90 to 0.93 with a satisfactory mean value of 0.91, suggesting that the three scales are reliable in measuring participants' perceptions. The inter-scale correlations ranged from 0.50 to 0.66, with an overall average of 0.58. As expected, the inter-scale correlations are moderate ($r > 0.40$) because most of the programs are simultaneously implementing most of these components. Table 22 presents the alpha reliability coefficients and inter-scale correlations of the scales.

Table 22

Alpha Reliability and Inter-scale Correlations of General Academy Scales

Scale	Alpha Reliability	Inter-scale correlation		
		1	2	3
RPD	0.91		0.66	0.58
IT	0.93			0.50
LAS	0.90			

Notes. RPD = Research and Professional Development. IT = Incorporation of Technology. LAS = Learning Academy Seminar.

Overall, academy participants had positive perceptions in regard to general academy scales. The scale with the highest mean value was the research and professional development scale (*M*=3.33). The mean values for the incorporation of technology scale (*M*=3.29), and the learning academy seminar scale (*M*=3.25) were also relatively high.

A one-way multivariate analysis of variance (MANOVA) was conducted by academy on the three general academy scales. The results of the MANOVA revealed a significant difference among the academies (*Wilks' lambda*=.500, *F*(13, 349)=6.96, p<.000). In the follow-up MANOVA, enrollment in a specific academy was statistically significant for all three scales at the $p < .001$ level. The effect sizes of the three scales ranged from 0.10 to 0.26, indicating a small effect of the program. The Tukey post hoc results are reported in Table 23. Some of the general post hoc results reveal that for the RPD scale, participants enrolled in Academy D had significantly higher perceptions than participants in Academy A or Academy F. In terms of the IT scale, participants in Academies B and D had significantly higher perceptions than participants in Academies A and M. Finally, results related to the LAS scale indicate that participants in Academy D had significantly higher perceptions of the Learning Academy Seminars than participants in Academies A, F, or H.

Table 23

One-way MANOVA on General Academy Scales

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Scale	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
RPD	3.07^{b}	3.52^{ab}	3.52^{ab}	3.61^{a}	3.17^{ab}	3.05^{b}	3.45^{ab}	3.41^{ab}	3.39^{ab}	3.42^{ab}	3.14^{ab}	3.31^{ab}	3.37^{ab}	3.15^{ab}	3.33	3.05*	.10
IT	3.19^{d}	3.67^{a}	2.51^{ab}	3.77^{a}	3.22^{abc}	3.14^{abc}	3.15^{abc}	2.73^{cd}	3.58^{ab}	3.20^{abc}	3.21^{abc}	3.26^{abc}	2.39^{d}	2.99^{abc}	3.29	9.44*	.26
LAS	3.00^{def}	3.68^{ab}	3.61^{abc}	3.72^{a}	2.26^{ab}	2.81^{ef}	3.37^{abcde}	2.97^{def}	3.50^{abcd}	3.30^{abcde}	3.04^{abcde}	3.38^{abcde}	3.13^{bcde}	3.12^{bcde}	3.25	8.15*	.23

Notes. *Wilks' lambda*=.500, $F(13, 349)=6.96$, $p<.000$. RPD = Research and Professional Development. IT = Incorporation of Technology. LAS = Learning Academy Seminar. 1 = Strongly disagree; 2 = Disagree; 3 = Agree; 4 = Strongly Agree.

* $p<.001$.

Technology. The survey also included a list of 14 types of technology in which participants were asked to what extent the academy had prepared them to incorporate these pieces into their technology. All items were scored on a four-point Likert-type measure: *Not Adequately Prepared* (1), *Somewhat Prepared* (2), *Fairly Well Prepared* (3), and *Very Well Prepared* (4). The 14 items were factor analyzed using principal component analysis with Varimax rotation. The analysis yielded one factor. The factor loadings of 14 items ranged from 0.66 to 0.88, and each item had its highest loading fall in the factor. The eigenvalues of the one factor (Technology) was 8.84, and the total variance explained by this scale was 63.11%. Table 24 displays the variables and their corresponding factor loadings.

Table 24

Factor Loadings of the Technology Scale

	Factor Loadings
Variable	TECH
MP3 player/ipod	0.78
Tape player/radio	0.81
Interactive whiteboard (e.g., SMART board, Promethean board)	0.66
Student response device	0.72
Flip camera/video camera	0.78
Digital camera	0.86
DVDs/CDs and headphones	0.88
Skype/video communication	0.75
Laptop computers	0.80
Desktop computers	0.82
Television	0.87
Document reader	0.77
Overhead projector	0.82
Handheld game/device	0.78
Variance	63.11
Eigenvalue	8.84

Note. TECH = Technology.

In addition, internal consistency reliability (Cronbach alpha) was calculated for the Technology scale. The internal consistency reliability coefficient of the scale was 0.96, suggesting that the scale is reliable in measuring participants' perceptions of how well the academy prepared them to use technology. Table 25 presents the alpha reliability coefficient.

Table 25

Alpha Reliability of Technology Scale

Scale	Alpha Reliability
TECH	0.96

Note. TECH = Technology.

As a whole, academy participants felt as though the academy had somewhat or fairly well prepared them to implement technology into the classroom (*M*=2.41). A one-way analysis of variance (ANOVA) was conducted by academy on the Technology scale. The results of the ANOVA revealed a significant difference among the academies (F=8.42, p<.000). The effect size of the TECH scale was 0.24, indicating a small effect. Additionally, Tukey post hoc results are reported in Table 26. In general, the post hoc tests reveal that participants in Academy D felt the academy had prepared them more to implement technology into the classroom than Academy A.

Table 26

One-way ANOVA on Technology Scale

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Factor	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
TECH	1.51^{e}	2.95^{ab}	2.70^{abc}	3.10^{a}	2.76^{ab}	2.22^{bcde}	1.95^{cde}	2.21^{bcde}	2.80^{ab}	2.30^{bcd}	2.67^{abc}	2.53^{abcd}	1.85^{de}	2.22^{bcde}	2.41	8.42*	.24

Notes. TECH = Technology. 1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.
* p<.001.

Professional Development Needs. Participants were also given a list of five items that pertained to their professional development needs. The items were scored on a four-point Likert-type measure: None Needed (1), Minimal Need (2), Moderate Need (3), and Substantial Need (4). The 5 questions were factor analyzed using principal component analysis with Varimax rotation and yielded one factor. The factor loadings of five items ranged from 0.54 to 0.80, and each item had its highest loading fall in the factor. The eigenvalue of the factor was 3.17, and the total variance explained by this scale was 63.49%. The factor was labeled Professional Development Needs (PDN). Table 27 displays the variables and their corresponding factor loadings.

Table 27

Factor Loadings for Professional Development Needs Scale

	Factor Loadings
Variable	PDN
Deepening my content knowledge.	0.54
Using inquiry/investigation-oriented teaching strategies.	0.59
Using technology for instructional purposes.	0.65
Assessing student learning.	0.77
Differentiating instruction for all students.	0.80
Variance	63.49
Eigenvalue	3.17

Note. PDN = Professional development needs.

The internal consistency reliability (Cronbach alpha) was also calculated for the Professional Development Needs scale. The internal consistency reliability coefficient of the scale was 0.85, suggesting that the scale is reliable in measuring participants' perceptions of their professional development needs. Table 28 presents the alpha reliability coefficient.

Table 28

Alpha Reliability of Professional Development Needs Scale

Scale	Alpha Reliability
PDN	0.85

Note. PDN = Professional development needs.

A one-way ANOVA was conducted to determine whether there were significant differences by academy on participants' professional development needs. The results revealed there was no significant difference by academy on the PDN scale. The overall means for each academy are displayed in Table 29. The overall mean average for all participants was 2.74, indicating most academies' participants felt as though they had between minimal and moderate professional development needs. Academy B participants had the highest need for professional development (M=2.99) and Academy H participants had the lowest (M=2.58).

Table 29

Mean Professional Development Needs by Academy

Institution	Mean PDN
B	2.99
I	2.90
M	2.89
C	2.87
G	2.83
F	2.77
J	2.74
E	2.73
K	2.67
N	2.65
D	2.63
L	2.61
A	2.59
H	2.58
All Academies	**2.74**

Notes. PDN = Professional development needs. 1 = none needed; 2 = minimal need; 3 = moderate need; 4 = substantial need.

Classroom Instruction. The last group of questions that all participants answered was related to classroom instruction. Participants were asked how well the academy had prepared them to utilize each of the strategies listed. The items were scored on a four-point Likert-type measure: *Not Adequately Prepared* (1), *Somewhat Prepared* (2), *Fairly Well Prepared* (3), and *Very Well Prepared* (4). The 43 items were factor analyzed using principal component analysis with Varimax rotation and yielded four factors. The factor loadings of 43 items ranged from 0.44 to 0.79, and each item had its highest loading fall in the factor. The eigenvalues of the four factors were above 6.65, and the total variance explained by these scales was 74.92%. Factor 1 was labeled Assessment (ASS), Factor 2 was labeled Student Centered Learning (SCL), Factor 3 was labeled Instructional Practices (IP), and Factor 4 was labeled Critical Thinking and Discussion. Table 30 displays the variables and their corresponding factor loadings.

Table 30

Factor Loadings of Classroom Instruction Scales

	Factor Loadings			
Variable	ASS	SCL	IP	CTD
Assisting students to prepare reports (e.g. project, laboratory, or research)	0.55			
Assisting students to use calculators for problem solving	0.51			
Teaching students who have limited English proficiency	0.54			
Using performance-based assessment	0.57			
Using portfolio-based assessment	0.65			
Introducing content through formal presentations	0.44			
Conducting a pre-assessment to determine what students already know	0.61			
Using assessments embedded in class activities to see if students are “getting it”	0.62			
Reviewing student homework	0.76			
Reviewing student notebooks/journals	0.80			
Reviewing student portfolios	0.81			
Facilitating students completing long-term projects	0.74			
Facilitating student presentations of their work	0.71			
Giving predominately short-answer tests (e.g., multiple choice, true/false, fill in the blank)	0.74			
Giving tests requiring open-ended responses (e.g., descriptions, explanations)	0.67			
Grading student work (e.g., open-ended, laboratory tasks) using defined criteria (e.g., a scoring rubric)	0.73			
Facilitating peer evaluations (i.e. students assessing each other)	0.68			
Considering students’ prior understanding when planning curriculum and instruction		0.64		
Providing opportunities for concrete authentic learning experiences prior to introducing abstract concepts		0.70		
Using the textbook as a supplemental resource rather than the primary instructional tool		0.59		
Providing opportunities for students to participate in cooperative learning groups		0.76		
Providing opportunities for students to participate in appropriate hands-on activities		0.73		
Providing opportunities for students to participate in inquiry-oriented activities		0.73		
Facilitating a classroom of students using investigative strategies		0.68		
Facilitating a classroom of students engaged in hands-on/project-based activities		0.71		
Assisting students to take responsibility for their own learning		0.69		
Using culturally responsive teaching strategies		0.58		

Table 30 (continued)

	Factor Loadings			
Variable	ASS	SCL	IP	CTD
Drill and practice			0.69	
Demonstrations of mathematical or scientific principles			0.75	
Learning games			0.71	
Laboratory simulations			0.79	
Collection of data using sensors or probes			0.67	
Retrieve or exchange data			0.77	
Solve problems using simulations			0.76	
Tests or quizzes			0.69	
Posing open-ended questions				0.68
Engaging the whole class in discussions				0.72
Encouraging students to supply evidence to support their claims				0.73
Encouraging students to explain concepts to one another				0.73
Encouraging students to consider alternative explanations				0.72
Allowing students to work at their own pace				0.55
Using questioning strategies to assess students' understanding as they work individually				0.57
Using questioning strategies to assess students' understanding during large group discussions				0.61
Variance	23.96	19.32	16.18	15.46
Eigenvalue	10.30	8.31	6.96	6.65

Notes. ASS = Assessment. SCL = Student centered learning. IP = Instructional practices. CTD = Critical Thinking and Discussion.

In addition, internal consistency reliability (Cronbach alpha) and inter-scale correlation coefficients (discriminant validity) of each scale were calculated. The internal consistency reliability coefficients of the three scales ranged from 0.94 to 0.97 with a satisfactory mean value of 0.96, suggesting that the four scales are reliable in measuring participants' perceptions related to classroom instruction. The inter-scale correlations ranged from 0.68 to 0.84, with an overall average of 0.77. As expected, the inter-scale correlations are high ($r > 0.65$) because most of the programs are simultaneously implementing most of these components. Table 31 presents the alpha reliability coefficients and inter-scale correlations of the scales.

Table 31

Alpha Reliability and Inter-scale Correlations of Classroom Instruction Scales

Scale	Alpha Reliability	Inter-scale correlation			
		ASS	SCL	IP	CTD
ASS	0.97		0.80	0.73	0.83
SCL	0.96			0.76	0.84
IP	0.94				0.68
CTD	0.96				

Notes. ASS = Assessment. SCL = Student centered learning. IP = Instructional practices. CTD = Critical Thinking and Discussion.

Overall, academy participants had positive perceptions in regard to the classroom instruction scales. The scale with the highest mean value was the Critical Thinking and Discussion scale (M=3.07), indicating that overall, participants felt as though the academy had prepared them fairly well to implement critical thinking and discussion strategies. The mean values for the remaining three scales were greater than or equal to 2.79. A one-way MANOVA was conducted by academy on the four classroom instruction scales. The results of the MANOVA revealed a significant difference among the academies (*Wilks' lambda*=.612, $F(13, 343)=3.30$, $p<.000$). In the follow-up MANOVA, enrollment in a specific academy was statistically significant for all four scales at the $p \leq .03$ level. The effect size of the four scales ranged from 0.07 to 0.16, indicating a very small effect of the program. All Tukey post hoc results are reported in Table 32. In general, the post hoc tests reveal that for the ASS scale, participants enrolled in Academy D felt significantly more prepared to use assessment strategies than participants in Academy A. In terms of the SCL scale, participants in Academies D felt significantly more prepared to utilize student centered learning than participants in Academies A. With regard to the IP scale, participants in Academy B, D, I, and J felt significantly more prepared to utilize a variety of instructional practices than Academy A participants. Finally, results related to the CTD scale indicate that participants in Academy C, D, E, and G felt significantly more prepared to utilize critical thinking and discussion strategies than participants in Academy A.

Table 32

One-way MANOVA on Classroom Instruction Scales

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Scale	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
ASS	2.41[b]	2.95[ab]	2.90[ab]	3.24[a]	3.08[ab]	2.70[ab]	2.77[ab]	2.80[ab]	2.92[ab]	2.78[ab]	2.72[ab]	2.85[ab]	2.46[ab]	2.55[ab]	2.79	1.90*	.07
SCL	2.37[c]	3.06[abc]	3.38[ab]	3.48[a]	3.18[ab]	2.96[abc]	3.36[ab]	3.13[ab]	3.23[ab]	3.31[ab]	3.81[abc]	3.04[abc]	2.71[bc]	2.82[ab]	3.06	4.55**	.15
IP	1.92[c]	3.03[a]	2.76[ab]	3.24[a]	2.70[abc]	2.68[abc]	2.64[abc]	2.68[abc]	3.11[a]	3.02[a]	2.57[abc]	2.92[ab]	2.16[bc]	2.55[abc]	2.79	4.80**	.16
CTD	2.53[b]	2.89[ab]	3.47[a]	3.44[a]	3.33[a]	2.89[ab]	3.30[a]	3.16[ab]	3.08[ab]	3.27[ab]	2.87[ab]	3.12[ab]	2.89[ab]	2.78[ab]	3.07	3.70**	.13

Notes. *Wilks' lambda*=.612, *F*(13, 343)=3.30, p<.000. ASS = Assessment. SCL = Student centered learning. IP = Instructional practices. CTD = Critical Thinking and Discussion.1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.
**p*<.05, ** *p*<.001.

Mathematics Participants Demographics. After completing the questions related to classroom instruction, participants were asked to answer questions related to their stated content focus (e.g., mathematics and/or science). Only those participants who indicated their content focus was mathematics answered the following questions. Of the 208 participants focused on mathematics, 32.2% indicated they majored in mathematics or mathematics education as an undergraduate. In addition, 41.8% specified they had some graduate coursework in mathematics or mathematics education and 39.9% were certified to teach mathematics. Table 33 displays the educational background for participants with a mathematics content focus.

Table 33

Participants with Mathematics Content Focus Educational Background (*n*=208)

Undergraduate major in mathematics or mathematics education	32.2%
Undergraduate minor in mathematics or mathematics education	9.6%
Some graduate coursework in mathematics or mathematics education	41.8%
Graduate-level degree in mathematics or mathematics education	9.6%
Certification to teach mathematics	39.9%
None of the above	13.5%

Note. Percentages do not add to 100, as participants were able to mark all that applied.

Academy participants were also asked to indicate how long it had been since they had completed a mathematics course for college credit. The majority (90.4%) of participants indicated they had completed a mathematics course as an academy participant. Table 34 displays participants' last mathematics course completed for college credit.

Table 34

Last Mathematics Course Completed for College Credit (*n*=208)

Completed a mathematics course as an academy participant	90.4%
Within the last 5 years	4.8%
Within the last 6-10 years	2.4%
Within the last 11-20 years	1.9%

Finally, participants with a mathematics content focus were asked whether or not they had taught one or more advanced mathematics classes in the last three years. Advanced mathematics classes included classes such as Algebra II, Trigonometry, or Calculus. Only 30.4% of participants indicated they had taught such a course.

Mathematics Instruction. Participants with a mathematics content focus were asked how well the academy had prepared them to implement a variety of mathematics instructional practices. The items were scored on a four-point Likert-type measure: *Not Adequately Prepared* (1), *Somewhat Prepared* (2), *Fairly Well Prepared* (3), and *Very Well Prepared* (4). The seven items were factor analyzed using principal component analysis with Varimax rotation and yielded one factor. The factor loadings of seven items ranged from 0.77 to 0.92, and each item had its highest loading fall in the factor. The eigenvalue of the one factor (Mathematics Instruction) was 5.31, and the total variance explained by this scale was 75.89%. Table 35 displays the variables and their corresponding factor loadings.

Table 35

Factor Loadings of Mathematics Instruction Scale

	Factor Loadings
Variable	MI
Providing in-depth coverage of fewer mathematics concepts, instead of in-depth coverage of more topics.	0.88
Developing students' conceptual understanding of mathematics.	0.92
Practicing computational skills and algorithms.	0.81
Making connections between mathematics and other disciplines.	0.89
Engaging students in mathematics applications in a variety of contexts.	0.92
Involving families in the mathematics education of their children.	0.77
Applying mathematics concepts to real and authentic life scenarios.	0.90
Variance	75.89
Eigenvalue	5.31

Note. MI = Mathematics instruction.

In addition, internal consistency reliability (Cronbach alpha) was calculated for the Mathematics Instruction scale. The internal consistency reliability coefficient of the scale was 0.94, suggesting that the scale is reliable in measuring participants' perceptions of how well the academy prepared them in mathematics instruction. Table 36 presents the alpha reliability coefficient.

Table 36

Alpha Reliability of Mathematics Instruction Scale

Scale	Alpha Reliability
MI	0.94

Note. MI = Mathematics Instruction.

As a whole, academy participants felt as though the academy fairly well prepared them to implement different types of mathematics instruction (*M*=2.91). A one-way ANOVA was conducted by academy on the Mathematics Instruction scale. The results of the ANOVA revealed a significant difference among the academies (F=1.82, $p \leq .04$). The effect size of the MI scale was 0.12, indicating a very small effect of the program. Tukey post hoc results are reported in Table 37. In general, the post hoc tests reveal that participants in Academy J felt the academy had prepared them more to implement a variety of mathematics instruction strategies into the classroom than Academy I.

Table 37

One-way ANOVA on Mathematics Instruction Scale

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Scale	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
MI	2.73^{ab}	2.63^{ab}	2.99^{ab}	3.43^{ab}	3.28^{ab}	2.83^{ab}	3.06^{ab}	3.29^{ab}	2.31^{b}	3.79^{a}	2.60^{ab}	2.90^{ab}	2.65^{ab}	2.55^{ab}	2.91	1.82*	.12

Notes. MI = Mathematics instruction. 1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.

*p<.05

Self Contained Teachers. Of the mathematics content focused participants, 18.8% indicated they currently teach or plan to teach in a self-contained classroom (i.e., teach multiple subjects to the same class of students all or most of the day). These participants were asked to indicate how qualified they felt to teach different subjects as a result of the academy. Participants indicated they felt the most qualified to teach mathematics (*M*=3.48). In contrast, participants indicated they only felt somewhat qualified to teach social studies. Table 38 displays self-contained teachers perceptions of the qualifications to teach different subjects.

Table 38

Self-contained Teachers Perceptions of Qualifications to Teach Subjects (*n*=33)

	M	*SD*
Mathematics	3.48	0.83
Physical Science	2.90	1.21
Life Science	2.71	1.22
Technology	2.71	1.10
Earth Science	2.65	1.14
Reading/Language Arts	2.65	1.25
Social Studies	2.31	1.25

Note. 1 = Not qualified; 2 = Somewhat qualified; 3 = Adequately qualified; 4 = Very well qualified.

Mathematics Topics. All mathematics content focused participants were asked to indicate how qualified they felt to teach different topics within mathematics as a result of the academy. The overall mean values for the 16 topics ranged from 2.13 for mathematical structures (e.g., vector spaces; groups, rings, fields) to 3.43 for patterns and relationships, indicating that participants felt somewhat qualified in regard to some topics and adequately qualified in others. A one-way MANOVA was conducted by academy on the 16 mathematics topics. The results of the MANOVA revealed a significant difference among the academies (*Wilks' lambda*=.166, $F(13,162)=1.42$, $p<.000$). In the follow-up MANOVA, enrollment in a specific academy was statistically significant for five of the mathematics topics (algebra, functions and pre-calculus concepts, discrete mathematics, mathematical structures, and calculus) at the $p<.05$ level. The effect sizes of the 16 topics ranged from 0.04 to 0.18, indicating a very small effect of the program. Tukey post hoc results are reported for functions and pre-calculus in Table 39. In regard to functions and pre-calculus, Academy J participants felt more qualified than Academy I participants. While a significant difference was found for the four other factors, Tukey post hoc tests did not reveal where the differences existed.

