MATHEMATICS TEKS CONNECTIONS PROGRAM IN TEXAS: FOLLOW-UP ANALYSIS OF TEACHER TRAINERS' ATTITUDES AND SYSTEMATIC OBSERVATION OF ELEMENTARY MATHEMATICS INSTRUCTION

A Dissertation

by

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ABSTRACT

The purpose of this study is to examine two components of a statewide professional development program designed to improve mathematics instruction in Texas: perceptions of train-the-participants and mathematics classroom processes during mathematics instruction. The dissertation utilized a multiple journal article format to explore each component as a stand-alone, yet connected, study using data from an evaluation of the statewide professional development program.

The first study explored the impact of the train-the-trainer model used in the professional development program. An online survey was administered to participants to determine their attitudes about a new mathematics curriculum, as well as the potential impact of the curriculum on teacher knowledge and student achievement in mathematics. Descriptive statistics identified the number of trainers who provided professional development in Texas. Independent sample *t*-tests revealed no statistically significant differences in the attitudes of the participant groups. A content analysis identified themes related to *conceptual knowledge*, *instructional strategies*, and *classroom interaction* as possible impact on teacher content knowledge and student achievement.

The second study examined the long-term effects of the statewide professional development program on mathematics classroom processes from one elementary school district in Texas. Quantitative analysis of the systematic classroom observation indicated significant differences in the classroom processes of teachers who participated versus those who did not participate in the professional development program.

Descriptive statistics identified the most frequently observed Setting, Instructional Orientation, and Instructional Practice used by teachers, and *t*-test identified significant different in the classroom processes of teachers who participated versus those who did not participate in the professional development program.

The findings from this dissertation have implications on mathematics education research. First, curriculum developers should monitor trainers' attitudes about curriculum materials on an on-going basis to establish differences over time. Second, classroom observations should follow professional development to determine the long term effects of the strategies used by teachers during mathematics instruction.

DEDICATION

This project is dedicated to

JAH

"Our deepest fear is not that we are inadequate. Our deepest fear is that we are powerful beyond measure. It is our light, not our darkness that most frightens us. We ask ourselves, Who am I to be brilliant, gorgeous, talented, fabulous? Actually, who are you *not* to be? You are a child of God."

~Marianne Williamson

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"For I know the plans I have for you," declares the Lord, "plans to prosper you and not to harm you, plans to give you hope and a future." Jeremiah 29:11 An undertaking of this magnitude would not have been possible without the source of my strength. Glory and honor to God for all the many blessings He has bestowed upon me. When I thought, "I can't do this." He said, "Yes, you can. Follow me." Enough said!

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CHAPTER I

INTRODUCTION

Overview

Systemic initiatives to provide teachers with effective professional development (PD) are an on-going issue in mathematics education research (Hill & Ball, 2004; Laura, McMeeking, Orsi, & Cobb, 2012; Ostermeier, Prenzel, & Duit, 2010). This is largely due to international and national concerns about the poor mathematics performance of K-12 students on various high-stakes assessments (Gonzales et al., 2004; Hanushek, Peterson, & Woessmann, 2010; National Center for Education Statistics, 2009). Several researchers provide evidence about the profound influence of teacher quality of students' ability to learn mathematics (Akiba, LeTendre, & Scribner, 2007; Darling-Hammond, 1999; Stewart, 2011). If students are to rise to the expected standard, then their teachers will need more effective PD to follow through on the professional standards outlined by the National Council of Teachers of Mathematics (National Council of Teachers of Mathematics, 1991).

Extant literature is replete with studies designed to evaluate professional development programs (Garet et al., 2010; Garet et al., 2011; Hill & Ball, 2004). Understandably, many of these evaluations focus on teachers' content knowledge (Bailey, 2010; Hill & Ball, 2004) as well as the design issues related to format and structure (Garet, Porter, Desimone, Birman, & Yoon, 2001; Koellner, Jacobs, & Borko, 2011; Loucks-Horsley & Matsumoto, 1999). While these topics are certainly beneficial to advance the knowledge base on effective PD for teachers, it is also necessary to broaden the scope and address other important issues which may have some impact on teacher development and student achievement.

The goals of this project are to use data from a statewide PD evaluation to: (a) determine the extent of teacher training after statewide PD, (b) provide a description of the attitudes of trainers about a new mathematics curriculum, and (c) observe mathematics classroom processes. To carry out the goals of this project, the purpose is to examine two components of a statewide PD program in Texas. The first component responds to the call for research on professional developers (Hill, 2007; Whitcomb, Borko, & Liston, 2009), and the second component responds to the need for classroom observation after teacher professional development (Desimone, 2009). Professional developers play a large role in teacher development because they are responsible for staying abreast of current issues in teacher education, and then creating and disseminating the material to K-12 staff. On the other end of the spectrum, observations of classroom processes after PD may determine the extent to which the strategies are implemented during mathematics instruction.

Description of Mathematics TEKS Connections Project

In 2005, the Texas Education Agency allotted $4.7 million to the development of the Mathematics Texas Essential Knowledge and Skills (TEKS) Connections (MTC) project. The project was funded to provide more effective learning opportunities to K-12 administrators and teachers, as well as teacher educators and preservice teachers. The primary goal of MTC was to improve mathematics instruction and student achievement throughout the state. Three objectives guided the project: (a) facilitate greater awareness of

Math TEKS content connections and the connections between the TEKS, instruction, and assessment, (b) facilitate mathematics teachers' ability to instruct effectively using TEKS, and (c) facilitate a common core of knowledge and methods between teachers and administrators and K-12 teacher preparation programs.

A train-the-trainer (TTT) model of PD was used to disseminate the MTC curriculum materials. A local research university, in partnership with two of Texas' Regional Education Service Centers (ESC), developed the modules for use with the TTT workshops. The modules covered mathematics content in five areas: (1) K-2, (2) 3-5, (3) 6-8, (4) 9-12, and (5) Geometry. The module development team invited members from their own ESC and the remaining ESCs, as well as faculty from state universities, community colleges, and alternative certification programs to participate in the TTT workshops. TTT was the preferred method of dissemination because of its potential impact to reach more educators throughout the state. The trainers received five 2-day TTT workshops to cover all curriculum modules starting in the 2007 spring semester.

In order to measure the effectiveness of the program, an evaluation team emailed a follow-up survey to the trainers in fall 2010 semester. The survey focused on the trainers' attitudes about the MTC curriculum. In addition, the survey asked open-ended questions about the curriculum and its potential to increase teacher knowledge and student achievement. Also in fall 2010, the evaluation team conducted systematic classroom observation of elementary teachers and their students during mathematics instruction. The present study used the evaluation data to describe the results of the TTT model and the classroom observations.

Presentation of Dissertation Format

The current research project is divided into four distinct chapters. In particular, Chapters II and III are complete journal manuscripts, and as such are written for peer-review and subsequent submission for publication. A brief summary of each chapter follows:

- Chapter I - Introduction and general structure of the dissertation
- Chapter II – A quantitative study examines the TTT model utilized to implement the statewide PD program. Additionally, this study explores the trainers' attitudes of a newly developed mathematics curriculum, as well as the perceptions about the impact of the curriculum on teacher content and pedagogical knowledge and student achievement.
- Chapter III – A quantitative study examines the classroom processes of elementary teachers and their students during mathematics instruction. Systematic classroom observations provided the data for this study.
- Chapter IV – General conclusions for the entire research project, and implications for mathematics education.
- Chapter V – Supplementary instruments used to collect data for each interior study.

Chapter I (this chapter) provides a brief introduction to the dissertation research project which includes a brief description of the literary problem and the general research question guiding this project.

Chapter II reports the findings from a follow-up online survey given to teacher trainers.

The purpose of this study is to describe the impact of the statewide training model. I analyzed data collected from 92 trainers throughout the state of Texas. The data measure consisted of two general questions about the training model, 30 Likert-type items, and two open-ended questions. Statistical analyses included descriptive statistics, exploratory factor analysis, crosstabs with chi-square analysis, and content analysis to report the findings the online survey.

Chapter III presents the results from systematic classroom observation. The purpose of this study is to examine is significant differences exited between teachers who did and did not participate in the statewide professional development program. The data collected came from three classroom observation instruments – two low-inference instruments and one high-inference instrument. The researcher analyzed data collected from 46 elementary teachers and 184 students. Statistical analyses included independent samples t-tests and descriptive statistics.

Chapter IV presents the conclusions to the research project. A summary of each journal articles finding's is provided with relevance to the entire study. Additionally, the summative findings for this project in relation to statewide professional development are discussed, which also includes overall implications for practice, professional development, prior research, and professional development.

Chapter V provides the supplementary material related to the research project. Appendices include Appendix A (MTC Follow-up Survey), Appendix B (MTC Teacher Observation Schedule), Appendix C (MTC Student Observation Schedule), and Appendix D (Overall Mathematics Observation Schedule).

CHAPTER II

MTC PROGRAM IN TEXAS: A FOLLOW-UP SURVEY OF TEACHER TRAINERS' ATTITUDES ABOUT STATEWIDE MATHEMATICS CURRICULUM

Introduction

There is no denying the importance of professional development (PD) to improve the teaching and learning of mathematics in K-12 education (Ball & Cohen, 1999; Borko, 2004; Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009; Garet et al., 2001 Guskey, 2002; Loucks-Horsley & Matsumoto, 1999; National Council of Teachers of Mathematics, 1991; Wei, Darling-Hammond, & Adamson, 2010. Nearly every effort to reform mathematics education has a component in which teachers need PD to learn new content, curriculum, and/or instructional strategies (Ball, Hill, & Bass, 2005; Desimone, Porter, Garet, Yoon, & Birman, 2002; Fennema et. al., 1996; Franke, Carpenter, Levi, & Fennema, 2001; Huffman, Thomas, & Lawrenz, 2003). In the *Professional Standards for Teaching Mathematics*, the argument is made for teachers to adopt new roles and discourse for effective teaching of mathematics (National Council of Teachers of Mathematics, 1991). Consequently, a growing body of research highlights various state and local efforts to provide teachers with quality mathematics PD (Borko, Elliott, & Uchiyama, 2002; D'Ambrosio, Boone, & Harkness, 2004; Higgins & Parsons, 2009; Hill & Ball, 2004; Ostermeier et al., 2010).

What about those who train teachers? Teacher trainers (also referred to as teacher educators, professional developers, or PD providers) have a unique role in the PD landscape. Stein, Smith, and Silver (1999) maintain professional developers, like teachers, have to modify their craft and enhance their knowledge, skills, and disposition to accommodate new state and local standards. Murray and Male (2005) highlight some of the challenges teacher educators face when they shift from being classroom teachers, to teachers of teachers in higher education. Hill (2007) suggests more research is needed which focuses on topics to help us understand how PD providers are prepared to teach teachers.

In their discussion of PD models and practices, and, in particular, how to scale up these models, Whitcomb, Borko, and Liston (2009) claim PD designers have to put careful thought into the overall features of the program in order for providers to train teachers toward the program expectations. Furthermore, they emphasis the need for designers to prepare curriculum materials and resources that align with the program goals and objectives, as well as allow the providers to adapt to diverse settings and still maintain a high level of integrity with program implementation.

The issue of PD scalability continues to be a primary concern for state policymakers and educators. In other fields, PD models such as train-the-trainer (TTT) are used frequently to facilitate the preparation of new and experienced trainers. The available research on TTT model in teacher education is limited. Missing, in particular, are data that explore the attitudes of teacher trainers. The purpose of this study, then, is to describe the results from a follow-up survey administered to teacher trainers after participation in a TTT program. Specifically, the study reports the findings on the trainers' attitudes about the content of the curriculum materials.

Description of Mathematics TEKS Connections Program

In 2005, the Texas Education Agency implemented the Mathematics Texas Essential Knowledge and Skills (TEKS) Connections (MTC) program. The purpose of the program was to develop and disseminate mathematics PD to K-12 teachers, teacher educators, administrators, and preservice teachers, and the overall goal was to improve mathematics instruction and student achievement throughout Texas. The TEKS are Texas' state standards for all K-12 content areas. Three core objectives established the guidelines for the program: (a) assist all groups in their awareness of the math TEKS and how to connect it to instruction and assessment; (b) help teachers effectively use the TEKS during mathematics instruction, and (c) establish a knowledge base of the TEKS, instruction, and assessment among all education stakeholders.

One component of the project was the use of a train-the-trainer (TTT) model of PD to disseminate the MTC curriculum. The TTT model was developed in collaboration with a large local university, and members from Texas' Regional Education Service Centers (ESC). The collaborators developed five mathematics modules, one for each grade band: (a) K-2, (b) 3-5, (c) 6-8, (d) 9-12, and (e) geometry. Mathematics and mathematics education faculty from the university served as content advisors for the teams who developed the modules. The development team included some members from K-12 education, ESCs, and university faculty. The curriculum was developed to complement a TTT workshop format.

The TTT workshops started in the spring 2007. The participants had several opportunities to examine the math TEKS at each grade band, explore connection between the TEKS, and learn more effective instructional and assessment methods for the content.

These elements dominated the curriculum material and the focus of the workshops. At the conclusion of the TTT workshop, the trainees responded in kind by providing PD to teachers within their assigned regions.

In an effort to expand the scope of the MTC program beyond classroom teachers, a separate seminar was developed to impact K-12 teacher preparation programs. Likewise, an objective of this seminar was to establish a common core of knowledge and methods between K-12 teachers, administrators, and preparation programs. Participants to this seminar included mathematics educators from local universities and community colleges, as well as faculty from alternative certification programs.

The primary goal of this component was the same as the overall project: to improve mathematics instruction and student achievement with a focus on making connections between the Math TEKS, instruction, and assessment methods. The content of the pre-service module reflected current research on best practices for teaching mathematics content for all K-12 grade levels, and served as a (1) resource for teacher education mathematics methods instructors, (2) material to facilitate connections between the TEKS and mathematics content, and (3) supplement to existing methods course curriculum materials.

The module was field-tested by mathematics and mathematics education professors, instructors, and graduate assistants from the partnering university.

Slightly different from the grade bands from the overall project, the modules for the pre-service components were: K-4, 5-8, and 9-12. A 3-day TTT workshop completed the training for the pre-service education seminar.

Conceptual Framework

The purpose of this section is to provide a link between the existing body of research on TTT in teacher education, as well as research on curriculum attitudes, and the need for the research questions asked in this study. Following this section is a description of the study methods, then the results, and conclusions.

Train-the-Trainer Model

Train-the-trainer is a model of PD whereby a small group of expert teacher leaders facilitate a training workshop to teach more lead teachers about new educational programs (e.g., curricula, instructional strategies, technology, to name a few). After the initial training workshop, the newly trained teacher leaders are responsible for disseminating the information to classroom teachers, and usually within the region they are assigned to work (Pancucci, 2007). The primary reason for use of TTT has been to provide more opportunities for teachers to receive quality PD. Hill (2007) addresses the lack of quality PD in her description of the types of graduate education and PD available to teachers.