Table 39

One-way MANOVA on Mathematics Topics

	Academies																
	N	E	B	F	D	C	K	J	L	I	H	M	G	A	All		
Topic	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
Numeration & number theory	3.21	3.56	2.14	2.85	3.67	3.11	2.89	4.00	3.08	2.80	3.60	3.21	3.00	3.43	3.13	1.62	.12
Computation	3.64	3.63	3.00	3.00	3.78	3.14	3.11	3.00	3.33	2.80	3.80	3.50	3.25	3.43	3.31	1.28	.09
Estimation	3.57	3.56	3.00	3.05	3.67	3.18	3.11	3.50	3.50	3.20	3.80	3.29	3.32	3.57	3.34	0.80	.06
Measurement	3.64	3.50	3.14	3.25	3.78	3.21	3.22	3.50	3.58	3.40	3.80	3.50	3.50	3.29	3.43	0.70	.05
Pre-algebra	3.64	3.00	3.43	3.20	3.56	3.18	3.33	3.50	3.58	2.80	3.20	3.50	3.36	3.71	3.34	0.82	.06
Algebra	3.50	2.44	3.43	3.00	3.44	3.07	3.22	3.50	3.50	2.40	3.00	3.36	3.36	3.71	3.19	1.88*	.13
Patterns & relationships	3.43	3.50	3.14	3.35	3.78	3.29	3.22	3.50	3.67	3.20	3.80	3.36	3.50	3.43	3.43	0.55	.04
Geometry & spatial sense	3.50	3.63	2.57	3.10	3.78	3.25	3.33	4.00	3.42	2.80	3.60	3.21	3.39	3.29	3.33	1.19	.09
Functions & pre-calculus concepts	3.00^{ab}	1.63^{b}	3.14^{ab}	2.70^{ab}	3.11^{ab}	2.54^{ab}	2.44^{ab}	4.00^{a}	3.08^{ab}	2.00^{b}	2.60^{ab}	3.14^{ab}	3.07^{ab}	3.43^{ab}	2.77	2.91**	.19
Data collection & analysis	2.86	2.94	2.71	3.20	3.44	3.21	3.33	3.50	3.33	3.40	3.80	3.07	3.14	3.00	3.16	0.75	.06
Probability	2.86	2.81	2.43	2.90	3.67	3.07	2.89	4.00	3.50	2.80	3.60	3.00	3.11	3.00	3.05	1.29	.09
Statistics	2.43	1.94	2.29	2.55	2.89	2.57	2.11	3.50	3.08	2.40	2.40	2.79	2.50	3.14	2.55	1.34	.10
Discrete Mathematics	2.07	1.75	2.43	2.15	3.11	2.14	2.00	3.50	2.92	1.80	2.00	2.57	2.04	2.71	2.25	1.91*	.13
Mathematical structures	1.93	1.38	2.14	2.15	2.67	2.14	1.89	2.50	3.08	1.60	2.20	2.57	1.89	2.43	2.13	2.34*	.16
Calculus	2.50	1.19	2.43	2.05	2.44	1.96	1.56	2.50	3.00	1.60	2.00	2.50	2.18	2.71	2.14	2.68*	.18
Technology in mathematics	2.57	2.25	2.71	2.65	3.22	3.07	2.33	3.50	3.17	1.80	3.40	2.86	3.18	2.71	2.84	2.17	.15

Notes. *Wilks' lambda*=.166, $F(13, 162)=1.42$, $p<.000$. 1 = Not qualified; 2 = Somewhat qualified; 3 = Adequately qualified; 4 = Very well qualified.

$*p<.05$, $**\ p<.001$.

Domains of Mathematical Processing. Academy participants were also asked to indicate how prepared they felt to guide and develop student learning in six domains of mathematical processing as a result of the academy. All mean values were greater than 3.0, indicating that participants felt adequately qualified to develop student learning in mathematical domains. A one-way MANOVA was conducted by academy on the domains of mathematical processing. The results of the MANOVA revealed a significant difference among the academies (*Wilks' lambda*=.480, $F(13,186)=1.69$, $p<.000$). In the follow-up MANOVA, enrollment in a specific academy was statistically significant for two of the domains of mathematical processing (reasoning and proof and oral and written communication) at the $p<.05$ level. The effect sizes of the six domains ranged from 0.07 to 0.14, indicating a very small effect of the program. The Tukey post hoc results are reported in Table 40. In general, academy participants in Academy J and A felt more qualified in the domain of reasoning and proof than Academy B. Additionally, participants in Academy J and I felt more qualified in communication than Academy J.

Table 40

One-way MANOVA on Domains of Mathematical Processing

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Domain	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
Problem solving	3.71	2.89	3.33	3.50	3.50	2.95	3.59	3.80	3.17	4.00	3.11	3.13	3.23	3.31	3.32	1.32	.09
Reasoning and proof	3.57^{a}	2.00^{b}	3.20^{ab}	3.40^{ab}	3.13^{ab}	2.81^{ab}	3.07^{ab}	3.40^{ab}	2.83^{ab}	4.00^{a}	3.00^{ab}	3.00^{ab}	3.00^{ab}	2.63^{ab}	3.01	1.88*	.13
Communication	3.00^{ab}	2.33^{b}	3.33^{ab}	3.60^{ab}	3.31^{ab}	2.86^{ab}	3.33^{ab}	3.80^{a}	3.00^{ab}	4.00^{a}	3.11^{ab}	3.00^{ab}	3.62^{ab}	2.94^{ab}	3.19	2.12*	.14
Connections within mathematics	3.43	2.78	3.27	3.60	3.38	3.19	3.44	3.80	3.00	4.00	3.22	3.07	3.46	3.19	3.30	0.93	.07
Connections from mathematics to other disciplines	3.00	2.67	3.27	3.50	3.44	3.19	3.22	4.00	3.00	4.00	3.22	2.93	3.23	2.75	3.00	1.49	.10
Multiple representations	3.43	2.56	3.33	3.60	3.62	3.00	3.59	3.80	3.00	4.00	3.22	3.07	3.38	3.06	3.30	1.73	.12

Notes. *Wilks' lambda*=.480, *F*(13, 186)=1.69, p<.000. 1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.
**p*<.05.

Collegiality and Support. The final three questions mathematics content focused participants were asked dealt with collegiality and support from the academy. Specifically, participants were asked the following: if other teachers had a shared vision of effective mathematics instruction, if teachers in the academy regularly share ideas and materials related to mathematics, and if teachers in the academy are well supplied with materials for investigative mathematics instruction. The overall mean averages for these three items ranged from 3.24 and 3.40. A one-way MANOVA was conducted but did not yield a significant result. Overall, academy participants felt as though the teachers in the academy had a shared vision of effective mathematics. Additionally, participants indicated they shared ideas and materials related to mathematics. Finally, academy participants indicated they were well supplied with materials for investigative mathematics instruction. Table 41 displays descriptive statistics related to collegiality and support by academy.

Table 41

Perceptions of Collegiality and Support by Academy

	Academies														
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All
Topic	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Shared vision	3.29	3.22	3.43	3.80	3.35	3.14	3.50	3.80	3.17	4.00	2.67	3.53	3.50	3.06	3.36
Share ideas	3.14	3.11	3.47	3.80	3.29	3.33	3.64	3.80	2.83	4.00	2.89	3.73	3.71	2.88	3.40
Well-supplied	3.00	3.00	3.43	3.70	3.12	3.33	3.57	3.40	2.50	4.00	2.56	3.40	3.07	2.81	3.24

Notes. 1 = Strongly disagree; 2 = Disagree; 3 = Agree; 4 = Strongly Agree.

Science Participants' Demographics. The remaining items on the survey were only asked of participants who their stated content focus was science. Of the 211 participants focused on science, 53.1% indicated they majored in science or science education as an undergraduate. This is slightly higher than the mathematics content focuses participants. Similar to the responses from mathematics participants, 41.7% specified they had some graduate coursework in science or science education and 51.2% were certified to teach science. Table 42 displays the educational background for participants with a science content focus.

Table 42

Participants with Science Content Focus Educational Background (*n*=211)

Undergraduate major in science or science education	53.1%
Undergraduate minor in science or science education	13.7%
Some graduate coursework in science or science education	41.7%
Graduate-level degree in science or science education	14.2%
Certification to teach science	51.2%
None of the above	8.1%

Additionally, participants indicated the length of time since they completed a science course for college credit. The majority (74.9%) of participants indicated they had completed a science course as an academy participant. Table 43 displays participants last mathematics course completed for college credit.

Table 43
Last Science Course Completed for College Credit (*n*=211)

Completed a science course as an academy participant	74.9%
Within the last 5 years	7.1%
Within the last 6-10 years	4.7%
Within the last 11-20 years	6.6%
More than 20 years ago	2.4%
Participant chose not to answer	4.2%

Science content focused participants were also questioned about the courses they had taught in the last three years. Specifically, teachers were asked if they had taught an advanced science class such as advanced placement physics, advanced placement biology, or advanced placement chemistry. Only 24.8% of participants with a science content focus have taught one or more advanced science classes in the last three years.

Science Instruction. Participants with a science content focus were asked how well the academy had prepared in terms of science instructional practices. The items were scored on a four-point Likert-type measure: *Not Adequately Prepared* (1), *Somewhat Prepared* (2), *Fairly Well Prepared* (3), and *Very Well Prepared* (4). The six items were factor analyzed using principal component analysis with Varimax rotation and yielded one factor. The factor loadings of seven items ranged from 0.82 to 0.94, and each item had its highest loading fall in the factor. The eigenvalue of the one factor (Science Instruction) was 4.90, and the total variance explained by this scale was 81.63%. Table 44 displays the variables and their corresponding factor loadings.

Table 44

Factor Loadings for Science Instruction Scale

	Factor Loadings
Variable	SI
Providing in-depth coverage of fewer science concepts instead of in-depth coverage of more science topics.	0.88
Developing students' conceptual understanding of science.	0.93
Making connections between science and other disciplines.	0.92
Engaging students in applications of science in a variety of contexts.	0.94
Involving families in the science education of their children.	0.82
Applying science concepts to real and authentic life scenarios.	0.93
Variance	81.63
Eigenvalue	4.90

Note. SI = Science instruction.

In addition, internal consistency reliability (Cronbach alpha) was calculated for the Science Instruction scale. The internal consistency reliability coefficient of the scale was 0.95, suggesting that the scale is reliable in measuring participants' perceptions of how well the academy prepared them in terms of science instruction. Table 45 presents the alpha reliability coefficient.

Table 45
Alpha Reliability of Science Instruction Scale

Scale	Alpha Reliability
SI	0.95

Note. SI = Science Instruction.

In general, academy participants felt as though the academy prepared them fairly well to implement different types of science instruction (*M*=2.91). However, participants in Academies A, F, and M only felt somewhat prepared. A one-way ANOVA was conducted by academy on the Science Instruction scale. The results of the ANOVA revealed a significant difference among the academies (F=2.79, $p \leq .001$). The effect size of the SI scale was 0.16, indicating a small effect of the program. Tukey post hoc results are reported in Table 46. In general, the post hoc tests reveal that participants in Academies D and E felt the academy had prepared them more in terms of science instruction than participants in Academy M.

Table 46

One-way ANOVA on Science Instruction Scale

	Academies																
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	All		
Factor	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*	η_p^2
SI	2.34[ab]	3.04[ab]	3.19[ab]	3.25[a]	3.33[a]	2.09[ab]	2.83[ab]	3.11[ab]	3.02[ab]	3.07[ab]	2.70[ab]	3.00[ab]	1.75[b]	2.86[ab]	2.90	2.79*	.16

Notes. SI = Science instruction. 1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.
*p<.001.

Self Contained Teachers. Of the science content focused participants, 18.8% indicated they currently teach or plan to teach in a self-contained classroom (i.e., teach multiple subjects to the same class of students all or most of the day). These participants were asked to indicate how qualified they felt to teach different subjects as a result of the academy. Participants indicated they felt the most qualified to teach all three areas of science (life, physical and earth). In contrast, participants indicated they only felt a little more than somewhat qualified to teach social studies. Table 47 displays self-contained teachers' perceptions of the qualifications to teach different subjects.

Table 47

Self-contained Teachers Perceptions of Qualifications to Teach Subjects (*n*=38)

	M	*SD*
Life Science	3.45	0.72
Physical Science	3.39	0.72
Earth Science	3.34	0.71
Mathematics	3.24	0.91
Technology	3.08	0.82
Reading/Language Arts	2.92	1.05
Social Studies	2.55	1.13

Note. 1 = Not qualified; 2 = Somewhat qualified; 3 = Adequately qualified; 4 = Very well qualified.

Science Topics. All science content focused participants were asked to indicate how qualified they felt to teach different topics within science as a result of the academy. The overall mean values for the 22 topics ranged from 2.36 for modern physics (e.g., special relativity) to 3.25 for formulating hypotheses, drawing conclusions, and making generalizations, indicating that participants felt somewhat qualified in regard to some topics and adequately qualified in others. Of the 22 topics, teachers indicated they were either adequately qualified or more than adequately qualified in seven science topics (interactions with living things/ecology, properties and states of matter, forces and motion, energy, formulating hypotheses, drawing conclusions, and making generalizations experimental design, and describing, graphing, and analyzing data). A one-way MANOVA was conducted by academy on the 22 science topics. The results of the MANOVA did not reveal a significant difference among the academies (*Wilks' lambda*=.155, $F(13,172)=1.10$, p=.150). Table 48 displays the mean values of each science topic by academy.

Table 48

One-way MANOVA on Science Topics

	Academies														
	N	E	B	F	D	C	K	J	L	I	H	M	G	A	All
Topic	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*
Earth's features & physical processes	2.83	3.67	2.67	1.71	3.11	3.06	2.85	2.94	2.83	3.00	3.50	2.00	3.50	2.83	2.92
The solar system & the universe	2.72	3.33	3.00	1.86	3.00	3.06	2.69	2.76	3.08	2.79	3.30	2.00	4.00	2.74	2.85
Climate & weather	2.67	3.67	3.00	1.86	3.06	3.00	2.69	2.65	2.67	2.88	3.10	2.00	3.50	2.83	2.83
Structure & function of human systems	2.44	3.67	3.22	1.71	3.22	2.78	3.00	3.06	2.67	2.97	3.30	2.00	3.50	3.30	2.93
Plant biology	2.56	3.67	2.67	1.86	3.00	2.72	2.85	2.47	2.58	2.88	3.00	2.00	4.00	3.04	2.77
Animal behavior	2.67	3.67	2.89	1.86	3.11	2.83	3.00	2.47	2.75	2.97	2.90	2.00	3.50	3.00	2.82
Interactions with living things/ecology	3.00	3.67	3.33	1.71	3.22	3.00	3.00	2.94	2.92	3.18	3.30	2.00	3.50	3.35	3.06
Genetics & evolution	2.50	3.00	3.00	2.00	2.94	2.72	3.15	2.88	2.75	2.76	3.00	2.00	3.50	3.13	2.81
Structure of matter & chemical bonding	2.22	2.67	2.89	1.86	3.06	2.72	2.85	3.12	2.92	2.68	3.20	2.50	3.50	2.91	2.77
Properties & states of matter	2.78	3.67	3.22	1.86	3.28	3.00	3.23	3.12	3.33	3.09	3.50	2.50	3.00	3.04	3.07
Chemical reactions	2.44	3.33	2.67	2.00	3.17	2.72	3.00	3.00	3.00	2.71	3.40	2.50	4.00	2.96	2.84
Energy & chemical change	2.39	3.33	2.78	2.00	3.11	2.89	3.15	3.12	3.00	2.74	3.40	2.50	4.00	2.96	2.89
Forces & motion	2.67	3.67	3.22	1.86	3.11	3.06	3.08	3.00	3.42	3.15	3.60	3.00	3.00	2.78	3.04
Energy	2.61	3.67	3.22	1.86	3.22	3.11	3.00	2.94	3.25	3.09	3.60	3.00	3.50	2.87	3.03
Light & sound	2.56	3.67	3.00	1.86	3.11	3.06	2.62	2.88	3.17	2.82	3.30	3.00	2.00	2.65	2.85
Electricity & magnetism	2.44	3.67	3.00	2.00	2.89	3.00	2.62	2.53	3.08	2.71	3.40	3.00	2.00	2.48	2.74
Modern physics	1.89	1.67	2.67	1.71	2.72	2.67	2.31	2.29	2.75	2.24	2.70	3.00	2.00	2.17	2.36
Pollution, acid rain, global warming	2.89	3.00	2.89	1.86	3.22	2.83	3.00	3.18	2.67	2.85	3.60	3.00	3.50	2.96	2.93
Population, food supply & production	2.94	3.00	3.11	1.86	3.28	3.00	3.08	3.18	2.67	2.97	2.90	3.00	3.50	3.04	2.98
Formulating hypotheses, drawing conclusions, making generalizations	3.06	3.67	3.33	2.00	3.61	3.22	3.31	3.47	3.25	3.24	3.70	3.00	3.00	3.04	3.25
Experimental design	3.00	3.33	3.22	1.86	3.50	3.06	3.31	3.35	3.25	2.97	3.50	3.00	3.00	3.00	3.13
Describing, graphing, & interpreting data	3.00	3.67	3.44	2.29	3.56	3.50	3.23	3.65	3.42	3.26	3.70	3.00	2.50	3.00	3.29

Notes. *Wilks' lambda*=.155, *F*(13, 172)=1.10, p=.150. 1 = Not qualified; 2 = Somewhat qualified; 3 = Adequately qualified; 4 = Very well qualified.

Student Knowledge and Use of Science. The final set of questions science content focused participants answered were related to the amount of emphasis participants would put on different student learning objectives in their classroom after being enrolled in the academy. The items were scored on a four-point Likert-type measure: *None* (1), *Minimal Emphasis* (2), *Moderate Emphasis* (3), and *Heavy Emphasis* (4). The 10 items were factor analyzed using principal component analysis with Varimax rotation and yielded one factor. The factor loadings of 10 items ranged from 0.46 to 0.83, and each item had its highest loading fall in the factor. The eigenvalue of the one factor (Student Knowledge and Use of Science) was 6.20, and the total variance explained by this scale was 56.37%. Table 49 displays the variables and their corresponding factor loadings.

Table 49

Factor Loadings for Student Knowledge and Use of Science Scale

	Factor Loadings
Variable	SKUS
Increasing interest in science	0.79
Learning basic science concepts	0.76
Learning important scientific terms and facts of students	0.66
Learning science process/inquiry skills	0.79
Preparing for further study in science	0.75
Learning to evaluate arguments based on scientific evidence	0.82
Learning how to effectively communicate ideas in science	0.83
Learning about the applications of science in business and industry	0.73
Learning about the relationship between science, technology, and society	0.80
Learning about the history and nature of science	0.79
Preparing for standardized tests	0.46
Variance	56.37
Eigenvalue	6.20

Note. SKUS = Student knowledge and use of science.

In addition, internal consistency reliability (Cronbach alpha) was calculated for the SKUS scale. The internal consistency reliability coefficient of the scale was 0.92, suggesting that the scale is reliable in measuring the amount of emphasis participants will put on student knowledge and use of science. Table 50 presents the alpha reliability coefficient.

Table 50

Alpha reliability of Student Knowledge and Use of Science Scale

Scale	Alpha Reliability
SKUS	0.92

Note. SKUS = Student knowledge and use of science.

In general, academy participants indicated they would put between a moderate and heavy emphasis on student knowledge and use of science (*M*=3.43). A one-way ANOVA was conducted by academy on the SKUS scale. The results of the ANOVA did not reveal a significant difference among the academies (F=2.31, p>.05). Mean values for the SKUS scale by academy are displayed in Table 51.

Table 51

One-way ANOVA on Student Knowledge and Use of Science Scale

	Academies															
	N	E	B	F	D	C	K	J	L	I	H	M	G	A	All	
Factor	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*M*	*F*
SKUS	3.34	3.21	3.60	3.43	3.53	3.26	3.71	3.37	3.46	3.55	3.43	3.32	3.27	3.22	3.43	2.31

Notes. SI = Science instruction. 1 = None; 2 = Minimal emphasis; 3 = Moderate emphasis; 4 = Heavy emphasis.

Qualitative Analysis

The qualitative analysis includes (a) director and student interviews, (b) documentation from academy end-of-year status reports, and (c) open-ended response items included in the participant survey. The results are presented in mini-case studies describing activities related to content knowledge, learning academy seminars (LASs), technology, mentoring and induction, and overall challenges and strengths of each academy.

Academy A

Academy A was located in east Texas at a public, 4-year university classified as a *Master's L* institution, per the Carnegie Classification system (Carnegie Foundation for the Advancement of Teaching, 2010, "The Carnegie Classification of Institutions of Higher Education") (see Appendix D for description of Carnegie Classifications). In December of 2009, the program received a grant to fund the academy through August 2011. Originally, the academy offered initial teacher certification, master teacher certification, and a Master's degree program. The initial certification program was unsuccessful however, due to the loss of students to other campus certification programs that could cover the full cost of tuition. As a result, the directors chose to focus their resources on the master teacher certification and Master's degree programs. The program that Academy A developed for their students was a hybrid of previously existing programs. Since the university already had a Master's program for mathematics and science, as well as mathematics education and science education, the academy combined these programs to create a new program. The new program required students to take at least 24 of the 36 hours required for a Master's degree from the College of Mathematics or the College of Science, with 18 of the hours being chosen from a single discipline in that college. The remaining 12 hours consisted of six hours from mathematics or science education and six hours from secondary education.

Content Knowledge. When participants were asked which aspects of the academy increased their content knowledge, they overwhelmingly responded: the required content area courses. Many of the participants indicated the quality of instructors, hands-on/laboratory activities, and frequency of testing as specific aspects of the courses that aided their learning. One student specifically commented on the required biology course, stating that it "reminded [me] of how fascinating life science is!" Another student commented on both a proofs class and a statistics class, saying that they "created a more secure background." Finally, some students commented on how the courses in science and mathematics education taught them how to apply the content knowledge within their classrooms.

Learning Academy Seminars (LAS). According to the directors, the structure of the LASs evolved over time. Initially, the LASs covered a variety of topics, but directors indicated that this organization made the LASs seem disconnected from the rest of the academy, making it hard to create a learning community. Therefore, after the first summer of the program directors changed the design, and the next year's LASs focused on the history of science or the history of mathematics (depending on a participant's content area). The following academic year (year two), the LASs focused on mathematics and science in the present day. The directors stated that when the LASs became more connected to the academy, there was more evidence of a learning community.

Both participants and directors commented on the environment of the LASs, which allowed students to ask questions and discuss topics without being graded. Such an approach seemed to create a relaxed, no-risk environment. One participant stated, “it was more about learning and education and no direct assessment, just learning for the sake of learning.” Another participant commented, “There were no tests involved, and we were able to ask questions and learn the content in a relaxed environment . . . the informal setting actually led to more conversations, because pressure of assessment was removed.” Participants also noted that the enthusiasm of the professors leading the LASs contributed to a positive learning environment.

Finally, academy participants commented on how the LASs improved their instruction. One participant stated, “Anytime you teach something, you have to know more than the kids . . . when you know the history and the quirkiness of the scientists, you are able to throw that into your instruction, and it excites and intrigues the students.” Another participant commented that the LASs “helped her to have a better understanding of where the students are coming from and where they should be going . . . it also helped with vertical alignment.” Other participants commented that the LASs gave them more tools and techniques to use with their students, and that the use of discovery learning and modeling increased their knowledge.

Technology. When directors were asked whether or not the academy had been successful in implementing technology, they clearly stated, “Yes.” The types of technology being implemented were limited to the mathematics participants. These participants utilized a mathematics software package related to calculus, one related to statistics, and Geometer's Sketchpad.

Mentoring, Induction, and Leadership. The mentoring/induction component of Academy A consisted of a course in secondary education, focusing on mentoring and leadership. In the course, students were assigned a project where they were to mentor someone on their respective campuses (ideally, a novice teacher). In addition, students were to conduct different action research projects on their campuses. When participants were asked to comment on the mentoring/induction component, many did not associate the course with mentoring. Of those who did, their experiences were mixed. Some felt as though the course taught them how "true" mentoring looks in practice. One student indicated, "The various mentoring strategies we discussed in our education courses helped me tremendously . . . the strategies learned have been helpful this year, as I am a mentor of two new teachers on my campus." Another student indicated that the course was helpful but lacked depth. Others stated the course was not helpful at all. Finally, several participants indicated that the mentoring component of the academy could be improved. One student noted that there was "very little mentoring . . . it was more collaborating with fellow teachers." Another student commented, "I would have loved some practice with case studies, evaluating teacher lessons, or other activities to help prepare for the MST exam."

Participants did indicate the course improved their leadership skills. One student commented that the course forced the participants to take a leadership role on their campuses. In the course, they were to identify a problem on their campus and work with the administration to find a solution. One participant indicated, “As a result of the project, I have more confidence, and am comfortable in the role of leader.” Another participant indicated that the class was “eye-opening,” and commented on how “leadership is not standing up and *doing* but quietly *showing* by example or by a gentle nudge.” Finally, a participant spoke of how the academy, in general, had increased her leadership skills. She stated, “Anytime you are more confident with your content knowledge, you become a better leader in that area. You are better able to keep students engaged in class, which leads to success in the classroom. And then others want to know what you are doing to create that success.”

Overall Challenges and Strengths. Several students noted problems with communication. These students specifically cited unclear requirements and poor communication with the academy’s online components. Other students identified the mathematics and science course content as a challenge, pointing to the amount of content covered in the courses as being too much for such a short time period. Additionally, some participants indicated that the content was “too high-level” for secondary teachers. Participants also requested more pedagogy and applications for their classrooms. Specifically, many students noted their lack of preparation for the case study portion of the MST exam. These students suggested that it would be helpful to review case study examples in their education classes.

Finally, students commented on the best practices or strategies implemented in the academy. Many participants noted the variety of activities, including:

demonstrations, hands-on activities, modeling, reflective practice, collaborative group work, and performance assessments. Others commented on open-ended questioning and discussion as strengths. Lastly, both participants and directors commented on the overall cohort structure, explaining that having a small group of participants moving through the program together seemed to create a cohesive, supportive learning community.

Academy B

Academy B was located in the Rio Grande Valley at a public, 4-year university classified as a *Master's M* institution, per the Carnegie Classification system. In July 2009 the program received a grant to fund the academy. In addition to the funds provided by THECB, Academy B has a cost-sharing agreement with two local independent school districts (ISDs). The only program offered by Academy B was the initial certification program. Participants could receive their mathematics or science certification in grades 4-8 or grades 9-12 through the completion of a traditional certification program or an alternative certification program. Therefore, the majority of participants were either employed with or assigned to a school within the local partnering ISDs. Directors indicated the academy was developed from scratch and sought to integrate technology in mathematics and science. Finally, directors indicated that English was a second language for many of the participants.

Content Knowledge. The aspect of the academy that participants indicated improved their content knowledge was the LAS. Participants noted the quality of the LAS speakers and the assigned tasks as two aspects that contributed to their content knowledge. Overall, participants indicated the LASs provided opportunities for participants to collaborate with each other, which proved to be a valuable learning experience.

Learning Academy Seminars (LAS). The LASs were conducted both on campus and out-of-town. The on-campus LASs covered a variety of topics and were interdisciplinary in their approach. The structure of the LASs was an attempt to meet the needs of both mathematics and science participants. The off-campus LASs offered participants opportunities to explore the educational settings along the Texas coast and in west Texas (e.g., Texas State Aquarium, Mustang Beach, NASA, Big Bend and McDonald Observatory). Directors indicated that the LASs have established a collegial type of atmosphere in which the students work together to create a learning community. A student commented on the environment of the LASs saying, “ they’re a great learning experience . . . the room is always packed with people who want to be teachers, so everyone is motivated . . . it’s a group of people with the same goal – teaching.”

Several students noted that the incorporation of technology into the LASs has taught them more things that they can teach their own students. One student noted, “it makes the students more engaged . . . it’s more real.” While another student stated, “the things I have learned will help draw students in when I am teaching.” Additionally students commented on the variety of topics covered in the LASs such as: how to incorporate hands-on activities in classroom, alternative strategies for managing a classroom, lesson planning, and how students learn. All participants noted they felt as though they would be a more effective teacher as a result of the LASs.

Technology. The LASs also sought to infuse a variety of technology pieces including: laptop computers, external hard-drives, flash drives, global positioning systems (GPS), digital microscopes, and digital cameras. One director stated, “we wanted the participants to be able to handle a variety of technology and use it in a transparent, everyday way as if it were second-nature to them, like using a pencil.” Additionally, the directors stated their desire for the participants to not only use the technology but also integrate it into their everyday teaching. The hope was that this would be a professional development they would not likely receive in a school district.

Academy B issued each type of technology to all participants. The academy’s intention was to allow the participants to keep the technology for use in their future classrooms. At the time of the interviews, directors indicated this was not possible due to grant stipulations but were looking for an alternative solution, as this was a key incentive for participation. Despite the incorporation of many types of technology, academy directors indicated they were not able to incorporate all the technology they would have liked to support (i.e., iPads, graphic tablets, Kindles, etc.).

Mentoring, Induction, and Leadership Skills. The mentoring component of Academy B consisted of nine faculty members from the mathematics or science serving as mentors to academy participants. These mentors were allowed to come to workshops and students selected which faculty member they wanted to be paired with. Some of the individuals were mentoring multiple participants. The mentors were required to meet with the mentees at least once a semester, but were encouraged to meet more times. The academy provided meals when the mentors met with the mentees whether they met on-campus or off-campus. Academy directors indicated that during the first year, they were focused on establishing and building relationships between the mentor and mentee. In the future, academy directors will direct the mentors to discuss how to establish a classroom, find resources, and develop classroom activities.

When participants were interviewed, there was a range of responses related to the mentoring program. Some participants met with their mentor every other week while others only met once. One participant indicated that his mentor provided additional activities related the LAS topics. Another participant indicated that her mentor would spend time discussing aspects of teacher preparation and activities for her future classroom with her. Participants who were not as satisfied with their mentor stated they needed to meet more with their mentors, mentors should be from the same content area, and mentors should be knowledgeable about the program. Overall, participants indicated the most valuable aspects of the mentoring program were the ability to ask questions, collaborate with faculty members, and the ability to have a discussion related to their content area.

Finally, academy directors indicated the overall increase in student leadership skills and confidence. As a participant in the academy, students were required to work together in groups and present material. Participants noted that the requirement to present material made them more confident in the English language. Additionally, one director indicated, “their command of the language is much better . . . most of our students are still Spanish language dependent, but I’ve really seen that change with many of our academy participants.” Participants indicated that they felt as though their knowledge was greater than their colleagues' in terms of technology, working with parents and the community, and working with colleagues, allowing them to take more of a leadership role.

Overall Challenges and Strengths. Overall, the directors noted that they were not able to recruit as many students as they would have liked. Additionally, the directors indicated they understood the challenges of the mentoring program and were working to change it for the better. Participants indicated that they would like to see more activities specific to their content area that they can use in their classrooms. Additionally, participants would like to have more interdisciplinary LASs focused on a variety of topics with diverse presenters.

In general, the directors felt as though a key strength of the program was the flexibility for participants and the support from the university. In addition, the quality of instruction in the LASs and the integration of the technology were definitely strengths. Participants, on the other hand, indicated the sense of community as strength. One participant noted, that the academy "gives you experience as to what to expect as a teacher and helps me to get excited about teaching." Another participant stated, "the academy brings a community of teachers together . . . we are learning new things, we will pass on to our students." Best practices as described by the participants were the ability to share experiences with fellow participants and faculty members, the integration of technology, and the modeling of an activity, followed by student implementation.

Academy C

Academy C was located in north Texas at a public, 4-year university classified as a *DRU* institution, per the Carnegie Classification system. In spring 2009 the program received a grant to fund the academy. The academy chose to offer all three programs: (a) initial teacher certification; (b) master teacher certification; and (c) Master's of Education. The majority of participants in the academy were enrolled in the Master's of Education program and only a few were seeking their master of mathematics teacher certificate or initial certification in mathematics or science. Participants in the academy represented 17 ISDs within an 80-mile radius of the university. In addition, participants represented all grade levels (elementary, middle, and secondary), both content areas (mathematics and science), and both rural and urban areas. Directors indicated that the program was not an extension of an existing program; rather, it was created new for the grant.

Content Knowledge. The majority of the participants indicated that the academy increased their content knowledge through one of the following activities: (a) Japanese Lesson Study; (b) problem-based learning; (c) collaboration with other mathematics and science teachers; or (d) content courses The Japanese Lesson Study project allowed the participants to work together on developing lesson plans that were observed, analyzed and revised in order to improve student thinking and lesson effectiveness. In regard to problem-based learning, one participant commented, "We came up with the problem, worked on, considered, created solutions, and discussed with the whole group our findings . . . it put us in the position of the learner and the teacher at the same time, awesome experience." Another student noted, "Multiple class projects have increased my awareness of projects in my own classroom." Finally, a student commented, "Working with other math teachers, allowed me to discuss subject matter to increase my content knowledge."

Learning Academy Seminars (LAS). All the participants interviewed indicated the LASs had improved their instruction. One participant specifically commented on the ability to collaborate with other teachers, particularly with regard to technology. She stated, "Some people are more well versed than others, so they teach the others." Another participant noted, "[The LAS] continues to open my eyes in terms of alternative ways of teaching."

Participants and directors both commented on how the LASs created a learning community and that this was the biggest strength of the LASs. A participant commented, "Absolutely . . . The professional learning community is what it's all about, the sharing of ideas." Another participant noted, "I have met so many people in so many districts . . . I have their emails, they have lessons, we communicate, we've built friendships . . . I have a list of people I can call on for help and advice, a network of math and science teachers." Additionally, a participant commented, "One person cannot think of everything, so the more people you have talking about things, it just opens your eyes to lots of aspects." One director indicated the participants support each other as friends as well as colleagues and learners. She noted, "This group has really pulled together as a community of learners." In addition, the director noted, "The participants will say 'I saw you do this, can you help me with that?'" Finally, the only negative comment about the

LASs was related to the online component. A student noted, "It was hard to get focused . . . Seemed like we wasted a lot of time at first, we did get better as we went on, but that was probably my least favorite part."

Technology. In terms of technology integration, the directors held conflicting opinions. A director commented, "We are still working on that aspect . . . We did more this summer than in the academic year." The other director stated, "We haven't had any LASs where technology hasn't been present in some form or fashion." The grant purchased Netbooks (e.g., mini laptops) and flip-video cameras for each participant in the academy. The director stated these items were utilized to "do classroom vignettes, quick video tapes of their kids, video tapes of student learning, and [participants] then brought them to class and use as a springboard for discussion on evaluating student learning." The academy also utilized online instruction for chats, discussions, and the sharing of projects. When looking toward the future, directors stated that participants would start sharing technology knowledge in mini-lessons on a monthly basis.

Mentoring, Induction, and Leadership Skills. In terms of mentoring, the directors indicated that they do not officially have a mentoring component. The directors stated they had discussed what it means to be a mentor in previous LASs and were going to be discussing it more in the future. When the participants were asked about the mentoring component, many referred to mentoring they received from the directors of the academy, but indicated they had not been involved in any kind of formal mentoring activities.

In terms of leadership skills, the directors indicated one of their overarching goals was to create teacher leaders. One way in which the directors were trying to increase leadership skills was encouraging their participants to attend conferences such as, Conference for the Advancement of Mathematics Teaching (CAMT) and Conference for the Advancement of Science Teaching (CAST). Specifically, a director noted that he had seen some of the participants take the next step in becoming a leader in their profession. Additionally, a participant commented, "The more educated you get, the better leadership you display . . . People start looking to you for direction and asking 'What should we do?' in certain circumstances." Another participants stated, "[The academy] sort of forces me to take leadership roles in the seminars in a way that is good for me, because I have anxiety."

Overall Challenges and Strengths. A challenge that was noted by both directors and participants was the coordination of schedules to meet all participants' needs. Some participants travel up to 80 miles to attend the academy; therefore, they struggle with coordinating all aspects of their life (e.g., family, work, etc.), while participating in the academy. In addition, some of these participants noted it was hard for them to make evening classes on time. Another challenge noted by a director was the diversity in the academy with regard to grade level taught and content area. The other director described the diversity as a strength of the program. Participants indicated this was, in fact, a challenge and this was reflected in their suggestions for academy improvements. Many participants suggested that the science and mathematics programs be separated. The science participants also suggested more science content courses instead of education courses. Finally, a majority of participants indicated they would like more technology integration in the academy.

Overall, the majority of participants were satisfied with the academy. Many noted the collaboration and networking with other teachers and faculty members as a strength of the program. Additionally, the participants indicated that the provided funding enabled them to continue their education. Directors noted that the flexibility provided to the students in terms of what courses they could take was a definite strength. Not all students were required to take the same courses, enabling the academy to meet the needs of all participants. Finally, participants indicated the following as best practices: problem-based learning, the Japanese Lesson Study, collaborative learning, the use of questioning, and the integration of technology.

Academy D

Academy D was located on the southern Texas Gulf Coast at a public 4-year university classified as a *Master's L* institution per the Carnegie Classification system. The academy received funding in January 2009 but did not start with the first cohort until the summer of 2009. The academy chose to offer two programs, initial teacher certification and Master's of Education. The initial teacher certification enabled participants to pursue both certification and a Master's of Education degree simultaneously through an alternative certification program (Master and Certification program [MAC]). The initial certification students were middle or secondary certification in mathematics or science. The participants in the Master's of Education program represented all grade levels of mathematics and science and taught at eight local high need districts. The academy was able fund five classes for each participant, accounting for 15 of the 36 hours required for a master's degree. Directors indicated that the academy relied on courses already established at the university as well as creating new courses and incorporating the LASs.

Content Knowledge. Overall, the majority of participants indicated the academy had improved their content knowledge through one or more of the following activities: field trips throughout the Coastal Bend, the integration of technology, research activities, and collaborative learning. The field trips were part of a course required of participants, wherein they explored the areas surrounding their teaching location. Participants were provided tools for exploring the environment (e.g., seining nets, rain gauges, wind meters, etc.), instructed on the proper use of the tools, and how to effectively incorporate them into their lessons. The academy also utilized the LASs to focus on how to effectively incorporate technology into their teaching. Finally, the academy required students to take an action research course in which they selected a teaching strategy to introduce into a mathematics or science classroom and determine its effect on student learning. Academy participants were expected to present the results of their studies at the ME by the SEa Mathematics and Science Education Conference.

Learning Academy Seminars (LAS)/Technology. Directors indicated the LASs, or what they refer to as "Technology Saturday Seminars," mainly focused on technology and how to effectively incorporate it into their instruction. Specifically, the academy tried to focus on free software available to teachers and students such as: podcasts, vodcasts, WIKI pages, blogging and moviemakers. The LASs were organized in such a way that students were assigned a task to complete prior to attending the seminar and then, as a group, they would build on what they had already created. After the seminar the participants were encouraged to incorporate what they had learned or created in their classrooms. Finally, the academy chose to purchase several items (VEDO cameras, headsets, TI NSpire calculators, USB memory devices, etc.) for each participant in order to encourage the integration of technology.

The directors also indicated that the LASs created a learning community. One director noted, “The students stay after to talk to each other and share ideas.” A participant stated, “[LASs] helped us get together and talk about how they were really incorporating ideas into the classroom.” Another participant noted, “[LAS] builds a supportive network.” In addition to creating a learning community, all participants indicated the LASs improved their instruction, as well as increasing their content knowledge. A participant noted, “[LASs] opened my eyes to what I can do with my students.” Another student noted, “Each seminar you pick up skills and are able talk to peers about how you approach different situations.” Additionally, a participant stated, “If anything else, the [LASs] have shown me what is out there, as opposed to the original methods that I have been using.” Finally, the participants commented that the regular meetings, collegiality, and technology instruction were the most helpful aspects of the LASs.

Mentoring, Induction, and Leadership Skills. The mentoring component of the academy is an area that the directors stated they were “working on”. With the first cohort of students, directors assigned participants to one of three experienced or “master” teachers. The participants were supposed to visit their mentors in the classroom. The inservice teachers enrolled in the academy all had more than five years of experience and directors indicated they were not interested in having a mentor assigned to them, or even open to working with a mentor. However, one of the master's program participants indicated that the master teachers provided strong resources and valuable feedback on her lessons. The initial certification participants, on the other hand, had a positive experience. They visited their supervising teacher and helped with field trips to the wetlands.

A couple of the initial certification students were in their capstone course during the first year of the program; so, they were paired with master's program students to help with the research required for the course. The initial certification participants and the master's program students who were paired together indicated the collaboration was extremely beneficial. One master's program student noted, "Usually students from the MAC program have new ideas." Additionally, the participant stated, "We worked on research projects together which was extremely helpful." Another master's program student noted, " I was kind of jealous I wasn't paired with a MAC student . . . the MAC students' specialty was research and I would have liked to have that experience." Due to the success of pairing initial certification students with master's program students, directors plan to organize the mentoring component in this fashion for the second cohort.

In terms of leadership skills, the directors indicated that the academy forces the students to develop these skills. A director noted that the students have "all talked about how they have become school leaders, especially in terms of technology." Additionally, directors indicated that students were expected to present at the ME by the SEa conference. A participant indicated that, through presentations in front of the academy and at ME by the SEa, she has gained confidence in her ability and as a result has sought out more leadership roles on her campus. Other participants also indicated that, through building their confidence, they have developed better leadership skills.

Overall Challenges and Strengths. A definite challenge stated by the directors was the mentoring component in the first year. Additionally, directors felt as though they did not communicate effectively the commitment participants were making when they joined the academy. In the first year of the program, some students did not attend the LASs as often as directors would have liked. In the future, directors intend to communicate to participants that they are committing to attending seminars and actively participating before joining the academy. A challenge stated by both directors and participants was the action research course. Participants stated that the course was "crazy". The action research course was completed in 10 days and participants were expected to create a three-chapter proposal and present it. While participants liked the content of the course, too much information was packed into a short amount of time. A final challenge noted by the participants was the amount of time required for all the academy activities.

Both the participants and directors indicated that the funding was a definite strength of the academy. One director noted, "The funding encourages the students to pursue a master's degree without having to accrue so much debt." Participants agreed and indicated they would not have been able to participate in such a program without the financial support. Additionally, directors and students noted collegiality as a strength of the academy. A participant noted, “The main strength is the community building or support system . . . You take a lot of classes and see each other all the time, and you feel comfortable asking each other questions and sharing ideas.” Finally, participants indicated the following as best practices utilized by the academy: hands-on activities, a research-oriented structure, modeling, collaborative learning, and technology integration.

Academy E

Academy E was located in central Texas at a public, 4-year university classified as a *Master’s L* institution, per the Carnegie Classification system. The academy received notice of funding in late July 2009 and was expected to have students enrolled for Fall 2009. The director indicated that due to the late notice, the academy felt rushed to get students enrolled and processed at the university. The academy chose to offer two programs, master teacher certification and Master’s of Education; therefore, all participants were inservice teachers. At the time of the interviews, all the participants were enrolled in both programs; however, the director indicated that some participants might not take the master teacher certification exam due to nervousness about passing. The director hoped that after participants reviewed practice exams, attended extra tutorials, and focused on their weakest areas, they would agree to the take the exam. In addition, the academy chose to focus exclusively on elementary mathematics. Finally, the director indicated the program was brand new and was created to fill a gap. In graduate courses the director taught, she noticed students were lacking pedagogy and content in the area of mathematics. Therefore, the director sought to create a program that would serve these needs.

Content Knowledge. Participants in Academy E identified several activities that contributed to increasing their content knowledge. Several participants indicated collaboration with other teachers led to increased content knowledge. One participant stated, “The sharing of ideas, successes, and concerns within the mathematics discipline in reference to tools and resources was wonderful.” The mathematics coursework required by the academy was another component participants felt was particularly beneficial. A participant noted, “The math coursework, itself, has proven most beneficial to increasing my content knowledge.” Finally, participants indicated the reading material selected by the director increased their content knowledge.

Learning Academy Seminars (LAS). Academy E conducted the LASs jointly with another MSTTP academy established at their institution. The joint LASs were conducted on campus during the school day. For those who could not attend, the seminars were videotaped and posted online. As LASs were a requirement of the academy, participants who did not attend were expected to view the LAS and respond to questions on an online discussion board. The partnering MSTTP academy primarily served participants focused on middle and secondary grades; therefore, the director of Academy E indicated the LAS material “was a little over their heads, and that my students needs are not always met.” Additionally, she indicated that the students felt as though the LASs were a waste of time and suggested in the future, Academy E conduct their LASs separate from the other MSTPP academy.

When the participants were asked about the LASs, their sentiments reflected the directors. One participant commented, “I feel a little separate from that . . . The LASs are really for those in the other academy and they are not completely relevant or related to what we are doing because it is for middle and high school.” Another participant stated, “[LASs] didn’t create a learning community because they were all online . . . They occurred during the workdays so we didn’t get to participate and we just watched them online and then posted written responses in the forums after watching them.” Another participant comment expanded on the online responses stating, “The answers to the questions are all the same because the questions are not open-ended and [the forum] doesn’t provide opportunities for discussion among peers.” When a participant was asked about the impact of the LASs on her instruction, she stated, “There was very little to get out of it . . . I get more out of my little group that meets to share ideas and materials.” Additionally, the participant noted, “I don’t really like them at all . . . We do it because we have to do it.” While almost all the participants were dissatisfied with the LASs, several did state that the LASs were informative but not relevant to their current situation.

Technology. Technology integration into elementary mathematics was a primary focus of the academy. The director stated, “I try to bring in as much of the 21st century skills as I can, such as problem based learning, and inquiry skills.” The director indicated that the teachers in the academy have made interdisciplinary problem-based instructional units built around a mathematical theme for three of their core mathematics classes. For each of the units, the incorporation of two pieces of technology was mandatory.

Therefore, the units showcased their innovative use of technology. Types of technology the academy has introduced include: Geogebra, Tinkerpolts, graphing calculators, interactive websites, and iPads.

Mentoring, Induction, and Leadership Skills. In regard to mentoring, Academy E assigned supervisors (individuals who were experienced mentors) to observe the participants. However, the director indicated that the majority of academy participants were experienced teachers, so the supervisors assisted the participants in becoming stronger leaders on their respective campuses. In order to accomplish this goal, the director utilized the Principles and Indicators for Mathematics Education (PRIME) Leaders framework. One participant elaborated on the framework stating, "[It] literally teaches you how to mentor, including how to do objective observations, how to support new teachers, and how to build relationships with new teachers." However, the participant indicated, "It was an affirmation of what I already knew." Another participant noted, "As a result, I have really examined my own practice a whole lot more than before specifically my math understanding . . . It also made me aware of how people work in different ways."

With the PRIME framework as a guide, participants developed action plans focused on individual goals and increasing their leadership potential. The director indicated that this activity was essential in developing their leadership skills. Additionally, all the participants indicated they had increased their leadership skills through their experience with the academy and the PRIME framework. One participant indicated, "After we took the PRIME leadership course, I am more confident to bring ideas back to my campus." Another participant stated, "I think at this point, I have a better understanding of mathematics, what good mathematics instruction looks like, and I am able to lead teachers in discussions about math and help them prepare for the students."

Overall Challenges and Strengths. Overall the biggest challenge stated by the participants was the irrelevant nature of the LASs. The participants indicated their desire to have LASs that are applicable to their grade level. Additionally, participants stated an area of improvement would be communication regarding expectations and requirements. The director stated this was an area on which she was working. She hoped that as the academy moved forward, the "kinks" would be worked out. Finally, several participants indicated the workload and finding time to complete all the activities was a challenge. As all the participants in the academy were full time teachers, they often stated it was hard to find a balance with everything going on in their lives.