In order to determine the extent to which the TTT model was implemented throughout Texas, it became important to ask the following research question:

1) *To what extent did the trainers provide professional development to K-12 teachers?*

Curriculum Attitudes

The study of attitudes has a long history in social psychology (Albarracin, Johnson, & Zanna, 2005). Eagly and Chaiken (1993) define attitude as "*a psychological tendency that is* *expressed by evaluating a particular entity with some degree of favor or disfavor*." One of the main purposes of research on attitudes is to determine the extent to which people agree or disagree with an object (e.g., policy, person, place), as well as their behavior toward the object (Ajzen & Fishbein, 2005) . This research has also added to our understanding of constructs that influence attitudes and vice versa (e.g., affect, beliefs, and behaviors) (Albarracin, Zanna et al., 2005).

More than 50 years of research acknowledge the importance and impact of the mathematics curriculum on the teaching and learning process. Teachers rely heavily on the curriculum to guide their instructional practices (Schoenfeld, 2004). Research findings suggest teachers with positive attitudes about the curriculum are more likely to implement the curriculum in the way the developers intended (Handal & Herrington, 2003; Lloyd, 1999; Penuel, Fishman, Yamaguchi, & Gallagher, 2007). Positive attitudes have been identified when teachers have an opportunity to participate in curriculum development (Ponte, Matos, Guimaraes, Leal & Canavarro, 1994) in particular.

Like teachers, those who have the responsibility to train them on new curriculum practices play a major role in teacher PD. Teacher trainers were often classroom teachers, first, so they have an established frame of reference related to the curriculum and other classroom contexts (Murray & Male, 2005). Very little research, however, exists on trainers' attitudes in the TTT literature. This is especially true of the trainers' attitudes about the curriculum materials they used during participation in a TTT program. This body of research provides the reason for the following research questions:

2) *Are there significant differences between the Specialists and Non-Specialists attitudes about the MTC curriculum?*

3) *What are the trainers' attitudes about the MTC curriculum for improving mathematics content and pedagogy of classroom teachers?*
4) *What are trainers' attitudes about the impact of the MTC curriculum for improving student achievement in mathematics?*

Method

Participants

An online survey was sent to the 304 participants from the TTT workshops and 95 (24%) responded. The 95 participants self-reported their job title during the training workshops as instructional/curriculum specialists from Texas regional Education Service Centers, K-12 mathematics teachers, university faculty, and representatives from consulting firms. For the purposes of this study, the participants were divided into training groups: Specialists (*N*=59, 62.8%) and Non-Specialists (*N*=35, 37.2%).
Table 1 displays the breakdown of study participants.

Table 1
Job Titles of Participants (*N*=95)

	# of Participants	% of Sample
Specialists		
Instructional Specialist/Coach/Coordinator	59	62.8%
Non-Specialists		
Department Chair/Head/Director	10	10.0%
K-12 Teacher	10	10.0%
Math Consultant	12	12.0%
University Faculty	3	4.0%

Note. MTC Follow-Up Survey.

Table 2 shows the educational background and years of teaching experience, including mathematics teaching, at the time of the study. The majority of the teachers held a Master's degree (65.3%), had more than 15 years teaching experience (73.9%), and more than 15 years teaching mathematics (68.1%).

Table 2
Participant Education and Experience

		% of Sample
Highest degree held (*N*=95)		
	Bachelors	17.9%
	Masters	65.3%
	Doctorate	11.6%
	Other	5.3%
Years of Teaching (*N*=92)		
	0-1	1.1%
	6-10	7.6%
	11-15	17.4%
	More than 15	73.9%
Years of Mathematics Teaching (*N*=94)		
	2-3	1.1%
	6-10	10.6%
	11-15	20.2%
	More than 15	68.1%

Note. MTC Follow-Up Survey.

The MTC project developed a training module to support K-12 classrooms. Table 3 displays percentage of participation in each of the training sessions: K-2, 3-5, 6-8, 9-12, and Geometry.

Table 3
Participation in MTC Training Modules

MTC Training Module	% of Sample
K-2	36.1%
3-5	44.3%
6-8	48.5%
9-12	43.3%
Geometry	25.8%

Note. Sample does not add to 100% as some individuals may have attended multiple training modules.

Instrumentation and Measures

As part of the evaluation of the statewide PD program, the MTC Follow-Up Survey was developed to measure some of the behaviors and experiences of the trainers (See Appendix A). The survey consisted of the following components: (a) Demographics; (b) MTC curriculum; (c) MTC Training; and (d) Open-Ended questions. A description of the specific items measured in this study is presented below.

MTC Training. Two questions measured the extent of implementation of the MTC PD program: (a) "*Since attending the TOT workshop(s), have you conducted mathematics professional development for others using the MTC materials?*" and "*If yes, how many mathematics professional development sessions have you conducted?*"

MTC Curriculum. Thirty statements measured the trainers' perceptions about the MTC curriculum (e.g., *The MTC curriculum developed conceptual understanding in mathematics*). Participants responded to the statements on a four-point Likert-type scale (1 = strongly disagree; 4 = strongly agree). All 30 statements were used to describe the trainers' attitudes about the curriculum.

Open-Ended Questions. The researcher used two of the open-ended questions to measure the trainers' perceptions about the impact of the MTC curriculum on teachers' knowledge: "*How do you think the MTC curriculum can improve mathematics content and pedagogical content knowledge of teachers?*" and "*How do you think the MTC curriculum can improve students' achievement in mathematics?*"

Data Collection Procedures

The survey was developed and administered to participants in fall 2010. The final follow-up survey was emailed to all participants of the TTT model within three years of their initial TTT program. The participants received weekly reminders over the course of a three-week period. A total of 95 (31%) responses were collected when the survey closed.

Data Analysis

Research Question One. The goal of this research question was to determine the extent of implementation of the PD program by the trainers after they participated in the TTT workshop. Descriptive statistics in the form of frequencies was the best method to analyze the nominal data obtained from this question.

Research Question Two. The first goal with this research question was to do a principal components analysis (PCA) (or, exploratory factor analysis) to determine whether the 30 statements could be redefined into a few dimensions, and still explain all or most of the variability in the data set (Sheskin, 2007). Using the results from the PCA, the researcher then computed descriptive statistics as well as multivariate analysis of variance (MANOVA) to determine any significant differences in the trainers' attitudes about the MTC curriculum. The description and results of the PCA are provided in this section, and the results of the inferential test are described in the Results section of this study.

Principal components analysis. A PCA with varimax rotation was performed on the 30 statements in an attempt to identify a few dimensions that are independently correlated. Four factors were extracted from the data. Table 4 provides the means, standard deviations, scale reliabilities and correlations from the four factors.

The means ranged from 2.97 to 3.35, and the standard deviations were moderate, which indicates some variation among the trainers' responses to the statements. Cronbach's alpha was performed to test the internal consistency of the four factors (Sheskin, 2007). The scales ranged from .90 to .96, which suggests a high degree of consistency. Pearson's r was computed to assess the degree of relationship between the factors. The Development and both Conceptual and Interdisciplinary factors were highly correlated, as well as the relationship between Conceptual and Interdisciplinary. A moderate relationship exists between Differentiation and each of the other factors.

Table 4
Descriptives of Factors Extracted from MTC Curriculum

Factor	*M*	*SD*	Cronbach's Alpha	Pearson's r			
				Development	Conceptual	Interdisciplinary	Differentiation
Development	3.35	.54	.96	1.00	.904	.800	.597
Conceptual	3.32	.55	.95		1.00	.858	.642
Interdisciplinary	3.17	.54	.90			1.00	.749
Differentiation	2.97	.61	.92				1.00

Note. Correlation is significant at the 0.01 level.

Four factors emerged from the PCA, and the factors were named to give the best meaning of the statements. The first factor, *Curriculum – Development* (from here known as *Development*), focused on some of the best practices for curriculum development (e.g., "The MTC curriculum material appropriately utilized the instructional technique of scaffolding.") The second factor, *Curriculum – Conceptual* (from here known as *Conceptual*), reflected on some of the instructional practices used to teach mathematics for conceptual understanding (e.g., "The MTC material conceptualized mathematics being taught for higher-order and critical thinking skills.") The third factor, *Interdisciplinary*, identified some of the cross-curricular practices to help students connect mathematics to other academic content (e.g., "The MTC curriculum encourages students to explore mathematics in diverse career paths (e.g., medicine, engineering, nursing, law, teaching, mechanics, cooking, etc.)") The last factor, *Differentiation*, reflected the curriculum's ability to reach diverse populations of students (e.g., The MTC curriculum supports modifications for English language learners.")

The loadings on the 30 variables are ordered and grouped by the loading size. Loadings under .35 are not recorded. A PCA with varimax rotation was performed on the 30 items from the MTC follow-up survey for a sample of 95 trainers. The first factor, Development, explained 25% of the variance, with the second factor, Conceptual, contributing about 18%, the third factor, Interdisciplinary, contributing about 16%, and the fourth factor, Differentiation, contributing about 15%. Table 5 provides the factor loadings.

Table 5
Factor Loadings for Principle Component Analysis with Varimax Rotation

Items	Factor 1: Development	Factor 2: Conceptual	Factor 3: Interdisciplinary	Factor 4: Differentiation
15) The MTC curriculum developed conceptual understanding in mathematics	.841			
19) The MTC manipulative materials used were interactive	.789			
10) I learned new ideas and/or skills by attending the MTC professional development	.768			
23) The MTC curriculum emphasized the development of mathematical thinking and reasoning skills	.743			
24) The MTC material appropriately utilized the instructional technique of scaffolding	.726			
20) The MTC manipulative materials were useful for developing mathematical concepts	.726			
9) The MTC materials provided were useful in learning the curriculum	.694			
12) The sequence of mathematics topics in the MTC curriculum was appropriate	.633			
16) The MTC materials were developmentally appropriate for the grade level I participated in	.574			
13) The mathematics content of the MTC curriculum was satisfactory	.555			
17) The MTC instructional materials were easily applicable to other teaching approaches	.536			
21) The technology (e.g., calculators, graphing calculators, geoboard, etc.) was used appropriately within each grade band to develop conceptual understanding in mathematics	.485			
22) The MTC instructional representations (e.g., concrete, pictorial, real-world, symbolic, etc.) were used appropriately with the mathematical ideas	.445	.738		
18) The examples provided in the MTC instructional materials were relevant for each topic	.439	.719		
28) The MTC curriculum provides a clear understanding of the different modes of assessment (e.g., formative, summative, standards-correlated, and authentic, etc.)		.641		
25) The MTC material conceptualized mathematics being taught for higher-order and critical thinking skills		.637		
14) The mathematics content of the MTC curriculum had vertical and horizontal alignment across grade levels		.627		
32) The MTC curriculum makes connections to students' prior knowledge in mathematics		.556		
26) The MTC curriculum integrates problem-solving strategies		.495		
11) All the MTC professional development activities were useful in learning the material		.469		
36) The MTC curriculum connects mathematics to applications in everyday life			.779	
38) The MTC curriculum emphasizes the use of interdisciplinary skills (e.g., reading, writing, vocabulary, performance, cooperation, collaboration, etc.)			.729	
37) The MTC curriculum encourages students to explore mathematics in diverse career paths (e.g., medicine, engineering, nursing, law, teaching, mechanics, cooking, etc.)			.648	
35) The MTC curriculum supports gender equity in mathematics			.640	
33) The MTC curriculum allows for multiple modes of communication (e.g., teacher-student, student-student, etc.)			.585	
27) The MTC curriculum explains how to create more effective lesson plans using children's mathematical thinking			.509	
31) The MTC curriculum supports modifications for students with special needs				.912
30) The MTC curriculum supports modifications for English language learners				.857
29) The MTC curriculum supports modifications for different ability levels				.794
34) The MTC curriculum includes diverse cultural perspectives in mathematics				.624
Eigenvalues	7.40	5.39	4.91	4.45
Total variance explained	24.67	17.99	16.37	14.85

Research Question Three and Research Question Four. A qualitative content analysis (Lincoln & Guba, 1985) of the open-ended responses was performed. According to

Hsieh and Shannon (2005), qualitative content analysis is “a research method for the subjective interpretation of the content of text data through the systematic classification process of coding and identifying themes or patterns.” (p. 1278) Hsieh and Shannon provide three approaches to qualitative content analysis: (a) conventional, (b) directed, and (c) summative. For the purposes of this study, a conventional content analysis was performed because “existing theory or research literature … is limited” (p. 1279), an advantage to this approach. Thus, an inductive pattern of analysis will be applied to the text data. The steps for the conventional content analysis included: (a) collecting the responses from each question and keeping the responses in a separate data file; (b) reading the responses to get a sense of the whole; (c) unitizing and coding the data; (d) describing the emergent themes and labeling similar data; (e) sorting the codes into categories based on relationships between the responses; and (f) labeling the emergent categories into broad clusters. Finally, definitions were provided for each category and subcategory.

Protection of Human Subjects

The Institutional Review Board (IRB) at Texas A&M University reviewed the IRB proposal for the use of existing data and determined this research project to be exempt.

Results

Research Question One

To what extent did the trainers provide MTC professional development to Texas teachers? The online survey asked two questions to determine the extent of training throughout Texas.

The first question ascertained how many of the trainers conducted PD with Texas teachers. Table 6 displays the results of whether the trainer conducted PD after participation in the MTC training workshops. Of the 95 participants, 78 (82.1%) conducted PD with Texas teachers and 17 (17.9%) did not conduct any PD to teachers.

Table 6
MTC Professional Development Conducted in Texas

Conducted PD in Texas	Total	Percentage
Yes	78	82.1
No	17	17.9

Source. MTC Follow-up Survey.

The second question ascertained how many PD sessions the trainers conducted after participation in the MTC training workshops. Table 7 displays the frequencies for the training sessions. Most of the trainers provided between one and three (22.4%) PD workshops throughout Texas. Many of the trainers provided between seven and nine (18.4%) workshops.

Table 7
Frequency of Trainings Conducted by MTC Participants (*N*=98)

Number of Trainings	Frequency	Percent
0	22	22.4%
1-3	22	22.4%
4-6	16	16.3%
7-9	18	18.4%
10+	20	20.4%

Source. MTC Follow-up Survey.

Some of the trainers (22.4%) did not provide any PD to K-12 teachers. The maximum number of PD workshops provided was between one and three (22.4%) and the minimum number was between four and six (16.3%).

Research Question Two

Are there significant differences in the trainers' attitudes about the MTC curriculum? The exploratory factor analysis revealed four factors related to the mathematics curriculum – content, materials, interdisciplinary, and differentiation. The mean scores for the four factors are presented in Table 8. The means ranged from 2.94 to 3.38, and most of the means have a value more than three which indicates the trainers were more likely to agree with the statements about the mathematics curriculum. The lowest mean (2.94) was related to Differentiation in curriculum and the highest mean was related to curriculum Materials (3.38). The standard deviations were moderate, which suggests some variation in their level of agreement about the statements.

Table 8
Mean Values for Trainers' Attitudes about the MTC Curriculum

	Specialists (*N*=59)		Non-Specialists (*N*=34)	
Factors	*M*	*SD*	*M*	*SD*
Materials	3.38	.55	3.30	.54
Content	3.37	.55	3.24	.54
Interdisciplinary	3.20	.55	3.15	.53
Differentiation	2.94	.66	3.03	.55

Source. MTC Follow-Up Survey.

A one-way MANOVA was conducted to determine significant differences in the trainers' attitudes about the MTC curriculum. No statistically significant (p < .05) differences existed in the trainers attitudes about the curriculum (See Table 9).