Overall, participants were satisfied with their experience in the academy. Some of the strengths stated by the participants included: professors, instruction, materials, incorporation of technology, and collaboration. In addition, participants enjoyed the collegiality of the academy and expressed how this environment contributed to their understanding of the concepts. In terms of best practices demonstrated by the academy, participants noted the following: hands-on activities, collaborative learning, discussion, manipulative use, modeling, and incorporation of technology.

Academy F

Academy F was located in central Texas at a public, 4-year university classified as a *Master's L* institution, per the Carnegie Classification system. The academy actually received funding during the first cycle of MSTTP academy awards in the fall of 2008. A year later, it received more funding through Cycle 2. An extension of the Cycle 2 funding was granted in fall 2010, and if no more extensions are awarded, the funding will be exhausted in the summer of 2011. The academy chose to offer all three programs: initial teacher certification, master teacher certification, and a master's program. In the initial certification program, the academy had a mix of undergraduate and graduate students. The majority of students enrolled were seeking a 4-8 math/science composite certification. The participants enrolled in the master teacher certification program and master's program were working towards completing a Master's of Mathematics Education, as well as preparing for the master mathematics teacher exam. The academy is an extension of two previously awarded grants, a Teacher Quality grant and a Fund for the Improvement of Postsecondary Education (FIPSE) grant. The FIPSE grant provided funds to restructure and develop courses that correlate mathematics and science. For an individual to participate in the academy, they must have taken one of these courses. The funds from the MSSTP academy helped to fund the participants, in addition to providing support for the academy. Finally, a primary focus of the academy was to integrate mathematics and science. Participants were expected to understand and develop correlated mathematics and science lessons.

Content Knowledge. Academy participants indicated three main activities that increased their content knowledge: (a) LASs; (b) correlated courses; and (c) collaborative learning. One participant noted that the LASs introduced, as well as provided an understanding of new math topics. Another participant commented, "Group work has allowed me to ask questions and hear other member's point of views." Finally, several participants listed specific math classes that increased their content knowledge.

Learning Academy Seminars (LAS). The LASs were held every other Friday during the school day. For those who could not attend, the seminars were videotaped and posted online. As LASs were a requirement of the academy, participants who did not attend were expected to view the LAS and respond to questions on an online discussion board. The academy jointly conducted the LASs with another MSTTP academy that was primarily focused on elementary mathematics. The seminars covered a variety of material including technology, College and Career Readiness Standards (CCRS), various mathematical topics, and student diversity. The last seminar of each semester was held on Saturdays so that all participants could attend. During this seminar, participants from both academies presented group projects.

Both directors indicated that the LASs created a learning community. The response from the participants was mixed. The undergraduate students who regularly attended the LASs felt as though they did create a learning environment. However, the graduate participants, who frequently could not attend, disagreed. One participant noted, "Graduate students that are at home online, don't get as much out of them, but the times they meet in class helps." Additionally the participant stated, "The 2 week session on campus creates more of a learning community."

Most of the participants felt as though the information provided in the LASs improved their instruction. One participant stated, "It gave me a more conceptual basis for what I was teaching in Algebra, which in turn helped me to explain it to my students." Another commented, "The content is good." Some specific topics that participants found helpful were mentoring, leadership, cultural diversity, and professional learning communities.

Several of the participants commented that some of the LASs were irrelevant. One participant commented, "In the last year, there have been about five where I was just watching the clock go by . . . These were the ones specifically geared towards science, graduate students, or elementary school." Also, a graduate participant noted, "I appreciate the opportunity to reflect about the LASs, but I do not get responses to my online posts . . . I would like to have my questions answered and some comments made on my reflection." Finally, many of the participants noted problems with the videotaping. One participant commented, "You can't hear the questions being asked." Another participant noted, "They had some audio problems, and if you were not physically in the room, you couldn't hear what was going on."

Technology. Technology was incorporated throughout many aspects of the academy. First, directors indicated that the correlated courses required for academy participants had technology imbedded in them. Additionally, the LASs have a strong technology emphasis according to the directors. The correlated lessons the participants develop must also include technology. The types of technology the academy participants have been exposed to include: TI Nspire, SMART Boards, Fathom, and Geometer's Sketchpad. One director indicated that, in the future, they would like to incorporate more advanced types of technology such as computer-aided design (CAD) software.

Mentoring, Induction, and Leadership Skills. Originally, the academy organized the mentoring component so that faculty members were mentoring doctoral students and doctoral students were mentoring academy participants. The directors reorganized the structure so faculty members were directly mentoring a group of academy participants. Participants worked in groups to complete one activity from a list of activities for both the fall and spring semesters. The academy required participants to complete a mentoring/field-based experience during the academic year. During the fall semester, groups completed one of the seven following activities: (a) created a correlated lesson in chemistry and five STEM gems; (b) observed at least three correlated lesson in a specified school district; (c) attended the SSMA conference in Reno, Nevada; (d) attended the CAST conference in Galveston, Texas; (e) created an investigational game; (f) charted your "math story" from grade school to the present; or (g) completed an individual research project. In the spring semester, participants chose one of four activities to complete: (a) 4x4 course exploration; (b) develop a lesson plan; (c) complete and administrator interview; or (d) develop an induction survey. During the summer, participants either attended four sessions at a local mathematics conference or viewed four seminars on College and Career Readiness Standards. In regard to the activities, one participant noted, "it would be nice to choose your own topic so that you have more of a say in the process." Another participant noted distance as a problem stating, "Not always being in the same place is difficult . . . Especially if all the people involved in the mentor group are spread out, it is hard to get everyone together." Additionally, undergraduate participants stated that since the graduate student participants are not always on campus, it was difficult to find time to meet and complete the activities.

When the undergraduate participants were asked about mentoring activities, almost all spoke about the informal mentoring of undergraduates by graduate students. One undergraduate participant stated, "We watched what [graduate students] did and then learned from them in terms of the correlated lesson plans." Additionally, she noted, "When we were with the graduate students, it was a lot of one on one and they helped me and gave me ideas on how to do correlated lesson plan . . . It helped me in the future." Another undergraduate stated, "I liked working with the graduate students more than the professors because the professors are more removed." Additionally, the participant commented, " I would like to have more face-to-face time with the graduate students so I could learn more . . . Maybe during the year, put a seminar on a Saturday so we could interact more instead of online."

In regard to leadership, the majority of participants indicated the academy had increased their skills. One participant noted, "Until I got involved in this program, I saw myself as a teacher in my classroom doing what I needed to do for my students . . . Through this program, I realized that if I involve other teachers I will become better teacher, as well as helping other teachers improve." Another participant commented, "As a participant in the academy, you have access to the latest research and experts in their fields, which helps to build your confidence." Additionally, the participant noted that with increased confidence, she felt more inclined to lead in other classes outside of the academy.

Overall Challenges and Strengths. One aspect of the academy that participants noted as an area that could be improved was the integration of mathematics and science. The participants indicated that the majority of the focus was on mathematics and they expressed a desire to see mathematics and science integrated at a deeper level. Another area for improvement as indicated by the participants, is LASs. Participants indicated that some of the LASs were repetitive and they would like more variety. Some participants indicated they would like to see more variety in the professors that teach the correlated courses. In addition, some participants felt as though some professors associated with the program were unapproachable. Finally, students enjoyed the flexibility afforded by the online components but indicated more face-to-face time would be beneficial.

A definite strength of the academy noted by participants was the use of cooperative learning. The participants felt as though this provided valuable learning opportunities. Additionally, the undergraduate participants felt as though the academy provided more opportunities to interact with inservice teachers. The undergraduate participants stated this aspect of the academy made them feel as though they were more prepared than others who were pursuing certification. Also, the directors and participants noted the emphasis on state and national standards as a strength. In terms of best practices demonstrated by the academy, participants noted the following: incorporation of technology, infusion of state and national standards, collaboration, hands-on activities, and the use of manipulatives.

Academy G

Academy G was located in the Dallas-Fort Worth Metroplex at a public, 4-year university classified as a *RU/H* institution, per the Carnegie Classification system. The academy received funding in August 2009 to support two programs, the initial certification program and a master's program. The academy represented a partnership between the university and two local school districts. Directors indicated that the academy was a "really nice way to bring together programs they already had and unite graduate and undergraduate students." The director also noted, "The primary thing the academy is supporting is the coursework . . . Most of the money goes towards tuition for courses."

During the first year, the academy essentially operated three separate programs. First, participants in the initial certification program were undergraduates seeking mid-level certification in mathematics and science. Within the master's program, there were two separate tracks. Secondary mathematics participants in the academy would earn 24 credit hours towards a Master of Arts in Mathematics, while K-8 mathematics teachers earned 18 credit hours towards a Master of Education. Each of the three programs conducted separate LASs during the first year. The directors indicated that during the second year, all participants would attend the LASs together.

Content Knowledge. Most participants identified coursework as the primary aspect of the academy that increased their content knowledge. Specifically, participants identified two courses, non-Euclidean geometry and pre-calculus. In addition to coursework, participants attributed increased content knowledge to class discussions, peer interactions, and collaboration. Finally, some participants commented on how the use of technology had increased their content knowledge.

Learning Academy Seminars (LAS). As previously stated, the LASs for each program were conducted separately. The LASs for the initial certification participants were held biweekly and coordinated with student observations of their mentor teachers. Mentor teachers also committed to attending the LASs so, they could provide insight to vertical connections and classroom practice. The participants were to observe their mentor teacher's classroom and write a reflection. Then, in the LASs, participants and mentor teachers discussed the different experiences. The director indicated that the coordinator for the initial certification program was "amazing". The coordinator was a previous graduate of the K-8 program at the university and an instructional facilitator in Arlington. The structure of the LASs allowed the participants to openly discuss and reflect on their experiences. The director of the program indicated that the creation of a learning community was evident when the participants had organized themselves to go the CAMT conference without any probing from her.

According to the director, the LASs coordinator for the secondary mathematics participants misgauged where the teachers were in terms of content and pedagogy. The director also commented on how dissatisfied the participants were with the LASs presented by the original coordinator. The coordinator eventually left the program and the director took over the instruction for the LASs. The LASs were then held directly after a course required for academy participants. Topics covered in the LASs included content, pedagogy, and teacher dispositions. However, the primary focus of the LASs was content remediation. When participants were asked about the LASs, it was hard for them to differentiate between the course and LASs. They weren't sure if the LASs had created a learning environment or the courses themselves. The director shared this sentiment. One participant noted, "It felt like an extension of class . . . when we had someone else teaching us it separated it in my mind." These participants felt as though the courses and the LASs improved their instruction by strengthening their content. A participant stated, "I mimicked what I saw in class/LASs and did those things in my own classroom."

The K-8 participants were all employed as mathematics coaches in a local school district, which allowed participants to attend courses during the workday at the district professional development center. As a result, the LASs were held immediately after class and primarily served as a time for participants to catch up on assignments. When these participants were asked about their experience with the LASs, the majority did not know what they were. After some explaining, one participant commented, "Sometimes we don't stay for the extra hour . . . If I do, I use the time to catch up on readings or grading papers."

Technology. Directors indicated that technology had been incorporated into all academy coursework. Additionally, directors emphasized the need for participants to understand how technology supports instructional objectives in a meaningful way. During courses, participants were required to develop lessons that effectively incorporated technology. Additionally, participants teaching secondary mathematics were required to take a course specifically focused on mathematics pedagogy and technology. The directors noted that during classroom visits, they observed the teachers using technology in their classrooms. This was cited as evidence of the impact of instruction participants are receiving on technology. The types of technology participants were receiving instruction on included calculators, Geometer's Sketchpad, and Promethean Interactive Whiteboards.

Mentoring, Induction, and Leadership Skills. When the directors were asked about the mentoring, they indicated only the initial certification participants were involved in formal mentoring activities. The initial certification participants were paired with inservice teachers who were graduates of the K-8 program at the university. Each inservice teacher was paired with two academy participants. The academy participants visited their mentor's classrooms before attending LASs. One participant commented, "I loved meeting with my mentor teacher . . . She is very innovative in her teaching style and very hands-on with her students." Another participant noted, "Being mentored by a middle school teacher allowed me to experience and see various teaching strategies."

Two math coaches working at one of the local school districts informally mentored the K-8 academy participants. These individuals had already taken the coursework required by the academy; therefore, they used their experiences to guide the academy participants. One participant commented, “Students who completed the program provided assistance when needed.”

When directors were asked whether the academy had increased participants’ leadership skills, they said yes for all three programs. In regard to the initial certification program, the director stated that when the academy participants are compared to the other students at the university, they stand out as leaders. The director also stated the academy has helped the K-8 and secondary participants establish their math knowledge, making them more confident in sharing their knowledge with teachers in their district. One participant stated, “The academy has gotten me more comfortable with the curriculum, studying student thinking, and studying the classroom environment . . . This has made me a better math coach.” Another participant noted, “A deeper understanding of content has provided me confidence in showing teachers instructional strategies.”

Overall Challenges and Strengths. The biggest challenge academy participants encountered was time. The participants noted it was sometimes difficult to balance all the responsibilities of the academy with their home and work life. Additionally, participants stated that the summer courses were not long enough to fully comprehend the topics. A participant noted that 3.5 weeks was not long enough to unpack all the information. Finally, a director stated the organization of the LASs for the secondary participants needed improvement.

The biggest strengths of the academy as identified by the participants were the curriculum and the professors. In addition, many of the students commented that collaboration with peers was another strength. The participants also commented on several best practices utilized by the academy. Specifically, participants indicated they had implemented the questioning strategies modeled by the professors in their classrooms. Other strategies included cooperative learning, investigations, discovery learning, hands-on activities, and modeling.

Academy H

Academy H was located in the Dallas-Fort Worth Metroplex at a public, 4-year university classified as a *RU/H* institution, per the Carnegie Classification system. The academy received notice of funding in the summer of 2009 and started its first cohort of students in the fall of 2009. The academy offered two of the three programs, initial certification and Master of Education in Science Education. The initial certification program was for mid-level (4-8) or secondary, mathematics or science; the master's program was for individuals in mid-level or secondary science. For participants in the initial certification program, the academy covered the cost of tuition for five courses required for certification. The initial certification program was a program that was previously established at the university. The master's program brought together the College of Science and the College of Education and was newly created for the academy. Over the course of the funding period, the academy was able to admit two cohorts of 22 master's degree program participants. In regard to the master's program, a director noted, "We would like to offer the program without funding for the participants, but I don't think that the teachers would pay for it . . . The funding allows us to bring in cohorts of teachers and provide support for the students."

Content Knowledge. Participants in Academy H identified several activities that contributed to an increase in their content knowledge. Several participants indicated collaboration with their peers led to increased content knowledge. In addition, participants commented on the knowledgeable professors associated with the academy. Participants also attributed an increase in content knowledge to the rigorous coursework. Specifically, participants noted the use of inquiry, lab activities, and cooperative learning as beneficial. Several participants noted they increased their content knowledge by working through real-world problems with peers.

Learning Academy Seminars (LAS). The LASs were held every 2 weeks, 1 hour prior to one of the master's program courses. The directors noted that several of the LASs were used for recitation and review of coursework. Additionally, directors indicated that the LASs were primarily lecture-based. Speakers from outside the academy led the remaining LASs. If the LASs generated a lively discussion, the directors allowed the LASs to run overtime. A participant commented, "In one of the LASs, the professor cancelled class and we stayed in there for four hours talking about classroom management, different ways to reach kids, how to capture students interest, and focusing student learning." Additionally, a director noted, "The students continue to talk about it even after class."

In terms instruction, the directors and a majority of the participants indicated the LASs had a positive impact. A director noted, "Some LAS speakers have made the students really change the way that they teach." A participant commented, "The ideas they give you, its not a lesson or a lesson plan . . . It is a little activity that captures [students] interest and then from there you can develop the lesson because they are more interested. Another participant noted, “Some of the topics gave more insight into students’ thinking and classroom management.”

Several participants commented that they especially liked that the LASs were scheduled an hour before class. One student stated, “It is really easy to fit into my schedule since I have to be here anyways.” Participants also commented on the relaxed nature of the LASs. The director commented, “[LASs] have a very friendly, open environment.” Finally, when asked whether LASs had created a learning community, directors were unsure. The directors felt as though the cohort nature of the program actually established a learning community among the participants.

Technology. The directors of the academy indicated they could be doing a better job of incorporating technology. One director referred to the use of web-based courses when asked about the integration of technology. Another director noted, “Individual instructors all work with the master’s program participants . . . These participants bring their strategies for incorporating technology into the classroom.” Finally, a director noted, “We are more focused on hands-on and inquiry activities, than technology.”

Mentoring, Induction, and Leadership Skills. When the directors were asked about the mentoring and induction components of the academy, the directors provided contradictory answers. One director stated, “The initial certification students have the names of content mentors they can email and if we can, we try to connect student teachers with a teacher in the graduate program”. The other director noted the academy was not really doing any of these activities. Finally, when an initial certification participant was asked what types of mentoring activities she had been involved in as a part of the academy, she simply replied, “None.”

When questioned whether the academy increased participants leadership skills, a director stated, “Absolutely . . . One of the first things we discuss is teacher leadership.” Additionally the director noted, “It is an expectation that participants will change things on their campus.” Directors stated that through the process of becoming involved in professional organizations, publishing, and researching, participants gained valuable leadership skills. One participant commented, “I feel stronger in a sense . . . My peers are looking towards me to change the way they teach and to help them.” Another noted, “The academy gave me information in my content area which has increased my confidence . . . This has led to better classroom management.”

Overall Challenges and Strengths. A challenge stated by several of the participants was the time frame to complete classes. Participants indicated the summer courses were 3 weeks long and they did not feel as though this was long enough to learn some of the material presented. Additionally, participants indicated the desire to have more instruction on teaching strategies and pedagogy. The participants were extremely satisfied with the subject specific content and only indicated the desire to supplement it with more pedagogy. Other participants also noted a desire for more technology integration.

A major weakness of the academy was the lack of attention to the initial certification students, specifically, those participants focused on mathematics. The majority of the program is focused on the master’s program participants and science and little attention is paid to mathematics. A mathematics initial certification participant noted “I feel like I’m in the wrong program . . . I have asked several times about it, but they always say it’s ok.” Additionally, the participant stated, “The biggest benefit to me is the tuition money . . . Other than that, I really haven’t gotten anything out of the academy.” The participant also stated that she had not attended any of the LASs, as they never pertain to mathematics.

A key strength as identified by the participants was the content preparation. One participant noted, “The coursework provided a more in-depth understanding which improved my classroom instruction.” Two additional strengths identified by the participants were collaboration and collegiality. The participants felt as though the academy provided an environment where teachers could work and learn together. Additionally, participants stated the directors were flexible and ensured students needs were met. Participants indicated they felt as though the directors were invested in ensuring in the success of all academy participants. The participants also indicated the financial incentives provided afforded the participants the ability to pursue advanced coursework. Finally, participants identified the following as the academy’s best strategies: cooperative learning, discussion, inquiry, modeling, and the use of the learning cycle method.

Academy I

Academy I was located in the Rio Grande Valley at a public, 4-year university classified as a *Master’s M* institution, per the Carnegie Classification system. The academy received funding in August 2009. Prior to the fall semester, principals and school administrators from the eleven partnering school districts assisted in choosing participants for the academy. However, due to delays, the participants did not start coursework until January 2010. All of the participants chosen for the academy were science inservice teachers from all grade levels.

The academy chose to offer two of three programs for participants, master teacher certification and a master's program. Directors noted both programs were established specifically for the grant. To complete the master teacher certification program, participants completed four education courses. Participants in the Master's of Education program completed 12 credit hours of science content and 24 credit hours of education coursework. The directors noted that several of the individuals who were enrolled in the master teacher certification program already had master's degrees.

Content Knowledge. Academy participants indicated three main activities that increased their content knowledge: (a) LASs; (b) content related coursework; and (c) collaborative learning. One participant noted, "My science content knowledge has increased due to the learning seminars and some of the graduate classes that we have been enrolled in . . . The learning seminars discussed topics in physics, animal behavior, ecology, and biology." Another participant stated, "Each of my science-related courses have helped me increase my science content knowledge." In addition, a participant stated, "The collaboration of ideas and resources among my classmates has helped increase my content knowledge." Finally, the majority of participants felt as though the academy had contributed to significant gains in content knowledge.

Learning Academy Seminars (LAS). The structure of the LASs for the academy differed slightly from other academies. During the spring and fall semesters, the academy hosted five, 3 hour LASs for a total of 15 hours. The academy, also, hosted 10 hours of LASs during the summer. Due to the vast area the academy served, the LASs were held at different locations each time. The directors attempted to schedule the academies on a specific participant's campus. The participants indicated they genuinely enjoyed being able to see different schools and their colleagues' classrooms.

When asked whether the LASs created a learning environment, a director indicated LASs were a contributing factor to the master's program learning community and only a minor factor for the master teacher certification program. The director indicated that the master's program students had already started to establish relationships from coursework they were enrolled in; so, the LASs provided a relaxed environment where a learning community could be established. The master teacher certification cohort, on the other hand, had not started classes; therefore, the participants were more hesitant to talk openly. A participant noted, "We all happen to be in different schools, so we're sharing ideas about what resources are out there." Another noted, "We share our problems . . . Everyone has a different viewpoint to contribute." In terms of instruction, the majority of participants noted the LASs contributed to improvements. A participant noted, "We've learned different strategies, and I've actually implemented them." Another commented, "It seems like the directors try to plan things that fit our needs at the time."

Finally, participants were asked to comment on the strength and weakness of the LASs. One participant noted, “A strength is that it brings teachers of all grade levels together.” Additionally, a participant noted, “Different aspects . . . I’ve been doing this for 21 years, but I’ve learned a lot of tricks.” Another participant commented, “The collaboration that they are able to do with other professionals has been a big eye opener for us.” Several participants also stated the emphasis placed on the Texas Essential Knowledge and Skills (TEKS) has helped them to understand exactly what the students need to know. Finally, the majority of weaknesses participants commented on were technical issues. However, one participant did state, “Sometimes, it seems like the group might be too large or too many in the group.”

Technology. When directors were asked about technology integration, they provided contradictory answers. One director noted, “We haven’t integrated too much technology.” While the other director indicated, “We have purchased laptop computers for all students . . . We will be using Camtasia to develop lessons.” The director also noted, the academy had used Wikis, Skype, and audio books. However, he did note that they had been more focused on science content, as this had shown to be a weakness of academy participants.

Mentoring, Induction, and Leadership Skills. In regard to mentoring, one director noted that the academy had provided some initial training on mentoring. In addition, the directors asked participants to mentor other participants in their courses. One participant noted, “We are learning how to mentor teachers at our campus, and then we are expected to come back and discuss with the group.” She also noted, “The academy places an emphasis on becoming a science teacher leader." Another participant noted, "We have had different workshops discussing ways in which I can mentor other teachers." A participant also stated, "These activities have guided me in being more assertive in dealing with the teachers I mentor." Finally, a participant offered a suggestion, "Maybe a little more direction as far as what to do . . . Things that force you to expand on other ways of mentoring."

The director also noted that the academy has been successful at increasing participants' leadership skills. He stated, "Their comfort in science content knowledge continues to increase their leadership skills." Participants' comments supported this sentiment. One participant noted, "It's given me a little more confidence when I speak to my colleagues about different strategies." Another commented, "Definitely."

Overall Challenges and Strengths. The main challenge participants spoke of was finding a balance in their lives. All of the participants in the academy were full-time teachers who had responsibilities associated with school and their life in general. One participant stated, "It is sometimes hard to find time to get everything done." While most participants were genuinely satisfied with their experience, several did offer suggestions for improvement. Several participants acknowledged the academy provided a great deal of science content; however, they still wanted more. Specifically, some participants indicated they would like the academy to offer more grade-level specific content. In addition, participants suggested the academy incorporate more pedagogical knowledge. Other suggestions included, more incorporation of technology, incorporation of some math content, and even more time for collaboration.

Two of the main strengths of the academy, as stated by the participants, were collaboration and collegiality. Participants felt as though the time they spent with fellow teachers increased their content knowledge and improved their instruction. Other participants commented on open-ended questioning and discussion as strengths. Finally, students commented on the best practices or strategies implemented in the academy. Many participants noted the variety of activities, including: demonstrations, hands-on activities, modeling, collaborative group work, and scaffolding.

Academy J

Academy J was located in the Dallas-Fort Worth Metroplex at a public, 4-year university classified as a *RU/H* institution, per the Carnegie Classification system. The academy received funding in July 2009 and enrolled the first group of students in August 2009. Directors indicated that they had to rush to get participants enrolled, but university rules stipulated a grant could not start until the money is received. In addition, directors stated that the program was an extension of the existing Master of Arts program at the university; however, the bi-weekly LASs were new.

The grant funds an initial certification program as well as a masters's program. The initial certification program utilizes the UTeach model. Participants in this program were seeking certification in middle school or secondary mathematics or science. The master's program allowed current inservice teachers to pursue a Master of Arts in Teaching in Science Education or in Mathematics Education. The inservice teachers taught mathematics or science in grades K-12.

Content Knowledge. Overall the majority of participants indicated the academy had improved their content knowledge. The two main activities participants cited as having improved improving their content knowledge were content courses and collaboration. One participant noted, “The core courses deepened my knowledge of mathematics.” Another participant commented, “Just being able to talk to teachers in the field now and see their concerns so I can have a plan for when I get into the classroom.” Additionally, a participant commented, “The collaboration with other physics teachers from different schools and different school districts improved my content knowledge.”

Learning Academy Seminars (LAS). The bi-weekly LASs exposed the participants to a wide range of content, teaching, and policy issues in STEM education. Directors indicated that LASs were conducted regularly; however, adjustments to the schedule were made to accommodate both the initial certification participants and master’s program participants. According to both directors and participants, the LASs established a learning community. A director commented, “[The LASs] provided a time where everybody’s together . . . They develop connections, friendships, collaboration, and networking,” A participant commented, “I have really gotten to know a lot of people . . . Even at work, I would think of things mentioned in seminar and would email my classmate for advice and ideas . . . They became a resource for ideas outside my classroom and district.” Another participant noted, “Absolutely . . . What’s really cool is we are all different ages and subjects . . . It’s given me contacts outside my district.”

The majority of participants also indicated the LASs improved their classroom instruction. A participant stated, “Absolutely . . . I feel so good about what I’m doing . . .

I feel so confident." Another participant noted, "When you're on the cutting edge of science, bringing current events back into the classroom, it keeps the kids involved in things that pique their interest and engages them." Another participant noted, "The research I've been involved in, I'm going to be adding to my chemistry curriculum.

In terms of the most beneficial aspect of the LASs, the participants agreed that the mathematics and science connections presented were the most beneficial aspect of the LASs. One participant commented, "The science and math connections . . . It has motivated me to go to the math department and learn the connections between the two fields." Another participant stated, "It is helpful to have math and science combined, because they tell us where they see holes are with what we are teaching." In terms of the least beneficial aspect, the participants' response varied. One participant noted, "Sometimes the information is too far off . . . I can't use it or it's too above my students' abilities." While another participant stated, "The LASs that are very subject specific and the presenter does not allow time for discussion are less productive." Finally, a participant commented, "Sometimes they are not as thoroughly planned as I would like, but that depends which seminar and who is presenting."

Technology. During the interviews, directors offered differing opinions on the academy's integration of technology. A director stated, "We haven't done that much of it, but we've recently received new equipment as a part of the UTeach program and will start working with that this year." While another director stated, "Technology is embedded in the curriculum." The director commented about the inclusion of online courses for the academy as well as the incorporation of electronic literature searching and bibliography developing. Additionally, the director described an educational technology course in which the master's program participants could enroll.

Both directors commented that they were slowly starting to integrate Probe and PASCO equipment. Additionally, the directors mentioned that they let inservice teacher participants borrow the equipment for their classes. A final comment from the directors was, "The participants are sometimes way ahead of where the university is on technology stuff they can use in their classrooms." While the academy indicated this type of technology use, there was little evidence to demonstrate the academy was modeling how to utilize technology in the participants' classrooms.

Mentoring, Induction, and Leadership Skills. Academy J did not have a defined formal mentoring program. The directors indicated there was only an informal mentoring of the initial certification students by the master's program participants. During the LASs, the initial certification participants would work with the master's program participants to problem solve classroom issues or look for strategies related to topics discussed at the time.

The director also indicated the master's program participants would be mentored by experienced senior level science and mathematics individuals who serve as coordinators or department heads at their schools. This aspect of the academy was implemented in the summer of 2010. These individuals were chosen as mentors because they were in positions to which the participants aspire. The director also indicated this would be a good learning experience for the participants, as they will likely be called on to be future leaders in their schools.

The participants were asked to comment on the strengths and weaknesses of the informal mentoring activities. One inservice teacher participant commented, “It just really helps me as a teacher to go back and re-evaluate some of the things I do, as well as be able to see what’s new out there . . . It’s nice to hear what’s coming up from people who are still in the university.” Additionally, the participant stated, “The only weakness is we don’t get to do it enough.” Another participant noted, “One-on-one discussions with new and preservice teachers helped to put my experience into a new perspective.”

Directors were also asked about the impact of the academy on participants’ leadership skills. The director noted, “We haven’t really focused on that, but next year we are doing a specific optional mentoring course.” Despite a lack of focus on leadership skills, participant indicated the academy as a whole had increased their leadership skills. A participant noted, “I do . . . Not only discussing concepts with peer teachers, but also working with UTeach students opens the door to leadership opportunities that might not be available at your school.” Another participant commented, “Absolutely . . . That’s one reason I received the department chair position recently . . . My principal told me she not only appreciated what I was implementing in my classroom, but sharing with other teachers as well.” Finally, a participant stated, “It’s given me more confidence to speak up professionally . . . I definitely want to share what I’ve learned with my department chair and my colleagues.”

Overall Challenges and Strengths. Definite challenges stated by directors and participants were time and finding a balance in life. A director commented, “I would like to spend more time with them in the academy . . . It’s hard for the teachers to find time .

. . We are supposed to have everybody through in 2 years, but sometimes real life interferes, so it's hard for participants to keep the pace." A participant stated, "Just balancing work and school . . . Giving them what they want and still being able to perform your duties as a teacher, a wife, a mother." An additional challenge stated by the director was being able to meet the needs of all the participants.

Participants also offered some suggestions for improving the academy. The participants commented that the content courses were valuable; however, there needs to be more diversity in the selection of courses. Several participants indicated there was a limited selection of courses each semester and sometimes the courses did not cover topics of interest. Additionally, participants noted that they would like more content courses to be offered in the evening instead of during the day. Finally, a participant suggested more structure with the mentoring program. The participant stated, "I would like to have a student to mentor one-on-one."

Both the participants and directors indicated collaboration and collegiality were strengths of the academy. One director noted, "The sense of community teachers have developed is one of our biggest strengths." A participant noted, "I would say the biggest strength was the sense of community among the participants . . . The environment is fair, safe, and equitable for all ideas." Additionally, directors and students noted the connection between initial certification participants and graduate participants was a strength. A participant noted, "I think the integration of different subjects and teachers of different experience levels, including the preservice teachers, is a big strength." Other strengths of the academy directors and participants noted were the content courses and the integration of mathematics and science. Finally, participants indicated the following as best practices utilized by the academy: hands-on activities, modeling, demonstrations, problem-based learning, and collaboration.

Academy K

Academy K was located on the far western border of Texas at a public, 4-year university classified as a *RU/H* institution, per the Carnegie Classification system. The academy was funded in June 2009 and directors indicated student enrollment for the fall semester was a challenge due to the short period of time allowed. The academy chose to offer two of the three programs (master teacher certification and a master's program) for mathematics, science, and technology. The director noted that all aspects of the academy were established for the grant. The mathematics and science participants were all middle or secondary inservice teachers; while some of the participants focused on technology were from elementary grades. The director indicated the elementary level participants taught in computer labs on their respective campuses.

While most of the academies had partnering ISDs, one of Academy K's partnering ISDs was providing more support than any other district. The director of professional development from the district indicated the district intends to help sustain the academy even after funding has ended. Through the grant, the district was allotted 13 slots for teachers; however, the district chose to fully fund an additional 20 slots. The district provided nearly $1,200 to cover tuition and books for each additional student each semester. The director of professional development stated, "We spend almost

$24,000 a semester for all of our students." He also indicated that in the past the district has had some input on the undergraduate teacher preparation program and now, with the academy, they are getting more input on the graduate programs. Finally, he indicated that the teachers who complete the academy and receive their master teacher certification would receive a stipend from the district comparable to the stipend of a head football coach in their district.

Content Knowledge. Overall, the majority of participants indicated the academy had improved their content knowledge through one or more of the following activities: content instruction, workshops (LASs), hands-on activities, questioning, the incorporation of technology, and collaborative learning. The content courses offered through the academy covered topics such as: research-based practices in mathematics classrooms, science tools, technology, safety and ethics, algebra content in feminist/multicultural contexts, and inquiry in science education in bilingual settings. One participant commented on the coursework noting, "The classes that we have taken have benefited my knowledge and development. Additionally a participant commented on the workshops stating, "The hands-on workshops have provided a great deal of information." In terms of incorporating technology, on participant stated, "This semester I am getting a lot of hands on technology instruction that is infiltrating my classroom." Finally, several participants commented on the collaboration with their peers and the effect on their content knowledge.

Learning Academy Seminars (LAS). The academy originally planned to provide 40 Saturday learning academy workshops (LASs) that emphasized interdisciplinary content, problem-based learning, technology fluency, and strategies for working with special needs students, especially second-language leaners. Directors indicated that they try to align the content of the workshops with the master teacher standards for all areas. During the first year of the program, the academy only offered 14 full-day workshops, six less than intended. The director noted attendance at workshops averaged 30 participants.

When asked whether the academy created a learning community, directors indicated it was helping to create it. One director stated, “It brings together all the math, science, and technology teachers . . . They all bring all different perspectives and go beyond just their area to really integrating all the areas.” The director also noted, “It is important for the content of the workshops to be deep and meaningful . . . It is important that the teachers are actively participating and going beyond their expertise and opening their minds.” Another director noted, “We are trying to build relationships among participants to where they know each other as [academy] participants and not from this district or that district.” Interviews with participants also revealed that the workshops had helped to create a learning community. One participant stated, “We work together as a group.” Another participant stated, “All the participants are constantly helping each other out.”

The strengths and weaknesses of the workshops, as stated by the participants, depended on their content area. If the participant was focused on science, they typically stated everything that was science based (e.g., labs) was the most helpful and anything mathematics based was the least helpful. The opposite was true for mathematics participants. A participant stated, "Having to sit through the math and technology components is the least helpful aspect . . . But I understand why they have to do it that way." Another student stated, "The new ideas I have for my math courses was the most helpful . . . However, the science lectures were the least helpful." In terms of improving instruction, participants were unsure. One participant noted, "I don't know where I will be able to put all of it yet within my classes." Another participant commented, "They are getting a lot of higher level but [the academy] needs to scale it down to what is actually happening in the classroom." Two other students specifically commented their instruction has been improved by the incorporation of technology.

Technology. Incorporation of technology was a key part of Academy K. Directors provided each participant with a jump drive with over 16 open source software applications for the participants to incorporate in their instruction. These programs included the following, among others: Audacity, Camtasia, and GIMP. A specific activity that included technology dealt with the British Petroleum (BP) oil spill in the Gulf of Mexico. The participants were instructed how to use graphics software to calculate the true area affected by the spill. Several participants commented they felt more confident incorporating technology in their classrooms after working through problems and experimenting with it as a member of the academy. Additionally, many of the participants commented on how the use of technology had increased their content knowledge. A participant commented, "Hands-on learning of different open source software increased my content knowledge." Another participant stated, "Using free software programs to design lessons based upon my [grade level] curriculum (TEKS) has forced me to stretch my awareness of content."

Mentoring, Induction, and Leadership Skills. The mentoring aspect of the academy included formal coursework in mentoring and leadership. The director stated that participants in all strands (mathematics, science, and technology) would complete the course. The course was developed with a local alternative certification program and would be conducted online. The director stated a large percentage of the course would be theory related. The idea behind the course was that participants enrolled in the course would mentor induction year teachers either in the partnering school districts or those associated with the alternative certification program. In the fall of 2010, only the science participants enrolled in the class. This course served as a pilot. The science students provided some comments on the course in the online survey. One student noted, "Working in a collaborative group with my peers to address the needs of the mentee was great . . . The online resources we were provided were good too." Another noted, "The online aspect of the class was new to me . . . We were encouraged to help other students with their projects, so this meant we were constantly emailing, reviewing projects of other students online, and participating in Blackboard discussion chains to help solve problems." The mathematics and technology participants were to enroll in the course during Spring 2011.

In regard to leadership, the directors and participants indicated the academy had increased their skills. Directors indicated that leadership had not been explicitly addressed; instead it was a part of their continuous activities. One director stated, "It is a part of our ethos . . . We are trying to show them how to be leaders on their campus." The director stated that participants are being exposed to peer coaching, cognitive coaching, and other leadership activities to improve their skills. Another director commented on the participants presenting their research at conferences. The director stated, "I had to push them a little to apply . . . Now that they were accepted, they realize there is value in what they are doing and see themselves more as mentors and leaders." Participants also commented that being accepted to conferences, such as CAST, has given them more confidence to share their knowledge. One participant stated, "I'm more willing to share what I'm learning with my colleagues."

Overall Challenges and Strengths. The biggest challenge stated by both participants and directors was the academy's ability to meet the needs of all participants. One director commented, "The biggest weakness is the range of people involved . . . How do we reach all the participants and give them something they can take away?" A participant commented, "There is a great focus on high school teaching with some middle school discussion . . . Elementary is very difficult and should not be overlooked." Several other participants stated their desire to have content knowledge specifically for their grade level. Another concern the participants expressed was related to the master teacher certification exam. One participant noted, "Some of the classes have not been effective as far as preparing us for the Master Math Teacher test." Other participants also stated, time was an issue. The participants indicated it was hard to find a balance between the academy and their other responsibilities.

Overall, participants were satisfied with their experience in the academy. Some of the strengths stated by the participants included: professors, incorporation of technology, and collaboration. In addition, participants enjoyed the collegiality of the academy and expressed how this environment contributed to their understanding of the concepts. The directors also noted the support provided by a local school district as a strength. Directors commented, that participants felt as though the district valued the academy. In terms of best practices demonstrated by the academy, participants noted the following: hands-on activities, collaborative learning, modeling, scaffolding, problem-based learning, modeling, and incorporation of technology.

Academy L

Academy L was located on the far western border of Texas at a public, 4-year university classified as a *RU/H* institution, per the Carnegie Classification system. The academy actually received funding during the first cycle of MSTTP academy awards in the fall of 2008. A year later, it received more funding through Cycle 2. An extension of the Cycle 2 funding was granted in fall 2010 and, if no more extensions are awarded, the funding will be exhausted in the summer of 2011. The academy chose to offer all three programs: initial teacher certification, master teacher certification, and a master's program. The academy was established as a part of the grant; however, it is based on the successes of a similar privately funded program.

Initial certification participants in the program were focused on teaching high school or middle school mathematics or science in the surrounding area. In order to be considered for the program, individuals were nominated by a university faculty member or university advisor. Upon acceptance to the program, initial certification participants committed to being members of a learning community, which met every 2 weeks for 3 hours during the academic year and for a one-week intensive program in the summer. The participants were expected to collaborate with current mathematics and science secondary teachers and university faculty and staff and to develop cross-disciplinary lesson plans supported by technology.

Master's program participants were current high school mathematics and science teachers in the surrounding area with at least 2 years of experience. Districts or principals nominated all individuals accepted to the program. The master's program participants assumed the same responsibilities as the initial certification participants with the exception of an additional role. Master's program participants were also required to help determine the scope and sequence of the academy to better support teaching in mathematics and/or science. Those in the master's program had the option of only committing to the learning community or committing to the learning community while pursuing a Master of Arts in teaching mathematics or science. If a participant chose to complete their master's, they received an additional financial stipend and were allowed to complete one or two additional courses per semester.

Content Knowledge. Participants in Academy L identified several activities that contributed to increasing their content knowledge. Several participants indicated the cross-disciplinary nature of the academy led to increased content knowledge. One participant stated, "Group projects that involved incorporating mathematic and science in each lesson increased my content knowledge." The collaboration between initial certification participants and master's program participants was another component participants felt was particularly beneficial. A participant noted, "Sharing knowledge among other teachers greatly increased my content knowledge." Finally, participants indicated the use of hands-on activities increased their content knowledge.

Learning Academy Seminars (LAS). The LASs were the major component of the academy. They were held every other week on Wednesday night for three hours for all initial certification participants and master's program participants. The LASs were also open to other university program participants. During the LASs, academy participants were expected to collaborate with university faculty and staff and to develop cross-disciplinary lesson plans supported by technology. The purpose of activities was to allow the participants to learn from one another. One director noted, "The seminars were incredibly effective . . . We are going to institutionalize them."

Both directors and participants agreed the LASs established a learning community. One participant noted, "Teachers have met and worked collaboratively across schools and districts." Another participant stated, "It is a very collaborative environment . . . It allows me to get resources from other teachers in other districts."

Additionally, the majority of participants indicated the LASs had improved their instruction. One participant commented, "Working with other teachers helps you with ideas and suggestions that make a difference." Another participant stated, "I learned how to incorporate science in my classroom."

Participants also described the most beneficial and the least beneficial aspects of the LASs. The majority of participants stated the collaboration and integration of mathematics and science were the most beneficial. The least beneficial aspects included problems with scheduling, usefulness of lessons, level of technology expertise.

Technology. During the interviews, directors discussed the types of technology integrated into the academy. A director stated, “We use Wiki’s to share lesson plans and information . . . We also use PowerPoint.” Additionally, another director noted, “The inservice teachers are not as comfortable with the technology.” Furthermore, a faculty member associated with the academy stated, “It was not the biggest part of the academy.” While the academy indicated they were integrating technology, there was no evidence to demonstrate the academy was modeling how to utilize technology in the participants’ classrooms.

Mentoring, Induction, and Leadership Skills. Academy L did not have a defined mentoring/induction program. The directors indicated there was only informal mentoring of the initial certification students by the master’s program participants. During the LASs, the initial certification participants would work with the master’s program participants to develop lesson plans. However, one participant noted, “Undergraduates stick to themselves and teachers from the same school want to stick together.” The participant also noted difficulties working with the inservice teachers because “the time constraints were greater for the teachers than the undergraduates.”

In terms of leadership skills, the directors indicated that the academy has helped to increase these skills in our participants. A director noted, “Many are becoming master teachers, writing curriculum for their district, or moving into leadership positions in their district." Additionally, directors indicated that students were expected to present their lesson plans to the group. A participant indicated that, through presentations in front of the academy, she has gained confidence. Other participants also indicated that they have improved their ability to work with others and improved their ability to explain and delegate to others.

Overall Challenges and Strengths. When asked about challenges, the directors stated a few. The first challenge the directors faced was recruiting participants for the academy. The directors noted that they could not get potential participants to see the value in attending. Another challenge was coming up with lesson plans that are unique and integrate both mathematics and science. The participants and directors both stated that time was a challenge. Directors noted, it is hard for the participants, inservice teachers especially, to commit to spending every other Wednesday night at a LAS. Additionally, it is hard to find times that accommodate all the participants schedules. Two suggestions the participants offered were using online sessions and incorporating more technology.

Two of the main strengths of the academy, as stated by the participants, were collaboration and integration of mathematics and science. Participants felt as though the sharing of ideas between preservice and inservice teachers with varied grade levels, content areas, and districts improved content knowledge their instruction. Other participants noted the use of problem-based learning and the creation of integrated lesson plans as strengths of the academy. Finally, students commented on the best practices or strategies implemented in the academy. Many participants noted a variety of activities, including: guest speakers, hands-on activities, collaboration, problem-based learning, and integration of mathematics and science.

Academy M

Academy M was located in the Rio Grande Valley at a public, 4-year university classified as a *Master's L* institution, per the Carnegie Classification system. In July 2009, Academy M received funding to support an initial certification program and a master's degree program. The programs were focused on middle and secondary mathematics or science (specifically, physics and chemistry) participants. Directors indicated the programs were established new as a part of the MSSTP Academy grant.

Master's program participants focused on chemistry were seeking a Master of Science in Interdisciplinary Studies focused on Chemical Education. The program required participants to complete 18 hours of graduate chemistry coursework, which would enable participants to teach dual credit courses. The academy offered a similar degree for those focused on physics, a Master of Science in Interdisciplinary Studies in Physics Education. Participants focused on mathematics were seeking a Master of Science in Mathematics Teaching, which also included 18 hours of graduate coursework in mathematics. While the degree is a non-thesis option, academy participants are required to complete an action research project prior to graduation.

The master's program was substantially larger than the initial certification program. Directors indicated it was difficult to recruit undergraduate preservice teachers to the program. The directors believed that undergraduate students at their university did not understand the difference between financial aid and a grant scholarship. In addition, directors stated that the majority of undergraduate preservice teachers would stay within a 75 mile radius teaching at a high-needs school, which would qualify them for loan forgiveness. Within the master's program, more participants focused on mathematics were enrolled than science. Directors indicated that most of the science teachers in the area were either teaching science (chemistry or physics) out of field or did not meet the minimum requirements of content preparation for the graduate coursework associated with the academy.

Content Knowledge. The majority of participants stated that the content courses were central to increasing their content knowledge. One participant noted, "Taking higher level mathematics courses has helped bring to light the abstract concepts behind much of the topics that I teach." Another participant stated, "The mathematics courses have been relevant and the math seminars have helped me understand the underlying concepts." Additionally, a participant commented, "The pure math courses that were offered provided me with deeper content knowledge." Other participants commented that action research projects and other projects had contributed to increasing their content knowledge. Finally, participants stated that discussion among peers led to further increases in content knowledge.

Learning Academy Seminars (LAS). The LASs were typically held every other Saturday for three hours in the spring and fall semesters. During the LASs, academy participants were engaged in various hands-on activities geared at improving participants' teaching and research skills. LASs consisted of five interrelated modules, which were integrated as partial requirements for education courses and content-specific research courses. The modules covered the following topics: effective research-based teaching techniques in mathematics and science, assessing student learning outcomes in mathematics and science classrooms, planning action research in mathematics and science classrooms, implementation of action research, and dissemination of action research plans.