Table 9
MANOVA Results for Trainers' Attitudes about the MTC Curriculum

Effect	Wilks' lambda	*F*	*df*	*p*
MTC curriculum	.948	1.20	1, 91	.314

Next, the researcher explored significant differences in the trainers' attitudes about the MTC curriculum according to whether the trainers conducted PD with K-12 teachers. The mean scores are presented in Table 10. The means ranged from 2.87 to 3.36, and most of the means have a value more than three which indicates the trainers were more likely to agree with the statements about the mathematics curriculum. The lowest mean (2.87) was related to Differentiation in curriculum and the highest mean was related to curriculum Materials (3.36). Most of the standard deviations were moderate, which suggests some variation in their level of agreement about the statements.

Table 10
Mean Values According to Amount of Professional Development Conducted After Training Workshop

	Yes (*N*=78)		No (*N*=16)	
Factors	*M*	*SD*	*M*	*SD*
Materials	3.36	.56	3.25	.52
Content	3.31	.57	3.37	.47
Interdisciplinary	3.17	.57	3.16	.37
Differentiation	2.99	.64	2.87	.50

Source. MTC Follow-Up Survey.

A one-way MANOVA was performed to determine significant differences in the trainers' attitudes about the MTC curriculum according to whether they provided PD to teachers after the trainers participated in the TTT workshop. There was no statistically significant ($p < .05$) difference in the trainers' attitudes about the MTC curriculum after they provided PD (See Table 11).

Table 11
MANOVA Results for Trainers' Attitudes after Providing Professional Development

Effect	Wilks' lambda	*F*	*df*	*p*
Conduct PD (Yes/No)	.912	2.13	1, 91	.083

Last, the researcher explored significant differences in the trainers' attitudes about the MTC curriculum according to how many PD sessions they conducted with K-12 teachers. The mean scores are presented in Table 12. The means ranged from 2.95 to 3.47, and most of the means have a value more than three which indicates the trainers were more likely to agree with the statements about the mathematics curriculum. The lowest mean (2.95) was related to Differentiation in curriculum and the highest mean was related to curriculum Materials and Content (3.47). Most of the standard deviations were moderate, which suggests some variation in their level of agreement about the statements.

Table 12
Mean Values for Trainers' Attitudes According to Number of Sessions Conducted with K-12 Teachers

	1-3 Sessions (*N*=22)		4-6 Sessions (*N*=16)		7-9 Sessions (*N*=18)		10+ Sessions (*N*=20)	
Factors	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Materials	3.47	.66	3.12	.62	3.40	.44	3.43	.41
Content	3.47	.70	3.09	.61	3.32	.44	3.35	.46
Interdisciplinary	3.29	.68	3.03	.59	3.21	.49	3.17	.51
Differentiation	2.96	.73	2.96	.53	3.11	.63	2.95	.68

Source. MTC Follow-Up Survey.

A one-way MANOVA to determine significant differences in the trainers' attitudes about the MTC curriculum according to how much professional development they provided to K-12 teachers. There was no statistically significant ($p < .05$) difference in the trainers' attitudes about the MTC curriculum according to how much professional development they provided to teachers (See Table 13).

Table 13
MANOVA Results for Differences in Attitudes According to Number of Sessions Conducted with K-12 Teachers

Effect	Wilks' lambda	*F*	*df*	*p*
Number Conducted	.844	1.01	3, 72	.439

Research Question Three

What are the trainers' perceptions about the MTC curriculum improving mathematics content and pedagogy of classroom teachers? The content analysis of the open-response question revealed five themes: *conceptual knowledge*, *standards-based knowledge*, *teacher knowledge*, *instructional strategies*, and *curriculum alignment*.

One goal of the MTC program was to infuse mathematics teaching and learning with conceptual knowledge. According to Hiebert and Lefevre (1986), conceptual knowledge is "characterized most clearly as knowledge that is rich in relationships. It can be thought of as a connected web of knowledge, a network in which the linking relationships are as prominent as the discrete pieces of information." (p. 3) The trainers indicated several instances in which the curriculum would improve teachers' conceptual knowledge.

For example, some of the trainers commented:

- MTC curriculum teaches the conceptual understanding of the math;
- MTC 9-12 allows teachers to move from concrete to abstract, modeling the strategy for the classroom;
- Guides the teachers to recognize the need to take students from the concrete to the pictorial to the abstract representations. This is key when learning any new concept;
- Provides structure for intentional instruction that bridge from concrete to abstract;
- Mathematics pedagogy can be improved through the use of conceptual development as outlined in the MTC workshop material; and
- By building a conceptual understanding of the concept, bridging that understanding, and connecting it to the abstract level of problem solving

Another goal of the MTC program was to help teachers better understand their state academic standards, Texas Essential Knowledge and Skills (TEKS), and make more connections in the classroom. One trainer commented:

> Many teachers are weak in understanding the TEKS as they are written. MTC helps apply the TEKS to the concept taught with examples and manipulatives and

strategies needed to teach the concept. Teachers that use this material will be much better prepared to teach their individual courses in Algebra, Geometry, Algebra 2, and Pre-Calculus. It is especially useful for the alternatively certified teacher.

Other trainers posited the MTC curriculum offered:

- Different ways to implement TEKS-based activities;
- Provides specificity of TEKS;
- It did provide clarification to various TEKS regarding cognitive and content expectations of equivalent fractions; and
- I would give them more training on the TEKS and the verbs used in the TEKS and what they are saying

Teacher content knowledge is characterized as the depth of understanding of mathematical concepts and the relationships made throughout the body of mathematics content. Some of the trainers provided a few instances in which teacher knowledge has a direct impact on student achievement:

- The better a teacher understands his/her content, the better the decisions he/she will make in planning and instruction;
- Teachers have to make the math knowledge and connections their own before they can share it with students;
- So many teachers do not have a thorough understanding of the mathematics. These PD sessions provide good materials to study, great opportunity to work with other highly qualified teachers. Great opportunity to gain new knowledge;

- The activities help teachers understand the "why" and "how" of a concept. It helps them see the progression of a concept; and
- If teachers will implement the curriculum, it will improve not only the teachers, but student knowledge tremendously.

Instructional strategies are the methods teachers use to deliver content in the classroom, and in organized sequence so as to ensure student learning in the environment (e.g., direct instruction, graphic organizers, and scaffolding, to name a few). The trainers provided some important ways in which they thought the curriculum would help with instructional strategies during mathematics instruction:

- Teachers who use activities from the MTC training will use the 5E lesson model which is more engaging for kids. Hopefully, teachers will see the benefits of this model and will learn to be more of a facilitator than a lecturer;
- The 5E model makes the material teacher friendly;
- Increase the use of online resources to differentiate instruction; and
- Gives examples of good questioning.

Curriculum alignment occurs when each grade level follows a natural sequence from the previous grade levels. The sequence allows the teacher to identify what prior knowledge students should have as they enter the next grade level. The trainers made a few comments about the alignment of the MTC curriculum:

- I would advise for each of the grade levels indicate the TEKS from the previous grades, that way, the teacher as she/he prepares for instruction they can have a better understanding of the students' academic knowledge; and

- MTC was good at focusing teachers on vertical alignment of the math concepts. It also gave examples of different strategies for teaching the math content.

Research Question Four

What are trainers' perceptions about the impact of the MTC curriculum for improving student achievement in mathematics? The content analysis of the open-response question revealed four themes: *conceptual knowledge*, *instructional strategies*, *classroom interaction*, and *teacher input*.

The trainers provided similar responses about conceptual knowledge about the impact the MTC curriculum may have on student achievement. The trainers indicated several instances in which the curriculum would improve conceptual knowledge. Some of the comments were:

- Deeper thinking and linking conceptual ideas with skills and practice;
- By building a conceptual understanding of the concept, bridging that understanding, and connecting it to the abstract level of problem solving;
- It helps students make connections to what they learned & how to apply those skills to solve other problems;
- The different models and modalities of instruction support students to close the gaps in their math instruction while building a deep conceptual level of understanding for future learning;
- Students who have a greater conceptual understanding can more easily apply that understanding to multiple scenarios; and
- Build concepts conceptually for deeper understanding and true learning of ideas

Instructional strategies are methods teachers use to deliver content in the classroom. One trainer commented, “By varying strategies, a competent teacher can help to improve student achievement.” Another stated, “Use of sample activities in the classroom can improve student achievement.” Some of the other comments were:

- By providing technology support and appropriate questioning;
- MTC has many practical lessons/activities teachers can use;
- The lessons gave teachers examples of model 5E lessons, so that they could apply the same components to their instruction;
- By teaching the teachers new strategies to use during mathematics instruction; and
- If teachers use the scaffolding structures for questioning and transitioning between representations, students will have more exposure to understanding multiple representations and their relevance for mathematics.

Classroom interactions occur in many a few different forms in the learning environment. The interactions can be no interaction, teacher-student interactions and student-student interactions. The trainers’ responses encompassed interactions which involved communication and student level of engagement. One of the trainers commented,

- Some of the activities from the MTC workshops provide opportunities for student to engage in the mathematics – students are allowed to explore, make connections to other mathematics and between and among the multiple representations – and then students are encouraged to communicate their findings.

Others expressed ideas such as:

- Focus on student engagement, interactive lessons;

- Allowing for student discourse; and
- Students would benefit from the MTC curriculum if they are given an opportunity to dialogue

Teacher input was identified by the trainers who emphasized the role of the teachers' behavior and the student outcome. Indeed, students respond to the level of instruction given to them. Some of the trainers indicated:

- Teachers have to make the math knowledge and connections their own before they can share it with students;
- Students who have teachers that understand the TEKS and the connections to the concepts will be better prepared in mathematics;
- Better teachers lead to better student achievement; and
- Addressing teachers' level of understanding of the mathematics and assisting teachers to move away from the math phobia in which we live in at the elementary level.

Discussion

The primary goal of this study was to examine the results of data collected as part of an evaluation of a statewide mathematics PD program. The data collected came from an online survey of participants from the TTT model used to disseminate a mathematics curriculum to K-12 teachers throughout Texas. This section presents, first, a discussion about the important findings from this study. Then, the implications of these results are presented.

The researcher posed four research questions for this study. The first question, "*To what extent did the trainers provide MTC professional development to Texas teachers?*", indicated most of those trained (78%) did carry on the mission of the program and deliver MTC training to K-12 mathematics teachers. The other essential part of this research question was how much training occurred. The frequency of trainings was close in number because most of the trainers (22.4%) conducted between 1-3 sessions, and an equal amount of trainers conducted no PD. Initially, five categories of participants emerged from the demographic information: Department Chair, Instructional Specialists, K-12 teachers, Mathematics Consultants, and University Faculty. While all of the participants may have contributed to the 78% who conducted sessions with teachers, one of the primary roles of instructional specialists in Texas is to stay abreast of PD initiatives and deliver sessions with K-12 teachers from within their assigned region. Most of the trainers indicated they were instructional specialists, thus we might conclude the trainers who conducted no PD have no ongoing contact with K-12 teachers (i.e., department chair, K-12 teachers, mathematics consultants, and university faculty). One goal with the TTT model was to have a greater impact on the number of teachers who receive this training. Most of the trainers delivered between 1-3 sessions, and almost as many conducted 10+ sessions (20.4%), and 7-9 sessions (18.4%). Consequently, the extent of the trainings appears to be high given that 78% of the trainers conducted sessions.

The second question considered significant differences in the trainers' attitudes about the mathematics curriculum from three categories: (a) trainer group; (b) whether the trainer conducted PD sessions after their initial training workshop; and (c) how many sessions they conducted. In each category, most of the means reported as more than a value of three which suggested the trainers were more likely to agree with the statements about the mathematics curriculum. The standard deviations for most of categories were moderate, so there was some variation in their level of agreement. In each category, the range between the highest and lowest means stayed close to one-half, which suggests the trainers stayed in close proximity to the same level of agreement.

It was important to determine whether the trainers who provided PD had a different opinion about the curriculum than those who did not. In the body of research of teachers' attitudes about their mathematics curriculum, several studies indicated the teachers who have a better attitude and/or perception about the curriculum are more likely to implement the curriculum as planned (Anderson, 2009; Daro, Mosher, & Corcoran, 2011). Consequently, in the same way that a teacher's attitude impacts their use of a curriculum, so too does a trainers' attitude about the curriculum. In this study, there was no significant difference in the attitudes of those who conducted PD sessions with K-12 teachers and those who did not, and most the trainers were more likely to agree with the statements asked about the curriculum. Likewise, there was no significant difference in the trainers' attitudes about the curriculum according to how many PD sessions they provided after they participated in the train-the-trainer workshop. Those who conducted between 1-3 sessions were almost equally as likely to agree with the curriculum statements as those who conducted 10+ sessions. There is reason to believe the trainers who conducted more sessions may have encountered some problems/concerns with the curriculum which may have caused them to modify how they presented the material to the teachers. The finding that there was no difference, however, does not mean they did not encounter any problems, only that the problems they encountered may have been minor and did not impact implementation.

The third question, *What are the trainers' perceptions about the MTC curriculum improving mathematics content and pedagogy of classroom teachers?*, revealed five themes (e.g., conceptual knowledge, standards-based knowledge, teacher knowledge, instructional strategies, and curriculum alignment), all of which are in-line with one of the primary goals of the PD - improve mathematics instruction. The body of research on past and current initiatives to improve mathematics instruction maintain the argument that in order for mathematics instruction to improve, teachers need a depth of knowledge about the content (National Council of Teachers of Mathematics, 1991), understand how to teach to their state and local standards (Huntley, Rasmussen, Villarubi, Sangtong, & Fey, 2000; Wang & Lin, 2005), provide more effective instructional strategies during mathematics instruction (Desimone et al., 2002), and understand not only their grade level standards, but also have familiarity with the grade levels before and after their own, as well as the grade bands (e.g., K-5, 6-8, 9-12, and college). Additionally, the trainers acknowledged teachers with limited knowledge of their content are not able to offer as many connections for their students. Among the themes identified in the open-ended responses, most of the trainers identified conceptual knowledge more than the other themes. Conceptual knowledge of mathematics, for both teachers and students, has been at the forefront of discussions to improve the teaching and learning of mathematics. A lot of the discussion focuses on whether conceptual knowledge or procedural knowledge (i.e., rote, drill and practice) is better to teach mathematics.

Findings are inconclusive, and acknowledge both are important and that it depends on the purpose of the instructional lesson (Hallett, Nunes, & Bryant, 2010; Rittle-Johnson, Star, & Durkin, 2009). That most of the trainers, in the various roles they play in the education community (state, local, K-12, and higher education), were able to identify within the curriculum as having a strong focus on conceptual development in mathematics may be a good indication of the future impact on teacher knowledge and student achievement.

The last question, *What are the trainers' perceptions about the impact of the MTC curriculum for improving student achievement in mathematics*?, revealed four themes (e.g., conceptual knowledge, instructional strategies, classroom interaction, and teacher input). Two of these themes are the same as those from the previous research question – conceptual knowledge and instructional strategies – and likewise, are align with the other goal of the PD program – increase student achievement. As mentioned previously, the trainers provided several more responses about the curriculum having a strong representation of conceptual development. To the extent the curriculum improves teachers' conceptual knowledge in mathematics, it too should have some impact on students' conceptual knowledge. Several studies present findings where most students in K-12 education learn mathematics through rote memorization and drill-and-practice (Cai & Wang, 2010; Isiksal & Cakiroglu, 2011). The National Council of Teachers of Mathematics, however, encourages more effective teaching of mathematics for conceptual knowledge (National Council of Teachers of Mathematics, 1989). As most teachers teach the way they are taught, students continue to receive content through passive transmission as opposed to active learning opportunities (Billstein, 2010; Good, Grouws, & Ebmeier, 1983).