According to the directors and participants, the LASs created a learning community among the participants. One director stated, "There is a lot of interaction among the teachers and when they present their own work, other teachers can comment and collaborate . . . They see that they aren't the only ones that are having problems." Another director commented, "They see what their peers are capable of doing and then they share what they know with each other." Additionally, a participant noted, "We have developed relationships and give each other advice."

Participants also expressed how their work on action research projects had influenced their classroom instruction. One participant noted, "The action research project made me look for literature on ways to learn . . . I'm already implementing parts of it and seeing results." Another participant commented, "The action research project gets me thinking about how I teach and how I am going to change what I am doing." Overall, the participants indicated the LASs provided new strategies and techniques that would improve their instruction. However, one participant noted that while some of the strategies worked theoretically, they did not work practically. Participants also stated the strategies and action research project were the most beneficial aspects of the LASs.

Technology. During the interviews, directors stated they felt as though the academy had been successful in integrating technology. A director stated, “All students were trained on using electronic databases for literature reviews and we are training them on constructing dynamic PowerPoint presentations and utilizing SPSS for data analysis.” Additionally, he stated, “We provided each student with a book and software for another data analysis program, Minitab . . . We have also done concept mapping with Cmap and Inspiration.” The other director commented about the use of Blackboard for the whole program and the creation of smaller online learning communities. While the academy indicated this type of technology use, there was little evidence to demonstrate the academy was modeling how to utilize technology in the participants’ classrooms.

Mentoring, Induction, and Leadership Skills. The mentoring component of the academy differed depending on the program. In regard to the initial certification participants, an academy director and a master’s program participant served as mentors. In addition, the initial certification participants observed in the graduate program participants’ classrooms. In regard to the master’s program participants, faculty members associated with the academy served as their mentors.

The master’s program participants stated the guidance provided by the faculty members was the key strength of the mentoring program. One participant noted, “The faculty members give us more direction on our action research projects.” Another participate commented, “They give us good guidance as far as research and keep us on track with our coursework." The participants did note the amount of time required for the mentoring activities as a weakness. One participant stated, "We have our jobs and the coursework and it is a lot; but that is just part of the program."

Finally, both directors and participants felt as though the academy had improved the participant's leadership skills. A director noted, "The students are seeing themselves as role models for other teachers at their schools." A participant commented, "[Academy directors] expect us to transfer what we are doing back to our campuses and become leaders in the action research world." Another participant stated, "I talk with teachers in the academy and that makes me more confident to talk to other teachers about what I am doing with my action research project." In general, the participants felt as though the academy increased their confidence in their content area and empowered them to become leaders on their campuses.

Overall Challenges and Strengths. A definite challenge stated by the participants was the time commitment for the academy. Participants indicated it was difficult to find a balance between the requirements of the academy and other responsibilities. Additionally, participants indicated the need for clearer expectations for the requirements of the academy. Several participants noted that they were unaware of the time commitment when they originally applied for the academy. Participants also indicated the need for more technology integration. Finally, the majority of participants stated the action research project needed a more streamlined process. Many of the participants felt as though the process was confusing and hard to grasp. Participants suggested the directors set clear expectations and provide a guide for what is to be accomplished with the action research projects.

Overall, the majority of participants were satisfied with the academy. Many noted the collaboration and networking with other teachers and faculty members as a strength of the program. Additionally, the participants indicated the action research project was a strength of the program, despite any confusion associated with it. Several participants indicated it was a good learning opportunity. Other strengths the participants named included the mentoring activities and the faculty associated with the program. Finally, participants indicated the following as best practices: reflective practice, modeling, the use of manipulatives, and inquiry-based lessons.

Academy N

Academy N was located in east Texas at a public, 4-year university classified as a *Master's L* institution, per the Carnegie Classification system. In the fall of 2009, Academy N received funding to offer two programs, initial teacher certification and a master's degree program. Participants in the initial teacher certification program were focused on mathematics or science and planned on teaching at grades four through 12. The initial certification program was modeled after the UTeach program at the University of Texas. The master's program participants were seeking a Master's in Curriculum and Instruction with an emphasis in mathematics, science, or STEM. The participants in the master's program were current inservice mathematics or science teachers at all grade levels. The academy built upon an existing master's program;

however, directors changed the core requirements of the previous master's degree plan. The new requirements of the master's degree included a minimum of 18 hours of content coursework; which enabled participants to teach at the community college level.

Content Knowledge. The majority of the participants indicated that the academy had increased their content knowledge through one of the following activities: (a) problem-based learning; (b) collaboration with other mathematics and science teachers; and/or (c) content courses. In regard to problem-based learning, one participant commented, "We did field work this summer that allowed us to have a hands-on experience to translate into a lesson a plan." Another student noted, "The graduate level math classes expanded my content knowledge . . . I can see more connections." Finally, a student commented, "Working with other math teachers, allowed me to discuss subject matter to increase my content knowledge."

Learning Academy Seminars (LAS). Directors indicated the LASs (Inquiry groups) provided a venue for participants to engage in common study to enrich their subject knowledge and teaching skills. The LASs were held twice a month with one meeting on campus and the other taking place online via a social networking site, Ning. Directors chose to conduct one of the monthly LASs online because some participants lived up to 2.5 hours from the university.

During the 2009-2010 academic year, only the master's program participants attended the LASs. The LASs focused on how to restructure secondary science and mathematics to better engage students. In addition, participants explored critical issues in STEM learning and planned and implemented responsive research projects to STEM issues in their schools. Finally, participants began developing a portfolio of instructional strategies during the LASs with an expected completion data of summer 2011. Directors indicated the initial certification participants would start attending the LASs in the fall 2010 to begin to make connections with the master's program students.

In regard to whether the LASs created a learning community, the directors and participants indicated the LASs in conjunction with the classes created a community of learners. A director noted, "The LASs are starting to build that community in conjunction with the classes." Another director stated, "They form a community within the greater rural community . . . The participants talk about how they can use what they are learning in the classes they teach." Finally, a participant noted, "Definitely . . . The group that's come together for the program helps one another a lot."

Overall, participants indicated the LASs had improved their instruction. A participant noted, "In the spring, the research methods revealed more in depth ways to explain things to my students . . . The summer provided more in depth ideas of how to teach biology in the field." Another student commented, "I have more access to resources and more awareness of what is out there for my classroom." In general, participants commented on both the usefulness of information as well as collegiality as the most beneficial aspects of the LASs. One participant commented, "I can use the information immediately in my classroom." Another participant noted, "The interaction with other colleagues was the most beneficial aspect of the LASs." Overall, participants indicated different logistical issues (e.g., distance, registration, etc.) as weaknesses.

Technology. When the directors were asked about technology, each one provided a different answer. One director stated, “We had to cancel class and we created online videos of material that would have been covered in class . . . We are also using Geometer’s Sketchpads and SMART Boards.” Another director noted, “Yes . . . The basis for community is technology such as Facebook.” The director also indicated they have a social networking site through Ning for the academy. Contrary to the aforementioned responses, one director commented, “Technology hasn’t really been a focus yet, but all participants are going to get flip cams.” Despite the use of technology for creating an online learning environment, there was little evidence to demonstrate the academy was modeling how to utilize technology in the participants’ classrooms.

Mentoring, Induction, and Leadership Skills. Directors noted the implementation of the mentoring/induction program would start in the fall 2011. The intent of the mentoring/induction program was that participants in the master’s degree program would mentor the preservice teachers throughout their first year of teaching. During the spring of 2011, the master’s program participants would be engaged in training designed to develop their mentoring, coaching, and leadership skills. Simultaneously, the preservice teachers would benefit from the knowledge and experience being shared by these mentor teachers. Master’s program participants indicated academy faculty served as informal mentors; however, this was not directly related to the mentoring/induction component. Direct quotations for participants’ experience in the mentoring/induction program could not be provided for this academy, because the program had not yet been implemented at the time of data collection.

When asked whether the academy increased participants' leadership skills, the directors indicated the participants in the program were already leaders on their respective campuses. A director noted, "[The participants] were already leaders in their buildings . . . Although, the students do share the information on their campus." Additionally, the majority if participants indicated the academy had increased their leadership skills. A participant noted, "My principal has made me an unofficial mentor at my school . . . I take the things I learn in the academy back to my department meetings."

Overall Challenges and Strengths. The major challenges experienced by participants was finding enough time in the day to fulfill all their responsibilities. A participant stated, "Time constraints . . . Having to study, prep to teach classes, time to read . . . But the professors have been flexible and make it fun." Participants also commented on the pace of the program. One participant suggested, "Make it more than two years in order to slow down the pace . . . I spent 8 hours a day during the first summer session on assignments." Another suggestion included more integration of technology. A participant commented, "More introductions to new technology could be used, so we as teachers know what is available." A director commented on the rigor of the courses. He indicated the professors teaching the mathematics courses did not understand their audience and to some extent, were teaching above the participants' heads. Finally, a director commented on the size and diversity of the group. He indicated it was hard to meet the needs of all students with such a great deal of diversity.

A key strength of the program, as stated by a director, was the financial assistance provided. The director stated, “In Texas and in this area, there is not a lot of incentive to get a master’s degree . . . why invest money when you don’t get a financial return . . . And it puts a master’s degree teacher into a low performing school district.” Another strength identified by directors was the creation of a community of learners. Finally, a director noted a strong sense of collegiality between the mathematics and science faculty at the university.

Overall, participants were satisfied with their experience in the academy. Some of the strengths stated by the participants included: professors, exposure to new information, and collaboration. In addition, participants indicated the academy had opened their eyes to new things and possibilities in their classrooms. In terms of best practices demonstrated by the academy, participants noted the following: collaborative learning, use of classroom observations, and use of problem-based learning.

Degree of Program Effectiveness

In an effort to integrate the qualitative and quantitative data, a degree of program effectiveness measure for the 14 MSTTP academies was calculated from three different sources of data: (a) interview data; (b) scale scores from the Math, Science, and Technology Teacher Preparation Academy Participant Survey; and (c) academy end-of-year status reports. Two coders reviewed all data sources and rated each academy based on seven indicators: (a) strengthening teacher subject matter knowledge; (b) strengthening pedagogical knowledge; (c) based on research in teacher preparation and professional development; (d) integration of science, technology, and mathematics; (e) implementation of a comprehensive mentoring/induction program highlight (f) emphasizing problem-based learning that offers a real-world context; and (g) infusion of technology into academy curriculum. Each of the seven indicators as assigned a value of 1 to 4 (1 = no sources of evidence; 2 = 1 source of evidence; 3 = 2 sources evidence; 4 = more than 2 sources of evidence), for a maximum program effectiveness overall rating of 28. The mean inter-rater reliability was M=0.857 which indicates a high level of consistency between raters. Table 52 displays the degree of program effectiveness.

Table 52

Degree of Program Effectiveness

Academy Goals	Academies A	B	C	D	E	F	G	H	I	J	K	L	M	N
Subject-matter knowledge	3	2	2	4	3	2	4	4	2	4	3	3	3	3
Pedagogical knowledge	3	3	4	4	3	2	3	2	3	3	2	3	2	2
Teacher preparation and professional development	3	3	3	3	3	3	3	3	3	3	4	3	3	3
Integration of science, technology, & mathematics	1	1	1	1	1	3	1	1	1	3	2	4	1	1
Mentoring/induction programs	2	3	2	3	1	3	3	1	3	2	3	2	3	2
Focus on problem-based learning	2	2	3	2	4	1	2	2	2	3	3	3	2	3
Technology Integration	2	4	2	4	3	2	3	2	2	2	4	2	2	2
Overall Total	16	18	17	21	18	16	19	15	16	20	21	20	16	16

Notes. 1=no sources of evidence; 2=1 source of evidence; 3=2 sources of evidence; 4=more than 2 sources of evidence. The highest and most effective score for an academy was 28; while the lowest and least effective score for an academy was 7.

The highest overall rating received by an academy was 21 and the lowest overall rating was 15. The mean rating of all 14 academies was 17.8 and a standard deviation of 2.1. Academies that were half a standard deviation above the mean (i.e., overall rating above 18.9) were labeled as more-effective academies. Less-effective academies were those academies that were half a standard deviation below the mean (i.e., overall rating below 16.8) Academies D, G, J, K, and L were rated as more effective academies. Academies B, C, and E were rated as effective academies. Finally, academies A, F, H, I, M, and N were rated as less effective academies.

In order to determine the extent to which the seven goals of the academies were associated with participants' perceived subject-matter knowledge and pedagogical confidence, multiple regression analyses were conducted. To determine an academy's perceived subject-matter knowledge, three measures, perceived mathematics knowledge, perceived science knowledge, and perceived overall content knowledge, were computed. These measures were computed by averaging academy participants' responses to questions asking how qualified they felt to teach different topics in mathematics and science. The perceived mathematics knowledge measure included 16 different mathematical topics. The overall academy mean for the perceived mathematics knowledge measure was 2.97 and a standard deviation of 0.29. The perceived science knowledge measure included 22 different science topics. The overall academy mean for the perceived science knowledge measure was 2.92 and a standard deviation of 0.36. The perceived overall content knowledge measure was computed by averaging the perceived mathematics and science knowledge measures. The overall academy mean for the perceived overall content knowledge measure was 2.95 and a standard deviation of 0.25. To determine an academy's perceived pedagogical confidence, a similar procedure was utilized. The measure was computed by averaging academy participants' responses to questions asking how well the academy prepared them to implement different pedagogical strategies. The perceived pedagogical confidence measure included 43 different items related to pedagogy. The overall academy mean for the perceived pedagogical confidence measure was 2.92 and a standard deviation of 0.21. Table 53 displays perceived overall content and pedagogical confidence measures by academy.

Table 53

Perceived Overall Content and Pedagogical Confidence by Academy

	Academy Means														All Academies	
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	*M*	*SD*
Perceived mathematics knowledge	3.19	2.70	2.89	3.36	2.69	2.76	3.00	3.16	2.40	3.47	2.75	3.15	3.09	3.00	2.97	0.29
Perceived science knowledge	2.93	3.02	2.95	3.17	3.38	1.94	3.25	3.26	2.90	2.97	2.96	2.97	2.55	2.65	2.92	0.36
Perceived overall content knowledge	3.06	2.86	2.92	3.27	3.04	2.35	3.13	3.21	2.65	3.22	2.86	3.06	2.82	2.83	2.95	0.25
Perceived pedagogical confidence	2.88	2.98	3.13	3.34	3.04	2.77	2.85	2.78	3.08	3.06	2.73	2.98	2.55	2.69	2.92	0.21

Notes. Content knowledge scale: 1 = Not qualified; 2 = Somewhat qualified; 3 = Adequately qualified; 4 = Very well qualified. Pedagogical knowledge scale: 1 = Not adequately prepared; 2 = Somewhat prepared; 3 = Fairly well prepared; 4 = Very well prepared.

In regard to the perceived overall content measures, academies that scored above a half a standard deviation above the mean were rated as more effective in preparing participants in content knowledge. Academies that scored a half a standard deviation below the mean were rated as less effective. Similarly, academies that scored a half a standard deviation above the mean on the perceived pedagogical confidence were rated as more effective in pedagogical preparation. Those academies scoring a half a standard deviation below the mean were rated as less effective. Finally, academies that scored a half a standard deviation above the mean on the overall effectiveness rating were rated as more effective. Those that scored a half a standard deviation below the mean were rated as less effective. Only one academy (Academy D) was rated more effective for all three ratings. Two academies (Academy F and Academy I) were rated as less effective for all three ratings. Table 54 displays the academies' overall content knowledge rating, overall pedagogical confidence rating, and overall academy effectiveness rating.

Table 54

Overall Academy Ratings

	Academy													
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
Overall Content Rating	0	0	0	+	0	-	+	+	-	+	0	0	0	0
Overall Pedagogical Rating	0	0	+	+	+	-	0	-	-	-	+	0	+	+
Overall Effectiveness Rating	-	0	0	+	0	-	+	-	-	+	+	+	-	-

Notes. "+" =Academy mean was half a standard deviation above the mean; "0" =Academy mean was between half a standard deviation above or below the mean; and "-" =Academy mean was half a standard deviation below the mean.

Two setwise multiple regressions were used to examine the extent to which the ratings on the seven goals of the academy were associated with participants' perceptions of their content knowledge (e.g., perceived mathematics and science knowledge measures). The results for the perceived mathematics knowledge measure, indicated that a significant regression model did not emerge ($F_{6, 13}$=2.210, p=.177). The results for the perceived science knowledge measure also indicated that a significant regression model did not emerge ($F_{6, 13}$=3.210, p=.088).

An additional setwise multiple regression was used to examine the extent to which the seven goals of the academy were associated with participants' perceived overall content knowledge measure. The perceived overall content knowledge measure was computed by averaging the perceived mathematics and science knowledge measures. The perceived mathematics and science knowledge measures were calculated using items from the participant survey. The regression results indicated that a significant model emerged ($F_{7, 14}$=9.789, p<.004). The seven goals of the academy accounted for 91.2% of the variance in overall content knowledge. The academy program effectiveness rating for content knowledge had a significant, high positive association with participants' overall content knowledge. The academy program effectiveness rating for pedagogical knowledge had a significant low positive association with participants' perceived content knowledge. The academy program effectiveness rating for teacher preparation/professional development, integration of mathematics, science, and technology, mentoring/induction, problem-based learning, and integration of technology were not significantly related to participants' overall perceived content knowledge. Table 55 displays the results of the multiple regression.

Table 55

Multiple Regression Results of the Academy Goals on Perceived Overall Content Knowledge

Academy Program Effectiveness Ratings	*B*	SE	β	*t*
Subject-matter knowledge	.228	.042	.717	5.46**
Pedagogical knowledge	.146	.056	.411	2.59*
Teacher preparation and professional development	.047	.175	.051	0.27
Integration of science, technology, & mathematics	-.012	.032	-.048	-0.37
Mentoring/induction programs	.011	.062	.035	0.19
Focus on problem-based learning	-.094	.066	-.283	-1.44
Technology Integration	.029	.053	.100	0.56
Multiple regression *R*	.955			
Adjusted R^2	.912			

Notes. ***p*<.01; **p*<.05.

Finally, a setwise multiple regression was used to examine the extent to which the ratings of the seven goals of the academy were associated with participants' perceived pedagogical knowledge. A significant regression model also emerged ($F_{6, 13}$=5.541, p<.027). The seven goals of the academy accounted for 86.6% of the variance in participants' perceived pedagogical knowledge. The academy program effectiveness rating for pedagogical knowledge had a significant high positive association with participants' perceived pedagogical knowledge. The academy program effectiveness rating for subject-matter knowledge, teacher preparation/professional development, integration of mathematics, science, and technology, mentoring/induction, problem-based learning, and integration of technology were not significantly related to participants' pedagogical knowledge. Table 56 displays the results of the multiple regression analysis.

Table 56

Multiple Regression Results of the Academy Goals on Participants' Pedagogical Confidence

Academy Program Effectiveness Ratings	*B*	SE	β	*t*
Subject-matter knowledge	-.010	.043	-.040	-0.25
Pedagogical knowledge	.266	.058	.895	4.59*
Teacher preparation and professional development	-.017	.180	-.022	-0.10
Integration of science, technology, & mathematics	.038	.033	.185	1.14
Mentoring/induction programs	-.035	.063	-.127	-0.55
Focus on problem-based learning	-.066	.068	-.235	-0.97
Technology Integration	.058	.054	.236	1.07
Multiple regression *R*	.931			
Adjusted R^2	.866			

Note. $^*p<.01$.

CHAPTER V

SUMMARY, IMPLICATIONS, AND CONCLUSIONS

This chapter is divided into six sections. The first section discusses the strengths and weaknesses of the 14 MSTTP academies. The second section discusses the extent to which participants perceive that the academies have improved their subject matter knowledge and pedagogical skills. The third section discusses the best professional development practices utilized by the academies. The fourth section discusses the extent to which the seven goals of the academies are related to teachers' perceptions of subject matter knowledge and pedagogical knowledge. The fifth section discusses implications for the literature and how this study's findings relate to other research in the field, implications for practice, and implications for future research. The last section of this chapter consists of conclusions based on the evaluation of the 14 MSTTP academies.

Academy Strengths and Weaknesses

Academy Strengths. The findings of the current study reveal three key strengths of the 14 MSTTP academies: (a) a strong focus on strengthening content knowledge; (b) the development of professionally-committed teachers; and (d) financial support for participants. The interview and survey data indicated that participants increased their content knowledge across all academies. Results from the current study also indicate that increases in content knowledge might have unanticipated outcomes. Several of the participants indicated in interviews that more in-depth content knowledge led to more confidence in their ability to teach and improved instructional practices. As one participant noted, “A deeper understanding of content has provided me confidence in showing other teachers instructional strategies.”

The development of professionally-committed teachers was another key strength of the academies. A professionally-committed teacher is an individual who: (a) commits themselves professionally by seeking advanced degrees and standards-based professional development; (b) engages in reflective practice through meaningful feedback and discussion, as well as action research; (c) engages in professional learning communities; and (d) seeks leadership positions (Troncoso-Skidmore, 2007). The majority (71%) of academy participants were inservice teachers seeking advanced degrees or advanced certification. Participants in these programs indicated that their participation improved their instruction, increased their pedagogical skills, and increased their content knowledge. Furthermore, participants indicated that academies utilized research-based articles and coached them on how to apply research-based practices. A participant commented, “As a participant in the academy, you have access to the latest research and experts in their fields, which helps to build your confidence.” Many of the academies also required participants to engage in action research or other research projects. Moreover, several academies encouraged participants to present their findings at local or regional conferences. A participant indicated that, through presentations in front of the academy and at a local conference, she has gained confidence in her ability and as a result has sought out more leadership roles on her campus.

Directors and participants frequently commented on the establishment of professional learning communities. Through the professional learning communities, participants engaged in meaningful discussions with their peers related to teaching. Many participants noted this as one of the most valuable learning experiences. A participant noted, “Sharing knowledge among other teachers greatly increased my content knowledge.” Several academies also noted a focus on developing teacher leaders and all academies indicated an increase in leadership skills. A participant commented, “The more educated you get, the better leadership you display . . . People start looking to you for direction and asking ‘What should we do?’ in certain circumstances.” The MSTTP academies have not only helped to develop more professionally-committed teachers, but also have ensured that these teachers remain at high-needs schools.

Finally, the academies provided funds to assist individuals in pursuing initial certification, advanced certification, or a master’s degree program. Many of the master’s degree program participants indicated that without the financial assistance provided, they would not have been able to pursue an advanced degree. As one director stated, “The funding encourages the students to pursue a master’s degree without having to accrue so much debt.” Another director also noted that, investing in a master’s degree does not have the same financial return in the teaching field as it does in other professions; therefore, the financial assistance is a key incentive.

Academy Weaknesses. Based on the degree of program effectiveness measure, none of the academies had fully implemented all seven goals at the time of the current evaluation. It should be noted, however, that when the present study was completed, nine academies were completing their first year, three academies were completing their second year, and two were completing their third year. Furthermore, some of the academies indicated they were still in the process of fully implementing all aspects of the academy. When examining overall program effectiveness, academies from Cycles 1, 2, and 3 were all rated among the more effective academies. Similarly, academies from all cycles were also among the less effective academies. This finding suggests that the amount of time in which academies have been operating does not correlate to their overall effectiveness. As academies move forward, they can utilize the degree of program effectiveness measure to determine areas of weakness and ways in which the academy can be improved.