Classroom behavior, and in particular classroom interactions, are a prominent topic in mathematics education literature (Good & Brophy, 1987; Pianta & Hamre, 2009). The types of classroom interactions identified by the trainers focused on communication and student engagement. Communication, according to the trainers, should "allow student discourse" and "opportunities to dialogue." Their responses are aligned with one of the standards presented in *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991). The NCTM publication maintains student discourse as an important method to help students engage with the content and make the necessary connections in mathematics. Additionally, the trainers mentioned interactions related to student engagement. Students need to have opportunities to engage with the teacher and other students to enhance and increase their chances of building conceptual knowledge in mathematics (Gilmore & Papadatou-Pastou, 2009; Givvin, Jacobs, Hollingsworth, & Hiebert, 2009; Ross & Willson, 2012). The trainers posited interactive lessons to support more student engagement in the classroom.

Implications

The purpose of this study was to report the results from a follow-up survey of teacher trainers employed to disseminate the MTC curriculum statewide to K-12 mathematics teachers. Analysis of the data revealed several salient findings about the trainers' attitudes and perceptions of the curriculum. The implications are explored in this section, with particular attention to practice and future research. A brief discussion of the limitations concludes this section.

Practice

The findings from the attitude survey are important to consider when designing future train-the-trainer models to disseminate professional development to classroom teachers. The teacher trainers responded favorably toward three of the four factors extracted from the curriculum (i.e., Curriculum – Development, Curriculum – Conceptual, and Interdisciplinary), and slightly less favorable toward one factor (i.e., Differentiation). This suggests there may be areas within the curriculum where the content related to Differentiation was not developed in such a way that the trainers could easily identify its characteristics within the curriculum. In this study, Differentiation focused on the types of instructional modifications used for diverse student groups (e.g., English language learners and students with special needs). That trainers were not able to identify these types of modifications should concern program developers because previous studies highlight the value of differentiation having more focus in mathematics curriculum (Harris, 2011; Schofield, 2010).

Another important finding from this study was the trainers' identification of conceptual development in the curriculum. They maintained a positive attitude about the different ways mathematics concepts were presented throughout the curriculum. This suggests the curriculum was developed with a clear focus on how teachers can learn to teach mathematics for conceptual understanding. This also suggests the students may have more opportunities to focus on problem solving strategies and less on procedural learning of mathematics. There was no difference in the trainers' attitudes about conceptual development. Therefore, the diverse background of the trainers had little to do with how they interpreted the strength of the mathematics content in the curriculum.

Future Research

Program developers, and in particular, curriculum developers, need to be cognizant of the differences in trainers' general attitudes about curriculum materials. Knowledge of their general attitudes about an object or entity, in this case, the curriculum, would help the developers identify where gaps exist in the planned curriculum. The present study provides the results of the trainers' attitudes several years after their initial training workshop, when it is less likely for the curriculum materials to be modified before dissemination to classroom teachers. More research is needed to measure trainers' attitudes about curriculum materials before, during, and after participation in a train-the-trainer program to determine the longitudinal attitudes of the trainers.

In addition to the need for longitudinal studies of the trainers' attitudes, more research is needed to understand how teacher trainers identify conceptual development within the curriculum. Many of the trainers have backgrounds as mathematics teachers. Consequently, their knowledge of teaching, mathematics, and student learning have a lot to do with how they view conceptual development. Their experiences teaching mathematics for conceptual understanding should be researched and documented to ascertain what does or does not work with student learning. Future survey instruments may begin to develop around the key elements extracted from their experiences teaching for conceptual understanding.

The findings from this study are limited, first, due to a non-experimental design. All of the trainers were surveyed after participation in the train-the-trainer program, and though they were divided into Specialist and Non-specialist groups, there was no treatment and control group. Thus, the findings are not generalizable to the attitudes of other teacher trainers. The small sample size presents a limitation to the results from the factor analysis. A larger sample size allows greater reliability of the trainers' attitudes about the factors within the curriculum. A final limitation of the study results from when the survey was administered. The trainers received the follow-up survey within two years of the initial train-the-trainer workshop. Consequently, their attitudes are influenced by multiple opportunities to use the curriculum to train teachers.

Conclusion

Those who provide PD to K-12 teachers play an important role in the dynamic of improving the teaching and learning of mathematics. They are responsible for learning new national, state, and local standards, as well as new educational programs, and then disseminating the information with the level of integrity expected from the program developers. Their presence in extant literature, however, is limited. The goal of this study was to report the findings from a follow-up survey of teacher trainers after participation in a train-the-trainer program utilized as part of statewide PD program. In particular, the findings describe the trainers' attitudes about the mathematics curriculum developed for the program.

Despite the study's limitations, the trainers responded favorably to the factors extracted from the curriculum, especially the development, conceptualization, and interdisciplinary components. Several concerns about how to develop a mathematics curriculum to teach for conceptual understanding are present in extant literature. That the trainers were able to identify the factors and have a positive attitude suggest the need for more research about how this curriculum was developed, what framework(s) supported its development, and how the material was organized, in particular. Though the findings from this study are not generalizable to other train-the-trainer programs and its trainers, they provide some insight into a model of PD not often used in teacher education.

CHAPTER III

MTC PROGRAM IN TEXAS: SYSTEMATIC CLASSROOM OBSERVATION OF TEACHER BEHAVIOR AND RELATED STUDENT BEHAVIOR DURING ELEMENTARY MATHEMATICS INSTRUCTION

Introduction

The performance of U.S. students in mathematics has been a concern for several decades. In the most recent report from the Trends in International Mathematics and Science Study (TIMMS) (Gonzales, et al., 2004), U.S. fourth-grade students scored higher than the international mathematics average (518 and 495, respectively), performed better than 13 international counterparts, and was outperformed by just over 10 countries, all of which were Asian countries. Similar to fourth-grade students, U. S. eighth-grade students scored higher than the international mathematics average (504 and 466, respectively), performed better than 25 countries (20 of the 25 scored lower than the international average), and was outperformed by nine countries, again, all being Asian countries. The significance of Asian students outperforming U.S. students in mathematics has been documented by education researchers for several decades (Stevenson, Lee, & Stigler, 1986; Stevenson et al., 1990; Stigler, Lee, & Stevenson, 1987). The TIMSS report also found that between 1995 and 2003, there were no changes in mathematics performance of U.S. fourth-grade students, and only a slight change (two points) in U. S. eighth-grade students' mathematics performance.

In addition to the TIMSS report, the results from the most recent National Assessment of Educational Progress (NAEP) (National Center for Education Statistics, 2009), also known as the Nation's Report Card, provided similar results for U. S. mathematics performance. Specifically, there was no significant change in fourth-grade students' average mathematics performance from 2007 to 2009. These results were consistent for racial/ethnic groups from 2007 to 2009, and there continues to be a difference between White and Asian/Pacific Islander students compared to Black, Hispanic, and American Indian students. For eighth-grade students' mathematics performance, the NAEP reported continuous improvement from 2007 to 2009 and this improvement remained higher than previous years' testing sessions. Unlike U. S. fourth-grade students, there were some gains in the racial/ethnic performance of U. S. eighth-grade students, but like fourth-grade students, White and Asian/Pacific Islander students performed better than Black, Hispanic, and American Indian students.

Furthermore, the NAEP report presented the mathematics performance on a state-by-state basis. According to the report, of the 52 states and jurisdictions that participated in the assessment, fourth-graders in eight states (Nevada, Colorado, Kentucky, District of Columbia, Maryland, New Hampshire, Rhode Island, and Vermont) saw an increase from 2007 to 2009 in mathematics performance; a decrease in mathematics performance was reported in four states (Wyoming, Indiana, West Virginia, and Delaware). Thus, there were 40 states with no significant change in fourth-grade mathematics performance. The mathematics performance of U.S. eighth-grade students increased in 15 states (Washington, Idaho, Montana, Nevada, Utah, South Dakota, Missouri, Georgia, District of Columbia, New Jersey, Connecticut, Rhode Island, New Hampshire, Vermont, and Hawaii); none of the 52 participating states had a decrease in eighth-grade mathematics performance. Similar to the results from the fourth-grade assessment, 37 states had no significant change in eighth-grade mathematics performance.

Texas Mathematics Achievement

Texas was one of the more than 30 states with no significant change in mathematics for fourth- or eighth-grade students (National Center for Education Statistics, 2009). The fourth-grade assessment revealed 62% of the students tested performed at or below Basic level compared to 38% at or above Proficient level. Additionally, the results from the 2003 NAEP test administration was the last year Texas had a significant change in mathematics from the 2009 test administration for fourth-grade students. The results were similar for eighth-grade students in Texas. Specifically, 63% of eighth-grade students performed at or below Basic level compared to the 36% at or above Proficient level. Moreover, Texas was the only state with a decrease in the average mathematics score for Hispanic students. Additionally, the results from the 2005 NAEP test administration was the last year Texas had a significant change in mathematics from the 2009 test administration for eighth-grade students.

Reports like these provide the milieu for discussions about one of the reasons behind the low mathematics performance of U. S. students. Several researchers maintain student performance is a byproduct of teacher quality (Darling-Hammond, 1999; Hanushek, Kain, O'Brien, & Rivkin, 2005), and teacher quality, however, is often different for students in suburban, urban, and rural school districts (Levin & Quinn, 2003). The No Child Left

Behind (NCLB) Act of 2001 acknowledges a goal to have a ‘highly qualified’ teacher in every U. S. classroom. The requirements for a ‘highly qualified’ teacher consist of one with a postsecondary degree, full state certification, and content and grade level knowledge about the subject area(s) taught. Even with these requirements, however, research into teacher quality has revealed other areas that play an important role in the mathematics achievement of U.S. students.

Teacher Quality and Mathematics Achievement

The knowledge base surrounding teacher quality continues to gain interest from mathematics education researchers. Several variables are considered critical components for teacher quality, namely, teacher certification (Akiba et al., 2007; Darling-Hammond, 1999; Goldhaber & Brewer, 2000), subject-matter content knowledge (Ball, Hill, & Bass, 2005; Hill & Ball, 2004; Hill, Rowan, & Ball, 2005), pedagogical knowledge (Hill, Ball, & Schilling, 2008; Shulman, 1986), and teaching experience (Akiba et al., 2007; Darling-Hammond, 2000).

In a recent large scale study of teacher quality and opportunity gaps among 46 countries, Akiba, LeTendre, and Scribner (2007) reported the United States with 95.4% of eighth-grade students taught by fully-certified teachers (21 out of 39 countries). In comparison to the other countries with eighth-grade students being taught by teachers with mathematics as a major, the United States placed 41 out of 46 countries, 47.3% of eighth-grade students. Most eighth-grade students (55.3%) in the United States were taught by mathematics education majors and placed 24 out of 43 countries. In terms of teacher quality related to teaching experience, Akiba, LeTendre and Scribner also reported eighth-grade students (90.8%) in the United States placed 27 out of 46 with teachers of three or more years of teaching experience. The overall teacher quality in the United States (60.3%) with eighth-grade students being taught by teachers will all the indicators was close to the international average (62.3%) and placed 24 out of 39 countries. That said, the authors identified a 40% gap of eighth-grade students with access to these teachers in the United States. In another study, Goldhaber and Brewer (2000) found a statistically significant difference in high school students' mathematics achievement among teachers with a standard certification versus those with private school certification or no certification in the mathematics. They found no difference in mathematics achievement when the teachers had an emergency credential versus a standard certification in mathematics.

Mathematics content knowledge (MCK) and pedagogical content knowledge (PCK) are also closely related to teacher quality. Hill, Schilling, and Ball (2004) have advanced the necessity of MCK by developing measures for assessing the content knowledge of elementary teachers. They found the need for teachers to have knowledge of specific mathematics concepts as well as broader constructs like knowledge of content and how students learn the content. Similarly, teachers' PCK plays an important role in teacher quality. Shulman (1986) describes PCK first as those ideas and examples within a content area that have evolved to become the best representations of the content, and second as knowledge of those conceptions and preconceptions that make learning certain concepts difficult. Seminal studies by Carpenter, Fennema, and Franke (1996), Fennema, Carpenter, Franke, Levi, Jacobs, and Empson (1996) and Carpenter, Fennema, Peterson, Chiang, and

Loef (1989) have shown that teachers' pedagogical knowledge developed through cognitively-guided instruction and related to students' thinking enhances their achievement in mathematics.

In summary, research offers several critical components that impact teacher quality. Teacher quality is understood as it relates to teacher certification, subject-matter content knowledge, pedagogical knowledge, and teaching experience, to name a few. As the knowledge base grows for what constitutes effective teaching of mathematics, so too does the knowledge base need to grow for K-12 teachers. Teachers in the 21st century have greater demands placed on them for student achievement. The growing bodies of research about the knowledge, skills, disposition, attitudes, and perceptions of teachers of mathematics means teachers have to make substantial changes to their teaching repertoire that focuses on the new standards for effective teaching mathematics.

Professional Standards for Teaching Mathematics

In *Professional Standards for Teaching Mathematics* (National Council of Teachers of Mathematics, 1991), new standards and expectations for teaching mathematics are offered to shift teachers from their current pedagogical practices (i.e., teacher-centered, lecture-style) to those espoused in the publication. In short, the six standards relate to: (a) worthwhile mathematical tasks; (b) teacher's role in discourse; (c) students' role in discourse; (d) tools for enhancing discourse; (e) learning environment; and (f) analysis of teaching and learning. These standards require teachers to take on greater responsibility as, themselves, a learner of mathematics, and develop a deep conceptual understanding of mathematics (Ball, Hill, et al., 2005), and better decision-making skills about the pedagogical practices (Hill et al., 2008; Shulman, 1986) they employ to teach mathematics.

The new standard for effective teaching of mathematics will require effective professional development (PD). According to the National Staff Development Council (NSDC), PD is "a comprehensive, sustained, and intensive approach to improving teachers' and principals' effectiveness in raising student achievement" (Wei et al., 2010). Guskey (1999) adds to this definition with PD being "intentional, on-going, and systemic" (p. 16). In particular, the systemic component of PD advances the knowledge, skills, beliefs, and dispositions of not only teachers and principals, but all education stakeholders who have an impact on student learning and achievement. That said, research has started to converge about what makes for effective PD.

The next section will provide some of the results from a large-scale study commissioned by the NSDC about effective PD and learning opportunities for teachers in the United States.

Teacher Professional Development

Several decades of research (Grant & Zeichner, 1981; Hall & Loucks, 1978; Sandholtz & Merseth, 1992) has documented the landscape of PD for K-12 teachers. Within the last 20 years, however, research has started to converge on effective teacher PD. Most recently, the largest national study of professional learning - a three-part series – discussed (a) the research findings about effective professional learning, then compared practices in the United States and abroad, (b) trends and challenges with professional learning, and (c) a four-state case study related to polices and strategies of professional learning (Wei et al., 2010).

In the first part, the authors reported PD design should (a) be intensive, on-going, and connected to practice, (b) focus on student learning and address the teaching of specific curriculum content, (c) align with school improvement priorities and goals, and build strong relationships among teachers. By comparison, teachers in high-achieving countries are provided with (a) ample time for professional learning structured into teachers' work lives, (b) extensive mentoring and induction supports for beginning teachers, (c) encouragement to participate in school decision-making, and (d) more levels of support for additional PD. Taken together, it is more shocking, then, to find out from the 1999-2000 and 2003-04 Schools and Staffing Surveys that most teachers (a) received fewer than 16 hours of content-specific professional development, (b) are dissatisfied with their opportunities, especially secondary teachers, (c) received little funding or support and (d) engaged in intensive professional collaboration around curriculum planning, to name a few.

In another large-scale study of high-quality PD, Garet, Porter, Desimone, Birman, and Yoon (2001) used data from a national sample of teachers on the Teacher Activity Survey to determine what aspects of *structural* features – form of the activity, duration of activity, and degree of collective participation – and *core* features – content, active learning and coherence, contributed to improved teacher outcomes. The results indicated that the activity in the form of reform-oriented tasks (i.e., higher-order thinking) and the duration had positive effects on teacher outcomes. All three *core* features had a positive effect on teacher outcomes.

Even with the research on effective and high-quality PD, overall concerns still exist, and especially concerns toward the development of mathematics teachers. While extant literature contains a plethora of concerns about teacher PD, a few concerns have been substantiated more than others. One concern has to do with the system of PD. In a study of the continuing education practices (e.g., graduate education and PD) available to K-12 teachers in the United States, Hill (2007) found little evidence to support improvements in the system of teaching and learning, as a whole, and cited four reasons: (a) very few high-quality PD programs, (b) lack of rigorous evaluation, (c) lack of incentives, and (d) the incoherence of the system itself, (i.e., PD does not always align with the district and/or school's curriculum materials, assessments, and standards).

Another substantial concern has to do with teachers' perception of their PD. Teacher professional development is often viewed as something teachers must do to maintain certification (Hill, 2007) and less so for the professional learning (Darling-Hammond et al., 2009) needed to meet the expectations for current standards and desired practices. Most states require teachers to obtain, on average, about 120 hours of PD over five years (Hill, 2007). The content of the PD runs the full spectrum of topics from subject matter knowledge to curriculum implementation to classroom management. Thus, teachers may choose from a catalog of offerings which may not follow the districts' curriculum materials, assessments, and standards (Darling-Hammond & Richardson, 2009). This concern is related to what Hill (2007) states about PD being a "hodgepodge of providers, formats, philosophies, and content (p. 114)."

And yet a third concern that has recently started to move to the forefront of PD research has to do with the PD providers. Whitcomb, Borko, and Liston (2009) and Hill (2007) have argued there is very little research on the preparation and knowledge of the people who deliver PD. This is important to consider when the providers' perceptions, knowledge, skills, and dispositions affect the way they provide PD to K-12 teachers.

There are also concerns about the PD available to mathematics teachers. In a recent study about the quality of mathematics PD provided to the typical mathematics teacher in a typical school district, Hill (2004) observed 13 K-6 PD sessions in one state. Based on the standards for effective PD identified in literature, most of the sessions met the desired standards (e.g., active/inquiry learning, examples from classroom practice, collaboration, focus on content, to name a few). That said, one area where several of the sessions did not meet the type of reform desired was the way in which the content focused on mathematics. Ball and Cohen (1999) stated it is not enough to just focus on content. Rather, what is more important is how the content is treated within the PD context.

Another concern with mathematics PD is the impact on classroom instruction. Very few studies have been able to provide evidence of change in mathematics teachers' instruction because of professional development (Desimone et al., 2002; Hill & Ball, 2004; Huffman et al., 2003). In particular, in a study of the relationship between different types of PD (e.g., immersion strategies, curriculum implementation, curriculum development, examining practice, and collaborative work), mathematics teachers' instructional practices, and student achievement, Huffman, Thomas and Lawrenz (2003) found curriculum development and examining practice were the only two to have an impact on the teachers' instructional practice. Guskey (2002) argues that PD in and of itself is not the impetus for teacher change. Teachers' practices change if and only if a strategy is used and teachers have concrete evidence of a change in student achievement.

In summary, several dimensions need to be considered when designing effective PD for teachers of mathematics. One of the most critical being the extent to which the PD focuses on specific mathematics content. The next section will provide some background knowledge about Texas response to effective PD. Then, a description of the PD in Texas is provided.

Context of the Present Study

Federal mandates such as NCLB have required states to provide more effective PD to meet the demand for "highly-qualified" teachers in every classroom (No Child Left Behind Act, 2002) in the United States. In response to NCLB and other legislative mandates, Texas and other states have developed and implemented large-scale PD programs to improve the instructional practices of K-12 mathematics teachers. In particular, the Texas Education Agency (TEA) instituted the Texas Math Initiative (Texas Education Agency, 2008). According to TEAs website, the Texas Math Initiative is comprised of four components: Skills Diagnosis, Instructional Intervention, Instructional Support, and Professional Development. Within the PD component, seven training suites were created to cover a wide array of mathematics disciplines: Algebra II, Geometry, Mathematics for English Language Learners (MELL), Math TEKS Connections (MTC), MTC Preservice, Math TEKS Refinement (MTR), and Teaching Math TEKS through Technology (TMT3).

To support the PD programs, three training resources were utilized: in-person, online, and TTT. The next section will provide a description of the PD program.

Mathematics Texas Essential Knowledge and Skills (TEKS) Connections

In 2005, the Texas Education Agency funded the Mathematics TEKS (Texas Essential Knowledge and Skills) Connections (MTC) initiative to develop and disseminate learning enrichment opportunities to K-12 mathematics teachers, K-12 administrators, teacher educators, and preservice teachers. The $4.7 million investment was designed primarily to strengthen mathematics teachers' ability to connect state content standards (TEKS) to instruction and assessment.

One component of the program consisted of a new mathematics curriculum. The curriculum modules were developed by curriculum and instruction personnel from three Regional Education Service Centers. The mathematics curriculum was comprised of mathematics content for four grade bands: K-2, 3-5, 6-8, 9-12, and geometry.

The second component of the program was the PD trainings that occurred during fall 2007 and spring 2008. The trainings were attended by personnel from the remaining Regional Education Service Centers and university faculty and staff. One aspect of other PD models that continues to be a problem is that it does not reach enough teachers (Hill, 2007). Thus, the MTC utilized a TTT model that included five 2-day trainings for each grade band, and geometry.

In fall 2010, three years after the TTT model was completed, and the trainers had opportunities to train classroom teachers in their respective school districts, follow-up classroom observations were done to determine the level of MTC compliance. The researchers observed 50 elementary teachers in one school district, and four representative (i.e., ethnically- and linguistically-diverse) students (N = 200) in each classroom.

The first evaluation of the Mathematics TEKS Connections project took place during the TTT workshops. The evaluation consisted of formative and summative surveys. The present study will provide follow-up evaluation of the effectiveness of the PD program.

Purpose of the Study

The purpose of this study is to describe the classroom processes of one school district's elementary teachers and their students. Specifically, I will explore various measures of teacher behavior and student behavior during mathematics instruction. Additionally, I will describe the most frequently observed instructional setting and orientation utilized during the observation period. There are three research questions guiding this study:

1. Are there significant differences in the mathematics classroom processes – measured by interaction, setting, instructional orientation, nature of interaction, purpose of interaction, and instructional practices – according to whether the teacher participated in the MTC program?
2. Are there significant differences in the related student behaviors – measured by setting, manner, interaction, activity types, and content - according to whether their teacher participated in the MTC program?
3. To what extent are there mean differences in the overall mathematics classroom processes according to whether the teacher participated in the MTC program?

Method

The current study examines data from a statewide evaluation of the MTC program. One component of the evaluation entailed systematic classroom observations of one school district's elementary teachers and their students. The purpose of this study, then, is to examine the observation data with two goals in mind. First, compare the teachers' instructional behaviors and resulting student behaviors according to whether the teacher participated in the MTC program. Second, determine the most prevalent "instructional orientation" and "instructional practice" used during mathematics instruction.

Research Design

The evaluation component which focused on the classroom observations operated from a non-experimental research design (Shadish, Cook, & Campbell, 2001). Non-experimental research designs are used when it is not possible to establish a cause-effect relationship between the independent and dependent variables. Most commonly, the measurements are taken simultaneously and describe the effects of the intervention, in this case, the MTC program. As part of the evaluation process, the researchers used a one-group posttest-only design focusing on one school district's elementary teachers and their students. Using the one-group posttest-only design, it is possible to describe the current classroom environment as it related to the teachers' instructional behaviors and the resulting student behaviors during mathematics. The following sections present the school district setting and participants, independent variable, dependent variables and instrumentation, data collection procedures and data analysis strategies.

Setting

The school district was located in a suburban-rural area in the southern region of Texas and served 31,614 racially, ethnically, linguistically, and culturally diverse students in 2009-10. The ethnic breakdown of the district's students was: 27.5% African-American, 6.5% Asian/Pacific Islander, 21.0% Hispanic, 0.7% Native American, and 44.4% White. Additionally, 36.2% of the students were classified as coming from *economically disadvantaged* families; 33.6% were *at-risk*; and 10.4% had *limited English proficiency* (AEIS, 2010).

The school district had 21 elementary schools, and in the current study researchers conducted observations in nine (43%) of them. Class sizes ranged from 11 to 30 students, with a mean size of 17.8 students. In terms of state accountability ratings, two elementary schools were identified as *Exemplary*, six as *Recognized*, and one as *Academically Acceptable*.

Table 14 shows the percentage distribution of economically disadvantaged and limited English proficient (LEP) students compared to the overall school district percentage.

Table 14
Percentage of Economically Disadvantaged and Limited English Proficient Students with Overall District Percentage

School	% ED	%LEP	Campus achievement
A	20.5%	13.5%	Exemplary
B	42.5%	23.5%	Recognized
C	72.6%	39.8%	Recognized
D	74.1%	27.5%	Academically Acceptable
E	73.0%	41.1%	Recognized
F	27.6%	3.8%	Recognized
G	42.7%	19.4%	Recognized
H	33.3%	13.9%	Exemplary
I	49.5%	25.0%	Recognized
Overall District	***36.2%***	***10.4%***	***Recognized***

Participants

Participation in this study was voluntary. Researchers observed 50 public school teachers and four students from each classroom. During the observation period, teachers completed a questionnaire with demographic information as well as one question asking whether they participated in the MTC professional development program. The responses were 10 (22%) Yes, 22 (48%) No, and 14 (30%) Not Sure. There was no response from four teachers who did not disclose participation in the MTC program. Consequently, participants were 46 third- and fourth-grade elementary teachers; 26 (56.5%) third-grade and 20 (43.5%) fourth-grade. There were 42 (91.3%) female and four (8.7%) male teachers.

Additionally, there were 184 racially, ethnically, linguistically, and culturally-diverse students. The breakdown of student ethnicity in the study sample was 25% Hispanic, 32 % White, 31% African-American, and 12% Asian (AEIS, 2010). The grade-level distribution was 56.5% third grade (*n* = 104) and 43.5% fourth grade (*n* = 80); There were 92 (50%) female and 92 (50%) male students. Table 15 displays the student ethnicity in the study sample.

Table 15
Ethnic Breakdown of Study Sample (*N*=184)

	Third-grade	Fourth-grade	% of sample
White (n=59)	30	29	32.0%
African American (n=57)	32	25	31.0%
Hispanic (n=46)	28	18	25.0%
Asian (n=22)	14	08	12.0%
Total	104	80	

Note. From 2009-2010 Academic Excellence Indicator System (AEIS).

Independent Variable

The independent variable in this study was teacher participation in the MTC program. Three subgroups emerged from the data provided by the teachers:

- "Yes, I did attend the MTC program,"
- "No, I did not attend the MTC program," and
- "I am unsure if I attended the MTC program."

Preliminary analysis indicated no significant differences between the "No" and "Unsure" teacher groups. Consequently, these groups were compressed into (a) Treatment Group, and (b) Comparison Group.

Dependent Variables, Measures, and Instrumentation

The dependent variable in this study is observed classroom processes. For the purposes of this study, however, classroom processes, were the teachers' instructional behaviors and the resulting student behaviors. Two secondary dependent variables, "instructional orientation," and "instructional practice," are subsumed within the teachers' instructional behavior. One measure, systematic observation, assessed the classroom processes used by the elementary teachers. The researchers conducted the observations within two years after the MTC training program ended.

Classroom Processes. The researchers employed two instruments during the observation period to measure classroom processes (See Appendices A and C). The *Teacher Observation Schedule: MTC Follow-Up (K-6) (TOS)* is a low-inference instrument adapted from the *Teacher Roles Observation Schedule (TROS)* (Waxman, 2003; Waxman & Padrón, 2004;

Waxman, Tharp, & Hilberg, 2004). Waxman, Wang, Lindvall, and Anderson (1990) designed the *TROS* to reflect the best practices for classroom observation research and the most effective teaching practices in the context of on-going classroom instructional-learning processes. Consequently, the *TROS* was further augmented to reflect the growing body of knowledge about the most effective teaching practices for mathematics content. The *TROS* includes six sections: (a) Interaction, (b) Setting, (c) Instructional Orientation (e.g., direct instruction, seatwork), (d) Nature of Interaction, (e) Purpose of Interaction, and (f) Instructional Practices. Within each section, there was a minimum of four and a maximum of 20 categories used to measure the teachers' instructional behavior. All of the sections taken together make up the teachers' instructional behavior. The author used each of these sections in the current study. Mean inter-rater reliability was 0.97.

The second instrument, *Overall Mathematics Observation: MTC Follow-Up (K-6) (OMO)*, is a high-inference instrument adapted from the *Classroom Observation Measure (COM)*. Similar to the *TROS*, Ross & Smith (1996) designed the *COM* to reflect all the instructional events which occur in the naturalistic classroom setting. As part of the evaluation, the researchers observed the following: (a) Teacher [Behavior], (b) Instructional Use of Technology, (c) Student [Behavior], (d) Educational Use of Technology, and (e) [Types of] Technology. For the purposes of this study, the author focused on Teacher [Behavior] as it was consistent with the measures from the *TOS*. Mean inter-rater reliability was 0.91.

Student Behavior. The researchers used two instruments (See Appendices B and C) during the observation period to measure students' behavior in the classroom. The *Student Observation Schedule (SOS): MTC Follow-Up (K-6)* is a low-inference instrument adapted from the *Student Behavior Observation Schedule (SOS)*. Waxman, Wang, Lindvall, & Anderson (1988) designed the *SBOS* to observe systematically the influence of teachers' instructional practices on students' classroom behavior. Like the *TROS*, the *SOS* was designed to reflect best practices for classroom observation research and the most effective teaching practices in the context of on-going classroom instructional-learning processes. The *SOS* included the following seven sections: (a) [Classroom] Setting, (b) Manner, (c) Interaction, (d) Activity Types, (e) Content, (f) Technology, and (g) Educational Use of Technology. For the purposes of this study, the author focused on the first five sections because they were most closely related to the teachers' instructional behavior during mathematics. Mean inter-rater reliability was 0.98.

The second instrument used by the researchers was the *COM*, explained above. The only section used from this instrument to measure the resulting student behavior from the teachers' instructional behavior was Student [Behavior]. The *COM* was used in a number of studies and found to be reliable and valid (Ross, Smith, Lohr, & McNelis, 1994; Ross, Troutman, Horgan, Maxwell, Laitinen, & Lowther, 1997).