In general, there was a lack of evidence to suggest that the academies were accomplishing two of the stated goals, integration of the areas of science, technology and mathematics, and the infusion of technology into curriculum. With the exception of three academies, there was little to no evidence of the integration of mathematics, science, and technology. Even among the academies that received high ratings in regard to the integration of mathematics, science, and technology, participants often indicated that the connections between the three disciplines were unclear. Furthermore, some academies attempted to integrate the subjects by having all participants attend the same Learning Academy Seminars (LASs). The LASs, however, did not integrate the subjects and presented material only related to one content area. Participants from these academies often indicated the need for the separation of the content areas.

In regard to the infusion of technology into the curriculum, only three academies received the highest rating. These academies were modeling to their participants how to effectively utilize technology in the classroom in order to enhance student learning. Other academies utilized technology for purposes of communication or course delivery. Furthermore, participants in these academies indicated a desire for more technology integration. These teachers were eager to learn about technology that would engage and motivate their students to learn.

A final concern noted by both academy directors and students was the time required to participate in the academies. A requirement set forth by THECB was that master's program participants finish a degree in two years. Due to this constraint, many of the academies tried to cover too much material in a short amount of time. Several participants in different academies commented about how the courses that lasted 3.5 weeks did not allow enough time to fully process the material being covered. Additionally, the time commitment required for participation in an academy was difficult as the majority of the participants were full-time, classroom teachers. One director commented, "It's hard for teachers to find time." A participant commented, "[I'm] trying to balance my family, teaching, and taking courses, it's tough." Students across all academies echoed this sentiment.

Participants' Subject Matter Knowledge and Pedagogical Skills

Findings from both the interview and survey data indicate that participants perceived that the academies improved their subject matter knowledge and pedagogical skills. The findings, however, suggest that the academies were more focused on increasing subject matter knowledge than pedagogical skills. Participants from 12 of the 14 academies indicated that after being enrolled in the academy, they felt adequately qualified to teach a range of topics in mathematics and science. In regard to pedagogical skills, members from only 9 of the 14 academies indicated that after participating in the academy, they felt adequately prepared to utilize a variety of pedagogical skills. Furthermore, during the interviews, participants more commonly spoke of increasing their content knowledge rather than increasing their pedagogical skills.

Best Professional Development Practices

According to research, effective professional development has five key features. Effective professional development: (a) is content-focused; (b) provides active learning opportunities; (c) is intensive and sustained over time; (d) emphasizes collective participation; and (e) promotes coherence (Garet, et al., 2001; Goe, 2007). Based on results from the current study, all 14 MSTTP academies exhibit three of the five key features. First, the findings reveal that all the academies were content-focused. The majority of academies integrated content through LASs, content related coursework, or both. In general, participants noted that the LASs supported and supplemented their content knowledge. Additionally, the majority of participants (approximately 65%) participating in a MSTTP academy were enrolled in a master's degree program which required content related coursework to fulfill the degree plan requirements. Furthermore, some of the academies required 18 hours of graduate-level content related coursework.

By fulfilling the 18-hour requirement, teachers became eligible to teach dual-credit or community college courses. Participants enrolled in a master teacher certification program were generally also required to take additional graduate-level content related coursework.

Second, all academies provided active learning opportunities for their participants. When participants were asked what were the best practices the academy utilized for providing professional development, the majority responded with following: hands-on activities, problem-based learning, and inquiry activities. Most of the academies utilized active learning techniques instead of passive activities such as lecture. Almost all the academies engaged their participants in problem solving and experiential learning.

Additionally, the academies were intensive and sustained over time. Research has shown that professional development lasting more than 14 hours had significant positive impacts on student learning (Yoon, et al., 2007). Furthermore, the largest effect on student achievement was found in studies where professional development was offered between 30 and 100 hours, over six months to one year. In general, the academies allowed students to participate in the academy for period of two years. Over the course of the two years, participants engaged in several activities including LASs, coursework in both content and pedagogy, mentoring, action research, and other academy specific events. The LASs provided more than 15 hours of structured professional development each year. Additionally, the majority of participants enrolled in at least 12 hours of coursework each year to fulfill program requirements.

Only one of the 14 MSTTP academies demonstrated the remaining two features of effective professional development, collective participation and coherence. Academy K established a strong partnership with a local independent school district that will enable the academy to continue even without additional funding. The local independent school district currently has large cohort (33) of inservice teachers enrolled in the academy, for 20 of whom they provided funding for. As a result of this partnership, the academy has worked with the school district to ensure the curriculum meets the needs of the district and is aligned with their goals. The teachers from this district are able to work together with the knowledge that the district fully supports their efforts.

Relation of Academy Goals to Subject Matter Knowledge and Pedagogical Skills

To determine the extent to which the seven goals of the academies were associated with participants' perceived subject matter knowledge and pedagogical confidence, multiple regression analyses were conducted. The results from the multiple regression analyses revealed that the seven goals of the academy were not good predictors of participants' perceived mathematics knowledge and perceived science knowledge. These findings might be a reflection of the fact that many of the academies were focused on both mathematics and science. When the two measures were combined (perceived overall content knowledge), however, the goal of strengthening content knowledge accounted for 91% of the variance. These findings from the multiple regression analysis revealed that two goals of the academy, strengthening content knowledge and strengthening pedagogical knowledge, accounted for 87% of the variance in pedagogical confidence.

Implications for Research Literature

Research Related to the Goals of Academies. The results of the present study support the majority of the previously-cited research related to the goals of the academy. Previous research indicates a positive connection between subject matter and pedagogical preparation and teachers' impact in the classroom. A review of the research by Rice (2003) indicated that content area coursework is positively related to student achievement in studies of primarily mathematics and science, middle and high school education. Results from previous studies examining the importance of content knowledge are often mixed and appear to be content and grade specific; however, researchers continue to believe in the importance of content knowledge (Wilson & Floden, 2003). In regard to pedagogical knowledge, Wilson, Floden, and Ferrini-Mundy (2001) suggested that evidence points to a positive relationship between content methods coursework, teacher effectiveness, and student achievement. Participants from the current study indicated that an increase in content knowledge and pedagogical knowledge led to an increase in confidence, as well as improved instruction in the classroom.

In regard to teacher preparation and professional development, the most effective academies implemented programs based on research from these areas. Research in teacher preparation supports the implementation of the AggieTEACH model (Scott, et al., 2006). The results from the current study support previous research, as one of the most effective academies, Academy J, implemented a similar preservice preparation program, UTeach, Additionally, research has identified five key features of professional development (Garet, et al., 2001; Goe, 2007). The most effective of the 14 academies, Academy K, was the only academy to implement all five of the key features. The other 13 academies only implemented three of the five.

Finally, the results of the current study support research related to technology integration. Ertmer and Ottenbreit-Leftwich (2010) indicated that, for teachers to effectively use technology in their classroom, they need knowledge of the technology itself and how to effectively use the technology in their instruction. In addition, teachers need to feel confident in their ability to use the technology. The academies that were most effective in integrating technology, implemented research based practices for doing so. These academies provided professional development opportunities that allowed teachers to play with the technology and collaborate with their peers. Additionally, the academies focused on enhancing student learning through technology integration.

On the other hand, the present study provides inconclusive evidence for the integration of mathematics, science, and technology. Findings from a previous study indicate that students enrolled in a science course that integrated content from a statistics course scored significantly higher on a statistics unit test (Judson & Sawada, 2000). Findings from two additional studies, however, reveal that students engaged in an integrated classroom did not demonstrate significantly higher student outcomes (Childress, 1996; Merrill, 2000). Furthermore, of the academies demonstrating evidence of the integration of mathematics, science, and technology, two were among the most effective academies and one was among the least effective. These findings suggest that the integration of mathematics, science, and technology might be a complex process, which requires more research to examine the conditions under which successful implementation occurs.

Research Related to Previous Evaluations. After examining research on other programs implemented through NSF and other state organizations, it is evident that the MSTTP academies bear a strong resemblance to these programs. First, programs, such as the MSP Program, CaMSP, LSC, MSTTP academies, and several other evaluations, were charged with improving STEM education primarily through improving teacher quality (Banilower, et al., 2006; Blank, de las Alas, & Smith, 2008; O'Driscoll, et al., 2009; Yin, 2010). The majority of programs established provided professional development opportunities for K-12, mathematics and science teachers. The exception, the CaMSP program, was only focused on grades 3-8. Additionally, all of the programs focused on increasing teachers' content knowledge; however, only CaMSP, LSC, and MSTTP academies focused on increasing teachers' pedagogical knowledge. Finally, several of the programs, CaMSP, MSP Program and MSTTP academies, encouraged partnerships between institutes of higher education and K-12 school districts.

The amount of flexibility in creation of the programs varied. While the MSTTP academies provided flexibility to the individual sites to meet the needs of the participants, the other programs provided even more. The guidelines for the MSTTP academies specified three programs that could be offered by the academies and outlined seven goals, or requirements. In their proposals, principal investigators had to identify the programs to be implemented, as well as a plan for accomplishing the seven goals. The MSP Program, LSC, and CaMSP allowed principal investigators the flexibility to provide professional development through almost any means as long as it was focused on improving STEM teacher quality.

In regard to the evaluations of these programs, both similarities and differences existed. All of the evaluations, including the current one, employed a mixed-methods approach. The current evaluation only utilizes interviews (program directors and participants) and a participant survey. The evaluations of LSC and CaMSP were able to utilize more data sources including: interviews, questionnaires, classroom observations, and observations of the professional development activities. CaMSP also included analysis of student outcomes. Differing from other programs, the MSP Program primarily relied on secondary data analyses and, when warranted, conducted substudies requiring original data collection.

Measures of teacher content knowledge, teacher pedagogical skills, and student outcomes varied among the programs. LSC and the current evaluation both reported participants' perceived increases in content knowledge. On the other hand, the MSP program and 10 other evaluation studies cited measurable effects on teacher content knowledge. In regard to participants' pedagogical skills, LSC and the evaluation of MSSTP academies reported participants' perceptions. Four other evaluations reported measurable effects on teacher pedagogical skills; while CaSMP or the MSP Program did not cite findings in this area. Finally, findings related to student outcomes were less frequent. Of the evaluations reviewed, CaMSP, the MSP program and seven other evaluations reported findings related to student outcomes. The current study was unable to link impact of the MSTTP academies to any student related outcome.

Implications for Future Policy and Practice

Implications for Academies. Based on findings from the current evaluation, there are several implications for future practice. While the majority of academies placed a heavy emphasis on content knowledge, there appears to be a need for more of a balance between pedagogical knowledge and content knowledge. Participants from only five of the 14 academies indicated they felt more than adequately qualified in regard to pedagogical skills after participating in the academy. Both domains have been linked to gains in student achievement. However, a review of research indicated that the effect of pedagogical coursework does not diminish as the number of courses increases and that the effects of these courses might outweigh the effect of content area coursework (Rice, 2003).

Additionally, academies offering the master teacher certification program could try to ensure that participants are prepared to take the exam. Several participants indicated that they were not confident in their preparation. Specifically, participants commented they needed more preparation in regard to the case studies portion on the exam. Academies offering this program could complete practice exams with participants and provide tutorials for any areas of weakness.

The majority of academies also need to place more emphasis on integrating technology. Even though studies demonstrate that student motivation and teacher effectiveness both increase when teachers infuse technology into their curriculum; only three of the 14 academies provided evidence that they were integrating technology to enhance student learning. Directors of the remaining 11 academies could examine strategies that Academies B, D, and K utilized to integrate technology and determine if any could be implemented in their respective academy.

Additionally, implications regarding specific academies can be stated. Academies E and F directors might consider conducting their own LASs. Participants from both academies indicated this was a weakness of the academies. Separate LASs will enable the directors to ensure all material presented is relevant for participants. Additionally, because all Academy E participants are inservice teachers, the academy might consider holding the LASs during a time that is convenient for the teachers to attend in person.

Participants from Academies A, D, and G commented on the short amount of time for courses. Academy G participants indicated that 3.5 weeks was not long enough to fully comprehend material covered in a course. Participants in academies A and D also felt that the time allotted for certain courses was too short. Directors could try to find a way to provide a longer amount of time for courses. A possible suggestion would be to switch the order of courses. Courses with more complex material could be scheduled during the fall and spring semesters and those with less complex material scheduled during the short summer semesters.

Implications for Teacher Education Institutions. There are several implications from this evaluation that may be useful for other universities who are considering establishing a similar academy or program. First, principal investigators are given the freedom to establish an academy that offers a variety of programs for mathematics and science participants teaching or planning to teach in grades K-12. As a result, academies were established that offered programs geared for inservice and preservice teachers across all grade levels. Given the diversity of participants in these academies, the needs of all the participants were not always met. An academy only has a limited amount of resources and needs differ between: inservice and preservice teachers, elementary teachers and high school teachers, and mathematics and science teachers. Instead of trying to create programs for all types of participants, principal investigators might consider specializing in a particular area. For example, an academy might offer programs for only for inservice, mathematics and science teachers at grades 8-12. Current academies that narrowed their focus were more successful in meeting the needs of all participants.

Teacher education institutions may also consider establishing a strong partnership with a local, high need school district similar to the relationship Academy K established. The partnership between Academy K and the local school district ensures that, even without additional funding, the academy will be sustained. Additionally, the academy and the local school district work cooperatively to ensure that not only the teachers' needs are being addressed, but also the district needs. This type of relationship also instills a sense of value to the teachers participating in the program.

Implications for State Policy. Finally, the study revealed several implications for state policy and the P-16 Initiatives division at THECB. First, legislators may want to consider revising the state policy related to the MSTTP academies to direct funds to only master teacher certification and master's degree programs. The majority of participants enrolled in current academies are inservice teachers. These teachers indicated that without the funding, pursuing a master's degree would not have been a feasible option. Additionally, it could be more a valuable invest in teachers who have demonstrated a commitment to education. Finally, there are a number of other programs (Robert Noyce Teacher Scholarship Program, Teacher Quality Grants, loan forgiveness programs, etc.) that provide financial assistance for those individuals seeking initial teaching certification in mathematics and science.

Another implication for policy relates to the goal of establishing a mentoring and induction program. This goal is an important goal for academies that serve preservice teachers. However, the majority of participants enrolled in academies are inservice teachers with at least 3 years of experience. These participants are not necessarily in need of a mentoring and induction program. Therefore, this goal could only apply to programs serving preservice teachers. For the inservice programs, this requirement might be replaced with the goal of developing professionally committed teachers. With this goal in mind, academies would strive to increase the leadership skills of inservice teachers to help them become leaders on their campuses. Additionally, academies would engage participants in more research activities.

In addition to the previous implications, the P-16 Initiatives division may want to consider allowing participants to receive funding towards a master's degree for beyond the current two year limitation. One of the most noted concerns from both participants and directors was the lack of time. The majority of participants are full-time teachers who also have other responsibilities. Many participants indicated it was hard to find a balance between the teaching, family, and requirements of the academy. Additionally, academies were forced to offer enough courses during the two-year period for participants to complete the master's degree. As a result, some academies shortened courses to an extent that participants indicated they were not able to fully comprehend the material. If the academies were granted more time, the overall academy effectiveness might be enhanced.

Finally, the P-16 Initiatives division may want to consider allowing for a planning semester after the funds have been awarded. Many of the directors indicated that awards were granted just prior to the enrollment date for academy participants. These academies had rush to recruit and enroll participants, sometimes resulting in the academy failing to reach the enrollment minimum. Academy participants also indicated that there was often confusion and lack of preparation at the start of their respective academy. If a planning semester were allowed, directors could recruit and enroll participants, as well as effectively plan academy activities to avoid confusion.

Implications for Future Research

Research examining the impact of MSTTP academies on teacher quality could be greatly expanded. The absence of measures that determine actual gains in participants' content and pedagogical knowledge was a limitation to the current study. The study was only able to determine the participants' perceived knowledge. This was primarily due to the fact that many of the academies were operating prior to the beginning of the evaluation. Future evaluations could attempt to measure participants' content and pedagogical knowledge prior to enrollment in an academy and at the conclusion of participants' studies. This would allow researchers to determine the impact of the academy on these types of knowledge.

Another limitation of the current study is the inability to incorporate student achievement data. At the time of the present study, data directly linking teachers to student achievement measures were not available. However, this data should be available in the near future. Future studies could try to establish the impact of the MSTTP academies on student achievement by utilizing value-added modeling. A study that utilized this methodology could isolate the academy participants' contribution to student achievement.

While measures of student achievement are widely used to determine teacher effectiveness, they cannot determine strategies teachers utilize in the classroom. An observational study of academy participants could determine whether or not the teachers are implementing research-based practices such as problem-based learning or technology integration. Researchers could observe a sample of academy participants from partnering districts as well as other teachers in the district to determine if significant differences exist. An observational study of this nature could help to determine the impact of the academies on classroom instruction.

Future research might also attempt to determine the academies' impact on student interest in STEM related fields. The research-based practices implemented through the academy are designed to increase student interest in these fields. Potentially, researchers could survey academy participants' and non-academy participants' students to determine their level of interest in STEM related fields. Additionally, researchers could track academy participants' students longitudinally to determine whether students taught by an academy participant choose a college major in STEM related fields at a higher rate than other students.

Finally, future research could attempt to track the participants longitudinally to determine the lasting impact of academies. Specifically, researchers could focus on the retention rate of academy participants compared to other teachers in their teacher education programs. Additionally, a study of this type could also utilize student achievement data to determine if academy partner districts have significantly higher student achievement gains over time than comparable school districts. Studies could also attempt to track whether academy participants take on various leadership positions.

Conclusions

The purpose of the present study was to evaluate the effectiveness of 14 MSTTP Academies located across the state of Texas. THECB established these academies with the aim of increasing the number of highly qualified mathematics, science, and technology teachers, while also improving the quality of certified teachers in these areas. The academy goals set forth included: (a) a focus on strengthening teacher subject matter and pedagogical knowledge; (b) utilizing methods based on research in the fields of teacher preparation and professional development; (c) integrating the areas of science, technology, and mathematics; (d) highlighting problem-based learning that offers a real-world context; (e) implementing a comprehensive mentoring/induction program; and (f) infusing technology into academy curriculum (THECB, 2009).

The study focused on the seven goals set forth by THECB. In addition, the researcher examined best practices for professional development and teacher preparation utilized by the academies to increase teacher quality, and strengths and weaknesses of the academies as identified by both academy directors and participants. The study also examined the extent to which the participants felt qualified to teach in their content area after participating in the academy. Additionally, the extent to which the participants perceived the academy had improved their pedagogical skills was examined. Finally, the extent to which the seven goals of the academies are associated with participants' perceived subject matter knowledge and pedagogical knowledge was analyzed.

The study used secondary data from a larger evaluation of the Mathematics, Science, Technology Teacher Preparation (MSTTP) Academies conducted by the State of Texas Education Research Center at Texas A&M University between summer 2010 and spring 2011. A mixed-methods design was used to analyze both quantitative and qualitative data. Survey data was used to examine the perceptions of academy participants. At the same time, interview data and academy end-of-year status reports provided more in-depth knowledge of the programs.

The results of the current study revealed that the14 MSTTP academies demonstrated the following key strengths: (a) a focus on strengthening content knowledge; (b) a willingness for developing professionally committed teachers; and (c) providing funding for participants. In regard to weaknesses, the degree of program effectiveness revealed that none of the academies had fully implemented all seven goals at the time of the current evaluation. It should be noted that when the study was completed the majority of programs were only completing their first year. All 14 academies, however, struggled to accomplish two of the goals: (a) the integration of the areas of science technology and mathematics; and (b) the infusion of technology into curriculum. Additionally, the findings indicate that participants felt as though the academies had improved their subject matter knowledge and pedagogical skills. The findings also reveal that all academies exhibited three of the five features of effective professional development: (a) a focus on content; (b) active learning opportunities; and (c) intensive and sustained over time. Only one academy exhibited the remaining two features, collective participation and coherence. Finally, the study revealed that only the goal of strengthening content knowledge was a good predictor for participants' content qualifications, while strengthening content knowledge and strengthening pedagogical skills were good predictors of participants' pedagogical qualifications.

Implications for future practice include the need for: (a) a balance between content and pedagogical knowledge, (b) narrowing the focus of academies, (c) allowing academies to stipulate the number of participants to be served, and (d) replacement of the mentoring/induction program goal with a goal of developing professionally committed teachers for inservice participants. Future research regarding the MSTTP academies might include measures of gains in participants' content and pedagogical knowledge. Additionally, studies could include classroom observations of teachers enrolled in the program to examine possible associations between the academy and improved instructional practices. Finally, future research could attempt to include measures of student learning, as this is the ultimate goal of the academies.

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APPENDIX A

Math, Science, Technology Teacher Preparation Academies
Academy Director(s) Interview Protocol

Hello! My name is [interviewer's name]. I work with the State of Texas Education Research Center at Texas A&M University.

We are interviewing personnel affiliated with the Math, Science, Technology Teacher Preparation Academies project in order to obtain their perceptions of the their experiences with the Math, Science, Technology Teacher Preparation Academies.

All of your answers will be kept completely confidential. Your participation is voluntary, and if there is a question you do not wish to answer, please let me know, and I'll go on to the next question.

Participant's name:________________________________

1. Which of the following programs does your academy offer?
   _______ Initial Teacher Certificaiton
   _______ Master Teacher Certification
   _______ Master of Education

2. Currently, how many students are in your program?

3. How long have you been receiving funding for your academy?

4. Is the academy an expansion of a program that was previously established or created new?

5. Describe the activities/events the academy supports throughout the year*?*

6. Describe the mentoring/induction activities established as a part of the academy.

7. Did the Learning Academy Seminars (LAS) create a learning community? *(Probe: Please describe some ways the LASs were effective in creating a learning community. Or Why do you think the LASs were ineffective at creating a learning community?*

8. Has the academy been successful at integrating technology as part of the academy curriculum?

(Probe: Please describe some ways in which the academy has been effective at integrating technology. Or Why do you think the academy was unsuccessful at integrating technology?

9. Has the academy been successful at improving academy participants' leadership skills?
   (Probe: Please describe some ways in which the academy has been effective improving academy participants' leadership skills. Or Why do you think the academy was unsuccessful at improving academy participants' leadership skills?

10. What were the strengths of your teacher preparation academy?

11. What were some of the weaknesses of your teacher preparation academy?

12. What concerns or constraints hindered your academy from achieving all of their goals and objectives?

13. What additional supports or policies are needed to expand the teacher preparation academy?

14. What additional research is needed to provide evidence of your academy's effectiveness?

APPENDIX B

Math, Science, Technology Teacher Preparation Academies
Academy Participant Interview Protocol

Hello! My name is [interviewer's name]. I work with the State of Texas Education Research Center at Texas A&M University.

We are interviewing personnel affiliated with the Math, Science, Technology Teacher Preparation Academies project in order to obtain their perceptions of the their experiences with the Math, Science, Technology Teacher Preparation Academies.

All of your answers will be kept completely confidential. Your participation is voluntary, and if there is a question you do not wish to answer, please let me know, and I'll go on to the next question.