Instructional Orientation. The teachers' "instructional orientation" was measured from one section of the *TROS*. The measures included the following: (a) *direct instruction*, (b) *seatwork*, (c) *learner-centered*, and (d) *other*.

Instructional Practice. The teachers' "instructional practice" was measured from one section of the *TROS*. The measures included the following: (a) *uses concrete models*, (b) *uses pictorial representation*, (c) *uses verbal or written representation*, (d) *uses symbolic or numeric representation*, (e) *uses tabular or graphical representation*, (f) *uses area models*, (g) *uses linear models*, and (h) *uses sets models*.

Data Collection

The research questions were investigated via the use of systematic classroom observation. The principal investigator of this study worked with six other researchers to collect classroom observation data. Teachers were notified of the specific day the observer would be in their classrooms. Arrangements were made to observe regular classroom instruction, and classes devoted to special activities (e. g., standardized tests, laboratory, etc.) were avoided. Each classroom was observed for approximately 40 minutes. At the end of each classroom observation, the *Overall Mathematics Observation* was completed. The research team that visited the campuses was trained in rigorous research techniques, the necessary methodology for ensuring systematic data collection, and the necessary steps for validity and reliability in the observations. Prior to each campus visit, they were further instructed in the use of the specific observational protocols for the study in question.

Data Analysis

Research Questions One and Two utilized an Independent Samples *t*-test to determine group differences by those variables observed during mathematics instruction. The instructional practices analyzed are: (a) teacher interaction, (b) classroom setting, (c) instructional orientation, (d) nature of interaction, (e) purpose of interaction, and (f) mathematical representation. The resulting student behaviors are: (a) classroom setting, (b) student engagement, (c) student interaction, (d) activity types, and (e) mathematical representation.

Research Questions Three and Four used descriptive statistics to calculate the percentage of time teachers used various instructional orientations (e.g., direct instruction, learner-centered instruction, and seatwork) as well as describe the classroom setting (e.g., whole-class, small group, and individual) during the observation period. Additionally, descriptive statistics will show the percentage of time teachers utilized various mathematical representations (e.g., verbal, written, pictorial, symbolic) during the observation period.

Results

In this study, classroom processes were examined from systematic observation data of mathematics instruction from one school district in Texas. First, the researcher presents the results on differences in teaching behavior, and the related student behavior, according to whether the teacher participated in the PD program. Then, the researcher presents a description of the extent to which the teaching practices were used in all classrooms. Lastly, a description of the most frequently observed teaching practices concludes this section.

An overall picture of the teachers' classroom behavior indicated the most frequently observed *Setting* was *Whole class* (54.34%) and with *Direct instruction* (55.5%). Also, the most frequently observed *Instructional Practice* used during mathematics instruction was *Verbal or written representation* (43.2%).

Research Question One

Are there significant differences in the mathematics classroom processes according to whether the teacher participated in the PD program? An independent samples t-test was conducted to compare mathematics classroom processes of elementary teachers according to participation in a statewide professional development program. There was a significant difference in four of the five classroom processes: Setting, Nature of Interaction, Purpose of Interaction, and Instructional Practices.

Setting. The Comparison Group was observed in a Whole class setting almost twice as much as the Treatment Group. The standard deviation for Whole class was high, and this indicates a lot of variability from classroom to classroom. The *t*-test revealed a statistically significant ($p < .05$) difference for teacher participation, $t(44) = -2.24$, $p = .030$.

The teachers who did not participate ($M = 61.67$, $SD = 37.77$) were observed using Whole Class instruction more than teachers who did participate ($M = 32.51$, $SD = 30.03$). Table 16 provides the results of the *t*-tests.

Table 16
Teacher Behavior (Setting) by Participation in MTC Program

	Treatment Group (N=10)		Comparison Group (N=36)			
Factor	*M*	*SD*	*M*	*SD*	*t*(44)	*p*
Whole class	32.51	30.03	61.67	37.77	-2.24	<.05
Small group	18.83	28.06	24.66	36.16	-0.47	.64
Dyad	8.34	18.01	0.97	4.44	1.28	.23
Individual	19.35	33.30	9.52	16.10	0.90	.38
Traveling	20.00	30.82	3.47	8.17	1.67	.12

Source. Teacher Observation Schedule.

Nature of Interaction. The mean for the Comparison Group was 7.82, and the Treatment Group mean was zero. The zero mean indicates the teachers who participated were, in fact, observed for this behavior during the interval period, however, no consideration for the behavior was recorded. The standard deviation for Nature of Interaction was high, which means a lot of variability from classroom to classroom.

There was a significant difference in the Nature of Interaction according to whether the teacher participated, $t(44) = -2.97$, $p = .005$. The teachers who did not participate (M = 7.82, SD = 15.77) were observed giving Positive *Comments* more than the teachers who did participate (M = 0.00, SD = 0.00). Table 17 provides the results of the *t*-tests.

Table 17
Teacher Behavior (Nature of Interaction) by Participation in MTC Program

	Treatment Group (*N*=10)		Comparison Group (*N*=36)			
Factor	*M*	*SD*	*M*	*SD*	*t*(44)	*p*
Questioning	42.18	29.33	49.17	34.34	-0.58	.56
Explaining	70.36	22.67	69.11	27.84	0.13	.89
Positive Commenting	0.00	0.00	7.82	15.77	-2.97	<.05
Negative Commenting	0.00	0.00	2.50	10.52	-0.74	.46
Neutral Commenting	1.00	3.16	1.94	8.88	-0.32	.74
Listening	37.34	35.83	26.44	29.74	0.98	.33
Cueing or prompting	28.34	39.90	25.66	30.48	0.22	.82
Modeling/Demonstrating	14.17	22.22	15.68	23.98	-0.18	.85

Source. Teacher Observation Schedule.

Purpose of Interaction. The mean for the Comparison Group was 5.00, and the Treatment Group was zero. The zero mean indicates the teachers who participated were, in fact, observed for this behavior during the interval period, however, no consideration for the behavior was recorded. The standard deviation for Nature of Interaction was high, which means a lot of variability from classroom to classroom.

There was a significant difference for teacher participation, $t(44) = -2.31$, $p = .027$. The teachers who did not participate (M = 5.00, SD = 13.00) were observed *Presenting* *multiple perspectives* more than the teachers who did participate (*M* = 0.00, *SD* = 0.00). Table 18 provides the results of the *t*-tests.

Table 18
Teacher Behavior (Purpose of Interaction) by Participation in MTC Program

Factor	Treatment Group (*N*=10) *M*	*SD*	Comparison Group (*N*=36) *M*	*SD*	*t*(44)	*p*
Focus on content	42.84	41.61	65.32	30.12	-1.59	.13
Focus on process	45.01	29.56	50.64	33.10	-0.48	.62
Focus on product	59.84	27.87	47.22	34.43	1.06	.29
Connect content to other disciplines	1.67	5.28	5.11	14.30	-0.74	.46
Connect content to global communities	0.00	0.00	2.64	12.84	-0.64	.52
Present multiple perspectives on topic	0.00	0.00	5.00	13.00	-2.31	<.05
Redirect student thinking	10.00	17.48	11.19	20.24	-0.16	.86
Show interest in student work	1.67	5.28	6.01	14.06	-1.51	.13
Show personal regard for student	5.00	15.81	6.43	13.73	-0.28	.77
Encourage students to help each other	5.00	10.54	2.31	7.87	0.88	.38
Encourage students to succeed	10.00	21.08	13.55	22.95	-0.44	.66
Encourage students to question	2.67	5.84	4.67	10.95	-0.55	.58
Encourage extended student responses	6.67	16.10	5.37	12.90	0.26	.79
Encourage student self-management	18.35	35.54	7.99	14.47	0.90	.38
Praise student behavior	2.50	7.90	3.47	10.80	-0.26	.79
Praise student performance	12.50	18.10	13.56	21.01	-0.14	.88
Correct student behavior	3.67	7.77	12.41	21.34	-1.26	.21
Correct student performance	2.67	5.84	2.82	8.64	-0.05	.95
Assessment	8.00	25.29	0.00	0.00	1.00	.34

Source. Teacher Observation Schedule.

Instructional Practices. The mean for *Uses pictorial representation* was highest for the Comparison Group, and a range of 19.8 from the Treatment Group. The standard deviation was high, which suggests a lot of variability from classroom to classroom. Also, *Uses symbolic representation* was approaching significance, and the mean for the Treatment Group was almost four times higher than the Comparison Group.

There was a significant difference for teacher participation, $t(44) = -3.38$, $p = .002$. The teachers who did not participate ($M = 21.47$, $SD = 33.62$) were observed using Pictorial Representation more than teachers who did participate ($M = 1.67$, $SD = 5.28$). Table 19 provides the results of the *t*-tests.

Table 19
Teacher Behavior (Instructional Practices) by Participation in MTC Program

	Treatment Group (N=10)		Comparison Group (N=36)			
Factor	*M*	*SD*	*M*	*SD*	$t(44)$	*p*
Uses concrete models	9.18	21.71	6.29	18.08	0.42	.67
Uses pictorial representation	1.67	5.28	21.47	33.62	-3.38	<.05
Uses verbal or written representation	27.51	36.44	49.21	43.34	-1.59	.12
Uses symbolic or numeric representation	33.50	37.34	9.30	25.52	1.92	.07

Source. Teacher Observation Schedule.

Research Question Two

Are there significant differences in the related student behavior according to whether their teacher participated in the PD program? The *t*-test revealed significant differences for three classroom processes: Setting, Interaction, and Instructional Practice.

Setting. The students from the Comparison Group were in a *Whole class* setting almost twice as much as the Treatment Group. The students in the Treatment Group were in an Individual setting more than twice as much as the Comparison Group students. The standard deviations were high for each Setting, which indicates a lot of variability from classroom to classroom.

Results of the *t*-test revealed a statistically significant ($p < .05$) difference for three of four classrooms Settings: *Whole class*, *Dyad*, and *Individual*. The students whose teachers participated were observed in Dyad ($M = 15.42$, $SD = 32.99$) and Individual ($M = 40.14$, $SD = 16.06$) settings more than students whose teachers did not participate ($M = 2.46$, $SD = 12.91$) and ($M = 16.06$, $SD = 29.60$), respectively. Additionally, students whose teachers did not participate were observed in Whole class ($M = 56.30$, $SD = 41.96$) more than students whose teachers did participate ($M = 21.25$, $SD = 25.44$). Table 20 provides the results of the *t*-tests.

Table 20
Student Behavior (Setting) by Teacher Participation in MTC Program

	Treatment Group (N=40)		Comparison Group (N=144)			
Factor	*M*	*SD*	*M*	*SD*	$t(182)$	p
Whole class	21.25	25.44	56.30	41.96	-6.57	<.05
Small group	24.37	35.32	25.28	39.17	-0.13	.89
Dyad	15.42	32.99	2.46	12.91	2.43	<.05
Individual	38.12	40.14	16.06	29.60	3.23	<.05

Source. Student Observation Schedule.

Interaction. The students in the Treatment Group interacted with other students in their classroom almost twice as much as the Comparison Group students. Additionally, the students in the Treatment Group were observed for possible interaction with the teacher, but no evidence of this behavior was recorded. The standard deviations were high for each Interaction, and this means there was a lot of variability from classroom to classroom.

Results of the *t*-test revealed a statistically significant ($p < .05$) difference for two of five classroom Interactions: *With teacher – managerial* and *With other students*. The students whose teachers participated were observed *With other students* ($M = 35.00$, $SD = 41.09$) more than students whose teachers did not participate ($M = 19.32$, $SD = 31.77$). The students whose teachers did not participate ($M = 1.32$, $SD = 6.90$) were observed in *managerial* interactions more than students whose teachers did participate ($M = 0.00$, $SD = 0.00$). The zero mean indicates the teachers who participated were observed during the interval period, however, there was no record of the observed behavior. Table 21 provides the results of the *t*-tests.

Table 21
Student Behavior (Interaction) by Teacher Participation in MTC Program

	Treatment Group (*N*=40)		Comparison Group (*N*=144)			
Factor	*M*	*SD*	*M*	*SD*	*t*(182)	*p*
No interaction	60.55	40.57	71.05	34.84	-1.49	.14
With teacher	4.46	13.85	7.14	14.78	-1.02	.30
With teacher-managerial	0.00	0.00	1.32	6.90	-2.29	<.05
With other students	35.00	41.09	19.32	31.77	2.23	<.05

Source. Student Observation Schedule.

Activity Types. The students in the Treatment Group worked on written assignments more than the students in the Comparison Group. The students in the Comparison Group did more listening/watching than the students in the Treatment Group. Additionally, the students in the Treatment Group were observed for possible use of experiential/hands-on learning and working kinesthetically, but no evidence of this behavior was recorded. The standard deviations were high for each Activity Type, and this means there was a lot of variability from classroom to classroom.

Results of the *t*-tests revealed a statistically significant ($p < .05$) difference for four of 17 classroom Activity Types: *Working on written assignments*, *Experiential/hands-on learning*, *Working kinesthetically*, and *Listening/watching*. The students whose teachers participated were observed *Working on written assignments* (M = 53.18, SD = 36.44) more than students whose teachers did not participate (M = 38.12, SD = 34.71. Additionally, students whose teachers did not participate were observed in *Listening/watching* (M = 47.01, SD = 34.95) more than students whose teachers did participate (M = 27.50, SD = 27.08). The students whose teachers did not participate (M = 8.99, SD = 25.79) were observed using *Experiential/hands-on learning* more than students whose teachers did participate (M = 0.00, SD = 0.00). This was also the case for students whose teachers did not participate (M = 2.60, SD = 13.12) were observed *Working kinesthetically* more than students whose teachers did participate (M = 0.00, SD = 0.00). Table 22 provides the results of the t-tests.

Table 22
Student Behavior (Activity Types) by Teacher Participation in MTC Program

	Treatment Group (N=40)		Comparison Group (N=144)			
Factor	M	SD	M	SD	$t(182)$	p
Working on written assignment	53.18	36.44	38.12	34.71	2.40	<.05
Interacting/Instructional	18.33	32.42	9.47	21.20	1.63	.10
Sharing mathematical thinking with peers	12.91	28.80	3.41	15.34	2.00	.05
Participating in student-led discussions	0.00	0.00	0.17	2.08	-0.52	.60
Reading mathematics-related texts	2.50	11.03	5.76	19.21	-1.37	.17
Getting/returning materials	0.41	2.64	0.34	2.93	0.13	.89
Painting/drawing/creating graphics	3.54	13.73	2.25	9.76	0.67	.50
Playing mathematics games	12.92	28.87	14.04	30.30	-0.20	.83
Presenting/acting	0.00	0.00	0.14	1.66	-0.52	.60
Experiential/hands-on learning	0.00	0.00	8.99	25.79	-4.18	<.05
Tutoring peers	0.41	2.64	1.09	8.99	-0.47	.63
Working kinesthetically	0.00	0.00	2.60	13.12	-2.38	<.05
Listening/watching	27.50	27.08	47.01	34.95	-3.76	<.05
Distracted	4.79	17.30	4.47	13.01	0.12	.90
Acting-out	0.41	2.64	.013	1.66	0.81	.53
No activity/transition	8.29	19.34	6.06	14.15	0.80	.41

Source. Student Observation Schedule.

Content. The students in the Comparison Group worked with a pictorial representation almost three times as much as the students in the Treatment Group, and they used more verbal representations than the Treatment Group. The students in the Treatment Group worked with symbolic representation more than four times as much as the Comparison Group. The standard deviations were high for each type of Content, which indicates a lot of variability from classroom to classroom.

Results of the *t*-test revealed a statistically significant ($p < .05$) difference for three of 10 classroom Content behaviors?: *Working with pictorial representation*, *Working with verbal or written representation*, and *Working with symbolic or numeric representation*. The students whose teachers participated were observed *Working with symbolic or numeric representation* (M = 38.51, SD = 43.60) more than students whose teachers did not participate (M = 9.16, SD = 25.09. Additionally, students whose teachers did not participate were observed *Working with pictorial representation* (M = 13.58, SD = 30.31) and *Working with verbal or written representation* (M = 42.99, SD = 43.55) more than students whose teachers did participate (M = 4.79, SD = 19.05) and (M = 27.30, SD = 39.26), respectively. The *t*-test results are presented in Table 23.

Table 23
Student Behavior (Content) by Teacher Participation in MTC Program

	Treatment Group (*N*=40)		Comparison Group (*N*=144)			
Factor	*M*	*SD*	*M*	*SD*	*t*(182)	*p*
Working with concrete models	11.66	29.52	9.57	25.91	0.43	.66
Working with pictorial representation	4.79	19.05	13.58	30.31	-2.23	<.05
Working with verbal or written representation	27.30	39.26	42.99	43.55	-2.18	<.05
Working with symbolic or numeric representation	38.51	43.60	9.16	25.09	4.07	<.05
Working with tabular or graphical representation	3.33	16.54	1.21	7.43	0.78	.43
Using area models	0.00	0.00	0.69	6.57	-0.66	.50
Using linear models	0.00	0.00	0.00	0.00		
Using sets models	0.00	0.00	0.00	0.00		
Verbalizing solution process	8.75	27.47	0.83	5.32	1.81	.07
Working on basic skills	48.35	4.37	55.34	43.42	-0.89	.37

Source. Student Observation Schedule.
Note. A *t*-value cannot be computed because the standard deviations of both groups are zero.

Research Question Three

Are there significant differences in the extent of overall mathematics classroom processes according to teacher participation in the MTC program? The final instrument used during the observation period measured the extent of the overall mathematics classroom processes (See Appendix D). The rating scale used for this instrument ranged from "not observed at all" to observed a "great extent." The means ranged from 2.92 to 1.00. The standard deviations were mostly high, which suggests a lot of variability in the observed behaviors from classroom to classroom. Results from the *t*-test revealed no statistically significant ($p < .05$) differences between the Treatment Group and Comparison Group. Table 24 provides the results from the *t*-tests.

Table 24
Overall Classroom Mathematics Behavior by Teacher Participation in MTC Program

	Treatment Group (*N*=10)		Comparison Group (*N*=36)			
Factor	*M*	*SD*	*M*	*SD*	*t*(44)	*p*
Teacher actively facilitated students' engagement in activities and lessons to encourage participation	2.30	.82	2.39	.72	-0.33	.74
Teacher linked concepts and activities to one another and to previous learning	2.10	.73	1.83	.81	0.93	.35
Teacher applied new concepts to similar situations	1.90	.87	1.44	.73	1.66	.10
Teacher connected ideas and concepts	1.90	.87	1.64	.72	0.96	.34
Teacher initiated experiences, discussions and activities	2.60	.69	2.25	.77	1.29	.20
Teacher developed conceptual understanding	1.70	.82	1.69	.82	0.01	.98
Teacher used multiple representations	2.10	.99	1.56	.73	1.61	.13
Teacher used purposeful questioning for instruction	2.20	.78	2.00	.79	0.70	.48
Teacher acted as coach/facilitator	2.10	.87	1.92	.64	0.73	.46
Teacher allowed students to develop concepts or procedures	2.10	.73	1.72	.81	1.32	.19
Teacher asked many open-ended questions	1.60	.69	1.44	.65	0.65	.51
Teacher provided students opportunities for problem-solving	2.00	.81	1.72	.74	1.02	.31
Teacher provided feedback	2.30	.48	2.92	5.20	-.37	.71
Teacher assisted student to organize thinking	1.60	.84	1.47	.65	.0.51	.61
Teacher assisted students in generalizing learning to other situations, problems, etc.	1.60	.84	1.28	.61	1.35	.18
Teacher facilitated the generation of mathematical "rules" based on generalizations	1.30	.67	1.36	.63	-0.26	.79
Teacher integrated calculators into lesson	1.20	.63	1.08	.36	0.74	.45
Teacher integrated software into lesson	1.60	.96	1.33	.67	0.81	.42
Teacher integrated feedback and assessment into instructional cycle	2.00	.47	1.72	.65	1.50	.14
Teacher distributed feedback evenly	2.10	.56	1.89	.70	0.86	.39
Teacher redirected student thinking	1.80	.78	1.72	.70	0.30	.76
Teacher used technology for a non-instructional purpose	1.10	.31	1.00	.00	1.00	.34

Source. Overall Mathematics Observation.
Notes. 1 = Not observed at all, 2 = Some extent, and 3 = Great extent

In addition to the overall teachers' mathematics behavior, the overall students' mathematics behavior was recorded. The means ranged from 2.70 and 1.25. The standard deviations were high, which suggests great variability in the observed behavior from classroom to classroom. One item, *Students initiated and assumed responsibility for learning activities*, was approaching significance (p = .058). Results of the t-test revealed no statistically significant ($p < .05$) difference between the Treatment Group and the Comparison Group. Table 25 provides the results from the t-tests.

Table 25
Students' Overall Mathematics Classroom Behavior

	Treatment Group (N=10)		Comparison Group (N=36)			
Factor	*M*	*SD*	*M*	*SD*	t(44)	p
Students initiated and assumed responsibility for learning activities	2.20	.91	1.69	.66	1.94	.05
Students connected ideas and concepts	1.80	.78	1.64	.63	0.67	.50
Students utilized different ways to answer	1.70	.82	1.25	.50	1.64	.12
Students participated in problem-solving	2.00	.81	1.81	.66	0.77	.44
Students were engaged in classroom activities	2.70	.67	2.58	.55	0.56	.57
Student activities were learner-centered	2.30	.82	2.08	.80	0.71	.45

Source. Overall Mathematics Observation.
Notes. 1 = Not observed at all, 2 = Some extent, and 3 = Great extent

Discussion

The primary goal of this study was to explore mathematics classroom processes used in one school district after a statewide PD initiative to improve mathematics instruction and student achievement. The sample for this study consisted of two groups of teachers: those who did participate in the statewide PD program, and those who did not participate. Due to the extensive list of classroom processes observed, the discussion presents, first, a profile of the teacher behaviors followed by a profile of the student behaviors. Then, the results are discussed in relation to other studies of mathematics classroom processes.

Profile 1: Treatment Group and their Students

The teachers who participated did not have any significant findings in their classroom processes compared to the teachers who did participate. Their students were observed working in *Dyads* or *Individually*, and they worked *With other students* on *Written assignments* and used more *Symbolic representations* in mathematics.

Profile 2: Comparison Group and their Students

The teachers who did not participate were observed in *Whole Class* settings, using *Positive Comments*, and teaching with *Pictorial representations* in mathematics. Their students were observed in *Whole Class* and *Individual* settings where they *Listened/Watched*, used *Experiential/hands-on*, and *Kinesthetic* activities, and had worked with *Pictorial* and *Verbal* representations.

Treatment Group

The teachers who did participate were observed *Traveling* in their classrooms more than the teachers who did not participate, and the observation period revealed they used

Whole Class instruction less than the teachers who did not participate. Each observation period was 30 minutes in length, and this result may reflect when the observer made it to the classroom to conduct the observation. The observation time was random for each teacher. Consequently, the teachers who did participate were *Traveling*, which reflects more effective mathematics teaching practices. The image of traditional, lecture-style mathematics instruction has the teacher in the front of the classroom "telling" the students rules and procedures. Traveling suggests the teachers were actively engaged in learner-centered practices where it is necessary to move from desk-to- desk and group-to-group to answer student questions and check for understanding.

There were significant main effects in each category from the Student Observation Schedule (See Appendix C). The related student behavior for the teachers who did participate revealed students observed in *Dyads* or doing *Individual* work more than the students whose teachers did not participate. The standard deviations, however, were high for each *Setting*, and this means there was a lot of variability in the Settings from during the observation period. The related student behavior of interaction *With other students* supports the *Dyad* setting frequently observed in their classrooms. There was a significant main effect for Activity Types and the students whose teachers participated were observed *Working on written assignments* and less frequently observed *Listening/watching* or working with *Hands-on/kinesthetic* activities. In these categories, however, the mean scores were zero when compared to the students whose teachers did not participate. The Setting was mostly *Dyad* and *Individual* and this finding supports the students observed *Working on written assignments*, as it may have been in an *Individual* Setting. The standard deviations for all the items were high, and this indicates more variability among the different Activity Types. The final category on the Student Observation Schedule, Content, also had a significant main effect. The students whose teachers participated were more frequently observed *Working with symbolic or numeric representation* and less frequently *Working with verbal or written representation* and Working with pictorial representations. The standard deviations for these items were high, which indicates a lot of variability in the type of Content used during mathematics instruction. In particular, though, the presence of students' frequent use of symbolic or numeric representation (e.g., algorithms) is consistent with previous studies of elementary mathematics instruction in which students spend more time with procedural skills versus developing conceptual understanding (Stigler & Hiebert, 1997).

Comparison Group

The teachers who acknowledged no participation in the PD program were frequently observed in a *Whole Class* setting with mathematics instruction in the form of pictorial representations. The use of pictorial representation is common in elementary mathematics as students learn to translate between and among multiple representations (Ainsworth, Bibby, and Wood, 2002; Yang and Huang, 2004).

The students whose teachers did not participate were often in direct contrast to the students whose teachers did participate. They were frequently observed in a *Whole class* Setting, and they were less frequently observed in an *Individual* or *Dyad* Setting. The Comparison groups' students were less frequently observed in off-task behavior which is consistent with the level of Interaction during mathematics instruction because they were most frequently observed with *No Interaction* and less frequently observed *With other students*. In the Activity Type category, the Comparison groups' students whose teachers did not participate were most frequently observed *Listening/Watching* and less frequently observed *Sharing mathematical thinking with peers*, which again is consistent with the *Whole Class* instructional Setting. For the Activity Type category of *Working on written assignments*, the Comparison groups' students whose teachers did not participate were observed using this behavior during mathematics instruction, but it was not significantly different from the Treatment Group. In the last category for the student observations, three items were statistically significant ($p < .05$) and the Comparison groups' students were most often observed *Working with verbal or written representation* and less frequently observed *Working with symbolic or numeric representation* and *Verbalizing solution process*. As with all the previous categories, the standard deviations were high, which indicates a lot variation in the type of Content observed from classroom to classroom.

Implications

The purpose of this study was to report the results from systematic classroom observation of elementary teachers and their students during mathematics instruction. Analysis of the data revealed several salient findings about teacher and student behavior. The implications of those findings are explored in this section, with particular attention to current practice, observation research. A brief discussion of the limitations concludes this study.

Current Practice

The overarching finding that elementary teachers were frequently and randomly observed in a whole class setting, with their students working on written assignments and listening/watching, conjures up the image of traditional practices researchers espouse as less effective to improve student performance in mathematics (National Council of Teachers of Mathematics, 1991). There are likely many reasons why teachers gravitate toward and/or continue to use traditional practices (e.g., lecture). One reason not discussed very often in extant literature is a lack of awareness of classroom behavior (Good & Brophy, 1987). The authors argue teachers are often entrenched in the everyday life of classroom activity so as to not be aware of how much they employ certain instructional practices, and its subsequent behavior on students, and this lack of knowledge may result in "unwise, self-defeating behavior" (p. 1).

One purpose of classroom observation is to improve instructional practice by providing teachers with feedback from data collected in their classrooms, and in relation to other teachers in the school as well as the district as a whole (Waxman, Padrón, Shin, & Rivera, 2008). Knowledge of these strengths and weaknesses bring awareness to teachers about their daily instructional practice. Waxman et. al. also suggests schools need to offer focused staff development to improve upon the results of the observations. The evaluation cycle proposed by the NCTM posits the same idea in that the observations may be used to provide planned PD (National Council of Teachers of Mathematics, 1991).

Future Observation Research

The context of this study focused on elementary teachers (third and fourth grade) and their students during mathematics instruction. Several studies report the results of classroom observation with elementary teachers during mathematics instruction (Fennema et al., 1996; Stipek & Byler, 2004, however, this study is unique in that some of the teachers participated in a statewide PD program. As most education reforms require some type of PD, it becomes important to treat this variable with classroom observation research. Understandably, it is impossible to spend a lot of time in every teachers' classroom with each type of PD they have attend, but PD programs which focus on use of specific instructional strategies and/or knowledge of content would benefit from the results of systematic classroom observation. Also, this study reports the results of post-only observations, and future studies should encourage on-going classroom observation for longitudinal impact of teacher and student behavior before, during, and after PD.

Another area where the findings from this study have implications is the dependent variables used to assess teacher and student behavior during mathematics instruction. Previous studies explore classroom interactions as well as levels of student engagement (Pianta & Hamre, 2009). The present study included had multiple measures to explore more of the landscape of daily life in elementary classrooms. As it pertains to mathematics instruction, however, only one category for the teacher and student instrument focused on mathematics practices (e.g., Appendix A- Instructional Practices; Appendix B – Content). Professional organizations such as the NCTM suggest some guidelines for the type of classroom behavior desired for the effective teaching and learning of mathematics (National

Council of Teachers of Mathematics, 1991). Future studies should increase the number of categories to account for more of the behaviors recognized by NCTM (e.g., discourse, mathematical tasks) as critical to improve the teaching and learning of K-12 mathematics.

This study has several limitations. First, the research design was non-experimental and operated with a posttest-only format. As such, these results may not be generalized to other school districts, teachers, and students. No causal inferences are made from the results of the classroom observations, only to describe the current level of practice from one school district's elementary teachers and their students. Second, 50 teachers volunteered to participate in this study. Although, the sample size may be sufficient, more than one observation per teacher is preferred. Third, the only measure to record teacher and student behavior was the classroom observation instruments. The findings are limited without information about the scheduled lesson plan to determine whether the observed behaviors were warranted.

Conclusion

Classroom teaching is a complex conundrum, and the knowledge base continues to grow as studies provide new evidence of the process-process/process-outcome variables that impact classroom behavior. The goal of this study was to look at the classroom processes used by elementary teachers and their students during mathematics instruction. The data came from systematic classroom observation as part of an evaluation of a statewide PD initiative to improve mathematics instruction and student achievement. The post-only research design offers a snapshot of the classroom processes used by three groups of teachers according to whether they participated in the PD program. In short, the findings suggest the teachers who participated were observed utilizing more effective teaching strategies, and overall the teachers used more traditional practices (i.e., whole class setting and direct instruction). Additionally, the students whose teachers participated were more frequently observed working on written assignments and verbalizing the solution process.