Participant's name:______________________

1. Which of the following programs are you participating in?
   _______ Initial Teacher Certificaiton
   ________ Master Teacher Certification
   _______ Master of Education

2. If you are currently teaching, what grade level and subject area are you teaching?

3. How long have you been enrolled in the MSTTPA academy?

4. What types of mentoring/induction activities have you been involved with as a part of the academy?

5. What are the strengths of these mentoring/induction activities?

6. What are the weaknesses of these mentoring/induction activities?

7. Are there aspects of these mentoring/induction activities that should be changed?
   (Probe: Please describe some ways the mentoring/inductions activities should be changed.)

8. Did you feel as though the LAS created a learning community? Why or why not?

9. Did you feel as though the LAS improved your instruction? Why or why not?

10. What specific characteristics of the LAS have been most helpful to you? Why?

11. What specific characteristics of the LAS have been least helpful to you? Why?

12. After being enrolled in the academy, do you feel as though you have increased your knowledge of the TEKS and CCR standards? If yes, what kind of activities supported your knowledge?

13. Overall, do you feel as though the academy improved your leadership skills?

14. What are overall strengths of the academy?

15. What are overall challenges of the academy?

16. What are suggestions/improvements that could be made to the academy?

17. What were some of the best practices used in providing professional development?

18. What were some of the best practices used in implementing the College and Career Readiness Standards into the academy?

APPENDIX C

MSTTPA Participant Survey

The purpose of this form is to provide you in your decision regarding whether or not you choose to participate in this research. You have been asked to participate in a research study to help evaluate the Math, Science, and Technology Teacher Preparation Academies across the State of Texas. You were selected to be a possible participant because involvement with the Math, Science, Technology Teacher Preparation Academies. This study is being sponsored/funded by Texas Higher Education Coordinating Board (THECB).

If you agree to participate in this study, you will be asked to complete an online survey about your experiences with the Math, Science, and Technology Teacher Preparation Academies. The survey will take about 20 minutes to complete.

The risks associated with this study are minimal, and are not greater than risks ordinarily encountered in daily life. The possible benefits of participation are to more fully understand and address issues related to preparing K-12 teachers in the areas of math, science, and technology.

Your participation is voluntary. You may decide not to participate or to withdraw at any time without your current or future relations with your university or Texas A&M being affected.

The records of this study will be kept private. No identifiers linking you to this study will be included in any sort of report that might be published. Research records will be stored securely and only Dr. Jacqueline Stillisano and Dr. Hersh Waxman will have access to the records.

If you have questions regarding this study, you may contact Danielle Bairrington Brown at dbairrington@cehd.tamu.edu.

This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at (979)458-4067 or irb@tamu.edu.

Please be sure you have read the above information, asked questions and received answers to your satisfaction. If you would like to participate in this study, please complete this survey.

Sex

❍ Male
❍ Female

Ethnicity

- ❍ American Indian or Alaskan Native
- ❍ Asian
- ❍ African American/Black
- ❍ Hispanic/Latino(a)
- ❍ Caucasian
- ❍ Other (please specify) ____________________

Which of the following best describes your status with the academy?

- ❍ Current participant
- ❍ Graduated/completed the academy
- ❍ No longer with the academy but did not graduate/complete

Answer If Which of the following best describes your status with th... No longer with the academy but did not graduate/complete Is Selected

Please describe why you are no longer with the academy and did not graduate/complete the program?

Which of the following best describes you? (choose all that apply)

- ❑ Undergraduate student
- ❑ Graduate Student
- ❑ Teacher

Answer If Which of the following best describes you? (choose all th... Teacher Is Selected

Including the 2010-11 school year, how many years of experience do you have as a teacher?

- ❍ 1-3 Years
- ❍ 4-5 Years
- ❍ 6-8 Years
- ❍ 9-10 Years
- ❍ 10+

What was the content focus of the academy in which you participated? (choose all that apply)

- ❑ Mathematics
- ❑ Science
- ❑ Technology

Which of the following grade levels are you currently teaching or planning to teach?

- ❍ K - 2
- ❍ 3 - 5
- ❍ 6 - 8
- ❍ 9 - 12
- ❍ Other (please specify) ____________________

In which academy are you participating?

If you are a current participant, how many semesters have you been enrolled in the academy including this semester? If you were a previous participant, how many semesters were you enrolled in the academy? (Note: Spring, summer, and fall each count as 1 semester)

- ❍ 0
- ❍ 1
- ❍ 2
- ❍ 3
- ❍ 4
- ❍ 5
- ❍ 6
- ❍ 6+

In which of the following programs are you currently enrolled? (Check all that apply)

- ❑ Initial Teacher Certification
- ❑ Master Teacher Certification
- ❑ Master’s of Education or other Master’s degree

To what extent do you agree or disagree with the following statements?

	Strongly Disagree	Disagree	Agree	Strongly Agree
The mentoring/induction program was beneficial to me in my professional development.	❍	❍	❍	❍
The mentoring/induction program supported my learning.	❍	❍	❍	❍
The academy created a sense of collegiality among participants.	❍	❍	❍	❍
The academy utilized research-based articles related to my field.	❍	❍	❍	❍
The academy increased my ability to apply research-based practices to my teaching.	❍	❍	❍	❍
The academy increased my awareness of current issues in my field.	❍	❍	❍	❍
The academy prepared me to conduct research related to my field.	❍	❍	❍	❍
The academy encouraged me to present research I conducted at a professional conference.	❍	❍	❍	❍
The academy infused technology into the curriculum.	❍	❍	❍	❍
The academy demonstrated how to effectively use technology in the classroom.	❍	❍	❍	❍
The academy provided time for participants to practice with new pieces of technology.	❍	❍	❍	❍
Mathematics, science, and technology were integrated into all aspects of the academy.	❍	❍	❍	❍

To what extent do you agree or disagree with the following statements? (Learning Academy Seminars were a bi-weekly, 1 hour, seminar. However, they might have been referred to by a different name depending on the academy.)

	Strongly Disagree	Disagree	Agree	Strongly Agree
The Learning Academy Seminars created a learning community.	❍	❍	❍	❍
The Learning Academy Seminars supported improved instruction.	❍	❍	❍	❍
The Learning Academy Seminars improved my understanding of content knowledge.	❍	❍	❍	❍

How familiar are you with the following standards related to the content you currently teach or plan to teach?

	Not at all familiar	Somewhat familiar	Very familiar
Texas Essential Knowledge and Skills (TEKS)	❍	❍	❍
College and Career Readiness Standards (CCRS)?	❍	❍	❍

To what extent has the academy prepared you to implement the following standards relating to your content you currently teach or plan to teach in your instruction?

	Not at all	Minimal extent	Moderat e extent	Great extent
Texas Essential Knowledge and Skills (TEKS)	❍	❍	❍	❍
College and Career Readiness Standards (CCRS)?	❍	❍	❍	❍

Consider the grade level you currently teach or are planning to teach. Indicate the extent to which the academy has prepared you to effectively incorporate each of the following types of technology into your instruction.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
MP3 player/iPod	❍	❍	❍	❍
Tape player/radio	❍	❍	❍	❍
Interactive whiteboard (e.g., SMART Board, Promethean Board)	❍	❍	❍	❍
Student response device	❍	❍	❍	❍
Flip camera/video camera	❍	❍	❍	❍
Digital camera	❍	❍	❍	❍
DVDs/CDs and headphones	❍	❍	❍	❍
Skype/video communication	❍	❍	❍	❍
Laptop computers	❍	❍	❍	❍
Desktop computers	❍	❍	❍	❍
Television	❍	❍	❍	❍
Document reader	❍	❍	❍	❍
Overhead projector	❍	❍	❍	❍
Handheld game/device	❍	❍	❍	❍
Other (please specify)	❍	❍	❍	❍

Consider the grades you currently teach or are planning to teach. Indicate the extent to which the academy has prepared you to help your students use computers to participate in each of the following activities.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Drill and practice	❍	❍	❍	❍
Demonstrations of mathematical or scientific principles	❍	❍	❍	❍
Learning games	❍	❍	❍	❍
Laboratory simulations	❍	❍	❍	❍
Collection of data using sensors or probes	❍	❍	❍	❍
Retrieve or exchange data	❍	❍	❍	❍
Solve problems using simulations	❍	❍	❍	❍
Tests or quizzes	❍	❍	❍	❍

With regard to the following areas, describe the extent of your professional development needs.

	None needed	Minimal need	Moderate need	Substanti al need
Deepening my content knowledge	❍	❍	❍	❍
Using inquiry/investigation-oriented teaching strategies	❍	❍	❍	❍
Using technology for instructional purposes	❍	❍	❍	❍
Assessing student learning	❍	❍	❍	❍
Differentiating instruction for all students	❍	❍	❍	❍

Consider the grades you currently teach or are planning to teach and indicate the extent to which the academy has prepared you to implement each of the following strategies in your classroom.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Considering students' prior understanding when planning curriculum and instruction	❍	❍	❍	❍
Providing opportunities for concrete authentic learning experiences prior to introducing abstract concepts	❍	❍	❍	❍
Using the textbook as a supplemental resource rather than the primary instructional tool	❍	❍	❍	❍
Providing opportunities for students to participate in cooperative learning groups	❍	❍	❍	❍
Providing opportunities for students to participate in appropriate hands-on activities	❍	❍	❍	❍
Providing opportunities for students to participate in inquiry-oriented activities	❍	❍	❍	❍
Facilitating a classroom of students using investigative strategies	❍	❍	❍	❍
Facilitating a classroom of students engaged in hands-on/project-based activities	❍	❍	❍	❍
Assisting students to take responsibility for their own learning	❍	❍	❍	❍
Assisting students to prepare reports (e.g. project, laboratory, or research)	❍	❍	❍	❍
Assisting students to use calculators for problem solving	❍	❍	❍	❍
Teaching students who have limited English proficiency	❍	❍	❍	❍
Using culturally responsive teaching strategies	❍	❍	❍	❍
Using performance-based assessment	❍	❍	❍	❍
Using portfolio-based assessment	❍	❍	❍	❍

At this point in time, indicate the extent to which the academy has prepared you to use each of the following strategies in your instruction.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Introducing content through formal presentations	❍	❍	❍	❍
Posing open-ended questions	❍	❍	❍	❍
Engaging the whole class in discussions	❍	❍	❍	❍
Encouraging students to supply evidence to support their claims	❍	❍	❍	❍
Encouraging students to explain concepts to one another	❍	❍	❍	❍
Encouraging students to consider alternative explanations	❍	❍	❍	❍
Allowing students to work at their own pace	❍	❍	❍	❍

Consider the grades you currently teach or are planning to teach and indicate the extent to which the academy has prepared to use each of the following strategies in your instruction.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Conducting a pre-assessment to determine what students already know	❍	❍	❍	❍
Using questioning strategies to assess students' understanding as they work individually	❍	❍	❍	❍
Using questioning strategies to assess students' understanding during large group discussions	❍	❍	❍	❍
Using assessments embedded in class activities to see if students are "getting it"	❍	❍	❍	❍
Reviewing student homework	❍	❍	❍	❍
Reviewing student notebooks/journals	❍	❍	❍	❍
Reviewing student portfolios	❍	❍	❍	❍
Facilitating students completing long-term projects	❍	❍	❍	❍
Facilitating student presentations of their work	❍	❍	❍	❍
Giving predominately short-answer tests (e.g., multiple choice, true/false, fill in the blank)	❍	❍	❍	❍
Giving tests requiring open-ended responses (e.g., descriptions, explanations)	❍	❍	❍	❍
Grading student work (e.g., open-ended, laboratory tasks) using defined criteria (e.g., a scoring rubric)	❍	❍	❍	❍
Facilitating peer evaluations (i.e. students assessing each other)	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Math Is Selected

What is your educational background? (select all that apply)

- ❑ Undergraduate major in mathematics or mathematics education
- ❑ Undergraduate minor in mathematics or mathematics education
- ❑ Some graduate coursework in mathematics or mathematics education
- ❑ Graduate-level degree in mathematics or mathematics education
- ❑ Certification to teach mathematics
- ❑ None of the above

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

As a participant in the academy, did you complete at least one mathematics course for college credit?

- ❍ Yes
- ❍ No

If Yes Is Selected, Then Skip To In the last 3 years, have you taught ...

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

When did you last complete a mathematics course for college credit?

- ❍ In the last 5 years
- ❍ In the last 6-10 years
- ❍ In the last 11-20 years
- ❍ More than 20 years ago

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

In the last 3 years, have you taught one or more advanced mathematics classes (e.g., algebra II/trigonometry, pre-calculus, discrete mathematics, abstract or linear algebra, etc.)?

- ❍ Yes
- ❍ No

Answer If What was the content focus of the academy in which you pa... Mathematics Is Selected

Consider the grade level you currently teach or are planning to teach and indicate the extent to which the academy has prepared you to use each of the following strategies in your instruction.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Providing in-depth coverage of fewer mathematics concepts instead of less in-depth coverage of more topics	❍	❍	❍	❍
Developing students' conceptual understanding of mathematics	❍	❍	❍	❍
Practicing computational skills and algorithms	❍	❍	❍	❍
Making connections between mathematics and other disciplines	❍	❍	❍	❍
Engaging students in mathematics applications in a variety of contexts	❍	❍	❍	❍
Involving families in the mathematics education of their children	❍	❍	❍	❍
Applying mathematics concepts to real and authentic life scenarios.	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

Do you currently teach or plan to teach in a self-contained classroom? (i.e., you teach multiple subjects to the same class of students all or most of the day.)

❍ Yes
❍ No

If No Is Selected, Then Skip To Within mathematics, many teachers fee...

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

For teachers of self-contained classes: Many teachers feel more qualified to teach some subject areas than others. As a result of the academy, how well qualified do you feel to teach each of the following subjects at your grade level(s)?

	Not qualified	Somewhat qualified	Adequately qualified	Very well qualified
Life science	❍	❍	❍	❍
Earth science	❍	❍	❍	❍
Physical science	❍	❍	❍	❍
Mathematics	❍	❍	❍	❍
Reading/language arts	❍	❍	❍	❍
Social studies	❍	❍	❍	❍
Technology	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

Within mathematics, many teachers feel better qualified to teach some topics than others. As a result of the academy, how well qualified do you feel to teach each of the following topics at the grade level(s) you teach or plan to teach?

	Not well qualified	Somewhat qualified	Adequately qualified	Very well qualified
Numeration and number theory	❍	❍	❍	❍
Computation	❍	❍	❍	❍
Estimation	❍	❍	❍	❍
Measurement	❍	❍	❍	❍
Pre-algebra	❍	❍	❍	❍
Algebra	❍	❍	❍	❍
Patterns and relationships	❍	❍	❍	❍
Geometry and spatial sense	❍	❍	❍	❍
Functions (including trigonometric functions) and pre-calculus concepts	❍	❍	❍	❍
Data collection and analysis	❍	❍	❍	❍
Probability	❍	❍	❍	❍
Statistics (e.g., hypothesis tests, curve fitting and regression)	❍	❍	❍	❍
Topics from discrete mathematics (e.g., combinatorics, graph theory, recursion)	❍	❍	❍	❍
Mathematical structures (e.g., vector spaces; groups, rings, fields)	❍	❍	❍	❍
Calculus	❍	❍	❍	❍
Technology in support of mathematics	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

Many teachers feel better prepared to guide and develop student learning in some domains of mathematical processing than others. As a result of the academy, how prepared do you feel to provide guidance in the following at the grade level(s) you teach?

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Problem solving	❍	❍	❍	❍
Reasoning and proof	❍	❍	❍	❍
Communication (written and oral)	❍	❍	❍	❍
Connections within mathematics	❍	❍	❍	❍
Connections from mathematics to other disciplines	❍	❍	❍	❍
Multiple representations (e.g., concrete models, and numeric, graphical, symbolic, and geometric representations)	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Mathematics Is Selected

Indicate the extent to which you agree or disagree with the following statements.

	Strongly Disagree	Disagree	Agree	Strongly Agree
Teachers in this academy have a shared vision of effective mathematics instruction.	❍	❍	❍	❍
Teachers in this academy regularly share ideas and materials related to mathematics.	❍	❍	❍	❍
Teachers in this academy are well-supplied with materials for investigative mathematics instruction.	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Science Is Selected

What is your educational background? (select all that apply)

- ❑ Undergraduate major in science or science education
- ❑ Undergraduate minor in science or science education
- ❑ Some graduate coursework in science or science education
- ❑ Graduate-level degree in science or science education
- ❑ Certification to teach science
- ❑ None of the above

Answer If What was the content focus of the academy in which you ... Science Is Selected

As a participant in the academy, have you completed a science course for college credit?

- ❍ Yes
- ❍ No

If Yes Is Selected, Then Skip To Have you taught one or more classes...

Answer If What was the content focus of the academy in which you ... Science Is Selected

When did you last complete a science course for college credit?

- ❍ In the last 5 years
- ❍ In the last 6-10
- ❍ In the last 11-20 years
- ❍ More than 20 years ago

Answer If What was the content focus of the academy in which you ... Science Is Selected

Have you taught one or more classes of advanced science in the last 3 years (e.g., advanced placement physics, advanced placement biology, advanced placement chemistry, etc.)?

- ❍ Yes
- ❍ No

Answer If What was the content focus of the academy in which you pa... Science Is Selected

Consider the grades you currently teach or are planning to teach and indicate the extent to which the academy has prepared you to use each of the following strategies in your instruction.

	Not adequately prepared	Somewhat prepared	Fairly well prepared	Very well prepared
Providing in-depth coverage of fewer science concepts rather than less in-depth coverage of more science concepts	❍	❍	❍	❍
Developing students' conceptual understanding of science	❍	❍	❍	❍
Making connections between science and other disciplines	❍	❍	❍	❍
Engaging students in applications of science in a variety of contexts	❍	❍	❍	❍
Involving families in the science education of their children	❍	❍	❍	❍
Applying science concepts to real and authentic life scenarios	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Science Is Selected

Do you teach or plan to teach in a self-contained class? (i.e., you teach multiple subjects to the same class of students all or most of the day.)

❍ Yes
❍ No

If No Is Selected, Then Skip To Within science, many teachers feel be...

Answer If What was the content focus of the academy in which you ... Science Is Selected

For teachers of self-contained classes: Many teachers feel better qualified to teach some subject areas than others. As a result of the academy, how well qualified do you feel to teach each of the following subjects at your grade level(s)?

	Not qualified	Somewhat qualified	Adequately qualified	Very well qualified
Life science	❍	❍	❍	❍
Earth science	❍	❍	❍	❍
Physical science	❍	❍	❍	❍
Mathematics	❍	❍	❍	❍
Reading/language arts	❍	❍	❍	❍
Social studies	❍	❍	❍	❍
Technology	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Science Is Selected

Within science, many teachers feel better qualified to teach some topics than others. As a result of the academy, how well qualified do you feel to teach each of the following topics at the grade level(s) you currently teach or plan to teach?

	Not well qualified	Somewhat qualified	Adequately qualified	Very well qualified
Earth's features and physical processes	❍	❍	❍	❍
The solar system and the universe	❍	❍	❍	❍
Climate and weather	❍	❍	❍	❍
Structure and function of human systems	❍	❍	❍	❍
Plant biology	❍	❍	❍	❍
Animal behavior	❍	❍	❍	❍
Interactions with living things/ecology	❍	❍	❍	❍
Genetics and evolution	❍	❍	❍	❍
Structure of matter and chemical bonding	❍	❍	❍	❍
Properties and states of matter	❍	❍	❍	❍
Chemical reactions	❍	❍	❍	❍
Energy and chemical change	❍	❍	❍	❍
Forces and motion	❍	❍	❍	❍
Energy	❍	❍	❍	❍
Light and sound	❍	❍	❍	❍
Electricity and magnetism	❍	❍	❍	❍
Modern physics (e.g., special relativity)	❍	❍	❍	❍
Pollution, acid rain, global warming	❍	❍	❍	❍
Population, food supply and production	❍	❍	❍	❍
Formulating hypotheses, drawing conclusions, making generalizations	❍	❍	❍	❍
Experimental design	❍	❍	❍	❍
Describing, graphing, and interpreting data	❍	❍	❍	❍

Answer If What was the content focus of the academy in which you ... Science Is Selected

Based on your experience in the academy, how much emphasis in your teaching will you place on each of the following student learning objectives?

	None	Minimal emphasis	Moderate Emphasis	Heavy emphasis
Increasing interest in science	❍	❍	❍	❍
Learning basic science concepts	❍	❍	❍	❍
Learning important scientific terms and facts of students	❍	❍	❍	❍
Learning science process/inquiry skills	❍	❍	❍	❍
Preparing for further study in science	❍	❍	❍	❍
Learning to evaluate arguments based on scientific evidence	❍	❍	❍	❍
Learning how to effectively communicate ideas in science	❍	❍	❍	❍
Learning about the applications of science in business and industry	❍	❍	❍	❍
Learning about the relationship between science, technology, and society	❍	❍	❍	❍
Learning about the history and nature of science	❍	❍	❍	❍
Preparing for standardized tests	❍	❍	❍	❍

Describe aspects of the academy that increased your content knowledge.

Describe aspects of the mentoring/induction activities that were especially helpful. Why were these helpful to you?

Describe some of the best practices/promising strategies that were demonstrated in the math/ science technology academy in which you are currently enrolled.

How could the math/science technology academy in which you are currently enrolled be improved?

Your participation is greatly appreciated. Thank you for completing the survey!

APPENDIX D

Carnegie Classification of Institutions of Higher Education

The following is a brief description of the Basic Classification Categories of the Carnegie Classification of Institutions of Higher Education (Carnegie Foundation for the Advancement of Teaching, 2010, "Classification Descriptions"). Only categories relevant to the current study have been included.

Doctorate-granting Universities

Includes institutions that awarded at least 20 research doctoral degrees (excluding doctoral-level degrees that qualify recipients for entry into professional practice, such as the JD, MD, PharmD, DPT, etc.).

Abbreviation	Description
RU/VH	Research University with very high research activity
RU/H	Research University with high research activity
DRU	Doctoral/Research University

Master's Colleges and Universities

Includes institutions that awarded at least 50 master's degrees and fewer than 20 doctoral degrees during the update year (with occasional exceptions).

Abbreviation	Description
Master's/L	Masters College and Universities (larger programs)
Master's/M	Masters College and Universities (medium programs)
Master's/S	Masters College and Universities (smaller programs)

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B.S., Nutritional Sciences
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Selected presentations:

Waxman, H.C., Lee, Y.H., & Stillisano, J.R. **Bairrington-Brown, D.**, Alford, B. L., Rollins, K. B. (2011, April). *Urban High School Students' Academically Successful Learning Environment and Educational Aspirations.* American Educational Research Association (AERA) – New Orleans, LA

Waxman, H.C., **Bairrington-Brown, D.**, Lee, Y.H., & Stillisano, J.R. (2010, June) *Evaluating Educational Programs Using the Texas Statewide.* Fifth Annual IES Research Conference Data Warehouse – National Harbor, MD

Barrington, D., Goolsby, R.D., Hostrup, J., Lee, Y.H., Stillisano, J.R., & Waxman, H.C. (2010, April). *Teacher Quality and the Academically Successful School Environment.* American Educational Research Association (AERA) - Denver, CO

Alford, B. L. & **Bairrington, D. N.**, Lee, Y.-H., Stillisano, J., Waxman, H.C. (2010, April). *The Development and Use of the Academic Success Classroom Learning Environment Survey*. American Educational Research Association (AERA) - Denver, CO