Although the findings from this study are not generalizable, they do offer some support for the statewide PD initiative used in Texas. Future research, however, should seek to employ pre-and post-systematic classroom observation during the evaluation period as a gauge of the instructional practices, and also with more data collection in the form of lesson plans, multiple episodes, and with different mathematics content. The call for on-going classroom observation is promoted as a professional standard by the National Council of Teachers of Mathematics who maintain classroom observation as a necessity to improve mathematics teaching as a part of planned PD for mathematics teachers.

CHAPTER IV

CONCLUSION

Introduction Restatement

The call to reform mathematics education – teaching and learning – is a profound issue that plagues federal, state, and local stakeholders. The common denominator among many of the reform initiatives is teacher professional development (PD). At the state level, the initiatives and their subsequent evaluations produce results to highlight areas of progress with teacher PD, as well as where more research is needed to understand the depth and breadth of effective teacher development.

The purpose of this dissertation was to describe the results from data collected as part of an evaluation of a statewide mathematics PD program. Two separate research studies were developed from the evaluation, and are summarized below. Following the summaries is a brief discussion about the findings' relevance to the overall dissertation project.

Chapter Summaries

Chapter II

The purpose of Chapter II was to describe district trainers' attitudes and perceptions about the MTC curriculum. The participants included 95 district trainers (Specialists and Non-specialists). Data collection involved a follow-up online survey, and analyzed to examine significant differences in trainers' attitudes about the mathematics curriculum and perceptions about the impact of the curriculum on teacher knowledge and student achievement. The results indicated no significant differences in the trainers' attitudes about the curriculum. Additionally, the trainers' perceptions about the impact revealed teacher themes related to *conceptual knowledge*, *standards-based knowledge*, *teacher knowledge*, *instructional strategies*, and student themes of *curriculum alignment, instructional strategies*, *classroom interaction*, *teacher input*. Overwhelmingly, the trainers' stated the curriculum would improve teacher and students' conceptual knowledge of mathematics content for all K-12 grades.

Chapter III

The purpose of Chapter III was to describe the classroom processes – teacher and student behavior – during mathematics instruction. The participants included 46 elementary teachers and 184 students from one school district in Texas. The teachers and students were observed within two years of the teachers' participation in the MTC program. Data collection involved three classroom observation instruments, and analyzed to examine differences in teacher and student behavior according to whether the teacher participated in the PD program. The results indicated some significant differences in the teachers' classroom (e.g., use of whole-class instruction and type of mathematical representation). Whole-class instruction, however, was the method used most by both teacher groups. Additionally, there were some significant differences in the students' behaviors, and reflected the teachers' method of instruction (e.g., whole group instruction led to students working on written assignments and listening/watching) during mathematics instruction.

Discussion of Relevance to Overall Dissertation

The guiding question for this dissertation project was, "What can education researchers learn about systemic mathematics PD? The first study provided a fairly new dimension to systemic PD in that the people who train teachers are usually not the focus of research studies. Understandably, the focus is on the teachers because they have the most impact on student learning. The trainers in this study, however, gave us an idea of their attitudes about the curriculum they were responsible for using to train teachers, which was positive on all components of the curriculum. This finding provides a good place for more exploration into the "overall preparation and knowledge of the people delivering PD" (Hill, 2007, p. 118).

The trainers in the first study delivered PD to the elementary teachers observed in the second study. The opportunity to have a glimpse into the teachers' classrooms was important because systemic initiatives are only as good as what can be observed after PD. The systematic observations revealed elementary teachers' frequent use of whole class instruction while teaching mathematics content. This finding is important because the initiative focused on conceptual understanding and making connections, and whole class instruction is often related to traditional instructional practices (e.g., lecture).

Implications

Large-scale teacher PD is a rarity, and evaluations of such programs are few and far between. Two components of a large-scale teacher PD program are the focus of this study

– train-the-trainer model and classroom observation. The implications of the study's findings are discussed with regard to research, policy, and PD.

Implications for Professional Development

The findings of this research project have implications for designers of large-scale PD programs, especially those designed to improve mathematics teaching and learning. First, there is a wealth of research about models of PD, and in particular the train-the-trainer model. While many of the studies are based in the health field, much can be learned about how to use this model for teacher education. PD designers should make every effort to study this model for its effectiveness and challenges, and use this knowledge to impact teacher PD. Second, the trainers expressed a favorable attitude about most factors extracted from the curriculum. Their attitudes carry a lot of weight with how implementation of the materials will look in front of teachers. Designers must be cognizant of ways to encourage and keep trainers with a positive attitude about the curriculum materials. Future programs may attend to this concern with multiple opportunities to investigate trainers' attitudes throughout the initial training workshop, and even beyond to consider longitudinal impact of their attitudes.

The other component in this project featured systematic classroom observations of elementary teachers during mathematics instruction. The overall finding indicated the teachers used more direct instruction, and this has an obvious implication for PD design. According to the NCTM (1991), "efforts to improve the teaching of mathematics are necessarily a function of what good mathematics teaching is considered to be (p. 71)." If the goal of PD is to improve instructional practices, then designers need to be aware of what behavior they intend the PD to change or modify, and establish goals, expectations, and a plan to induce such changes (Loucks-Horsley, Love, Stiles, Mundry, & Hewson, 2003).

Implications for Policy

The program developers chose to use a TTT model because of its potential impact to reach more teachers across the state. The findings indicate most of the trainers did, in fact, return to their respective regions to provide PD to teachers, and many of them conducted 10 or more sessions. An implication of this analysis is that policy related to the PD program must account for the model of PD used to disseminate the material. New PD programs are complex infrastructures, and while there is no argument for the end result of improved teaching and learning of mathematics, equal consideration is needed to establish the appropriate framework to begin the dissemination process. Consequently, more research is needed about the train-the-trainer model and its use in teacher education to determine how to integrate this method into large-scale PD policy.

Teacher trainers, like teachers, respond to objects such as their assigned curriculum with a favorable or unfavorable attitude. Overall, the trainers regarded the factors extracted from the curriculum with a positive attitude. They were able to identify within the curriculum how the mathematics topics were developed, conceptualized, and made accessible for interdisciplinary purposes. The curriculum fell short, however, with how the material assisted with differentiation for diverse student groups. In the same way that teachers' attitudes about the curriculum dictate implementation, trainers' favorable attitudes may dictate how they interpret the material. Program development policies need to stipulate instruments related to how trainers' perceive the curriculum. In their description of the California's PD program to improve the teaching and learning of mathematics, Cohen and Hill (2001) discuss "a range of policy instruments – curriculum, assessment, and teachers' learning – that might shape practice" (p. 21). As there is not a lineage of research on trainers' attitudes about curriculum, especially in teacher education, more research is needed to identify where and how to integrate the needs of trainers into PD policy.

The ultimate goal of PD is to improve classroom instructional practices. A challenge addressed in extant literature concerns the lack of observations to determine whether and to what extent the PD strategies are implemented in the classroom. The present study accounted for this concern with a single follow-up observation of elementary teachers after participation in the statewide PD program. The overall finding indicated the teachers used more whole-class settings with direct instruction and mathematical algorithms. While these methods are sometimes effective, education researchers and the NCTM suggest these practices are antiquated and will not affect the kind of change needed for optimum student learning. Specifically, the NCTM encourages more frequent observations as part of on-going evaluation to improve teachers' instructional practices. Policymakers should make every effort to reinforce the need for classroom observations as an integral part of future PD programs to improve the teaching and learning of mathematics.

Implications for Research

This study reports findings from two components of a large-scale teacher PD program: teacher trainers' attitudes about mathematics curriculum and classroom observations after teachers participated in the program. As stated previously, PD is a complex infrastructure with so many nuances which contribute to its effectiveness (or lack thereof). The findings presented here add important information to what is already known about these components. Still we need more research to complete the landscape of influences for teacher development. Understandably, a full agenda for large-scale PD is too massive an undertaking within the limits of this project, but a few critical areas for more research is provided for consideration.

Train-the-trainer was the model chosen to disseminate the PD program throughout the state. Texas has regional education service centers with personnel dedicated to provide PD to nearby administrators and teachers. This model has the potential to work well for Texas because the framework is established and many of the kinks with having a body of providers available has been worked out. As this model continues to be used in Texas and other states, more research is needed on the processes within regional service centers that serve to build a TTT model which other states might be able to use. Also, it would be wise to gather more data on trainers' self-efficacy as PD providers based on the types of opportunities for training they receive within the service centers.

We know from the present study the trainers had a favorable general attitude about the mathematics curriculum materials. Research should continue with this line of inquiry, and grow into the connections between their attitudes and their behavior as PD providers.

So, to the extent we now the trainers in this study did not find favor with the factor related to Differentiation, we need to understand the potential impact their attitude will have when they train teachers in their region. Other areas to consider are how much of their prior classroom experience, graduate level coursework, and other PD training experiences shaped their thinking about the MTC curriculum? Also, the instrument developed to measure their attitudes only accounted for basic perceptions of the curriculum. Future research should attend to instruments which collect their attitudes about specific content development within the curriculum.

The other component addressed in this study is classroom observation after PD. To a greater extent, the teachers were observed using direct instruction, whole-class settings, and mathematical algorithms, and their students behaved accordingly. Their behaviors were not uncommon when compared with much of the research on teacher and student behavior during elementary mathematics instruction. As important as it is to observe teacher behavior, the present body of knowledge lacks substantial attention to classroom observation research. Thus, future research is needed to build the database on daily teacher and student behavior. In this study, the focus was observed behavior after PD, which means more research is needed before PD to ascertain a baseline of behavior.

The instruments used to measure classroom processes accounted for general best practices for teaching, in addition to some strategies identified from the PD program. While it is important to understand this level of practice, priority should be given to instrument development with essential elements from the standards addressed by NCTM (2001). For example, the first standard is "worthwhile mathematical tasks" (p. 25). One segment of the instrument should include explicit details about the types of tasks used during the observation period (e.g., computer software, textbooks, and projects), as well as how the task is mathematized. It is probably not necessary to have an instrument with every standard, but the development of a few instruments which streamline the ideas in the publication material is helpful.

Recommendations for Future Research

In future research with TTT models for teacher PD, the author suggests making a connection to adult learning theory during the training workshops. In particular, attention is needed on the difference between adult learners and child learners, learning styles of adults, and types of questions to draw out a high level of engagement from the participants. Knowles (1990) expressed concern with adult learners being a "neglected species," and with that have unique desires and reasons to learn new material. For example, adult learners need to be self-directed in learning, and adults are motivated to learn based on their experiences, needs, and interests. We need to understand how to prepare curriculum materials to satisfy those needs and desires of adult learners, so they do become more effective PD trainers.

It is imperative that classroom observation research become a focal point in discussions about how to improve mathematics instruction, if for no other reason than we need to identify what behaviors the PD attempts to modify. It may be useful to develop case studies of new, nearly new, and experienced mathematics teachers within one school to focus classroom observation research and define patterns of behavior. Then, individualized plans for PD could be implemented to help teachers modify the identified behavior.

Understandably, this is a slow process, but given that so much research in education is non-experimental and without generalizability, case studies of a few teachers might be more beneficial and cost-effective for designers of PD.

Conclusion

In conclusion, systemic PD to improve the teaching and learning of mathematics is still in its infancy. The results from this research project add to the growing knowledge base with two lines of inquiry not often addressed in the extant literature – teacher trainers, and systematic classroom observation. While the findings from this study may not be generalized, education researchers may use this information as a holistic approach to augment future statewide teacher PD programs.

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APPENDIX A

MTC TRAIN-THE-TRAINER FOLLOW-UP SURVEY

Math TEKS Connections (MTC)
Follow-Up Survey to TOT Workshop

As part of the TAMU evaluation of the Mathematics TEKS Connections project (MTC), we are asking those who attended the Training-of-Trainers (TOT) workshop(s) to complete the brief survey below. Your input and feedback is important because it will aid us in conducting a comprehensive and thorough evaluation of participant reaction to the TOT sessions and the MTC materials. All responses will be kept confidential and will be reported in summary format only.

Demographic Information

- What is your current job title? ____________________________
- What was your title when you participated in MTC TOT? _______________________
- Years of teaching experience completed:
  ____ 0-1 year ____2 to 3 years _____4 to 5 years
  ____6 to 10 years ____11 to 15 years _____more than 15 years
- Years of teaching mathematics completed:
  ____0-1 year ____2 to 3 years _____4 to 5 years
  ____6 to 10 years ____11 to 15 years _____more than 15 years
- Highest level of education completed
  - ______B.A. or B.S. Major:_____________
  - ______M.A. or M.S. Major:_____________
  - ______PhD. or Ed.D. Major:_____________
  - ______Other, please specify____________________
- Certification Level (Check all that apply)
  - _____Elementary
  - _____Middle
  - _____High School
  - _____Other, please specify_____________________
- MTC module(s) in which you were trained (Check all that apply)
  - _____K-2
  - _____3-5
  - _____6-8
  - _____9-12
  - _____Geometry

Reason(s) for participating (check all that apply)

I attended the MTC TOT workshop because:

- District encouragement ___Yes ___ No
- Gain more knowledge to apply in my school/district ___Yes ___ No
- To learn how to provide professional development on MTC materials ___Yes ___ No

- Strictly as an observer (did not plan to train others in MTC materials) ___Yes ___ No
- Other, please specify ____

MTC Curriculum

SD: Strongly Disagree D: Disagree A: Agree SA: Strongly Agree

- The MTC materials provided were useful in learning the curriculum. SD D A SA
- I learned new ideas and/or skills by attending the MTC professional development. SD D A SA
- All the MTC professional development activities were useful in learning the material. SD D A SA
- The sequence of mathematics topics in the MTC curriculum was appropriate. SD D A SA
- The mathematics content of the MTC curriculum was satisfactory. SD D A SA
- The mathematics content of the MTC curriculum had vertical and horizontal alignment across grade levels. SD D A SA
- The MTC curriculum developed conceptual understanding in mathematics. SD D A SA
- The MTC materials were developmentally appropriate for the grade level you participated in. SD D A SA
- The MTC instructional materials were easily applicable to other teaching approaches. SD D A SA
- The examples provided in the MTC instructional materials were relevant for each topic. SD D A SA
- The MTC manipulative materials used were interactive. SD D A SA
- The MTC manipulative materials used were useful for developing mathematical concepts. SD D A SA
- The technology (e.g., calculators, graphing calculators, geoboard, etc.) was used appropriately within each grade band to develop conceptual understanding in mathematics. SD D A SA
- The MTC instructional representations (e.g., concrete, pictorial, real-world, symbolic, etc.) were used appropriately with the mathematical ideas. SD D A SA
- The MTC curriculum emphasized the development of mathematical thinking and reasoning skills. SD D A SA
- The MTC material appropriately utilized the instructional technique of scaffolding. SD D A SA
- The MTC material conceptualized mathematics being taught for higher-order and critical thinking skills. SD D A SA
- The MTC curriculum integrates problem-solving strategies. SD D A SA
- The MTC curriculum explains how to create more effective lesson plans using children's mathematical thinking. SD D A SA
- The MTC curriculum provides a clear understanding of the different modes of assessment (e.g., formative, summative, standards-correlated, and authentic, etc.) SD D A SA
- The MTC curriculum supports modifications for different ability levels. SD D A SA
- The MTC curriculum supports modifications for English language learners. SD D A SA
- The MTC curriculum supports modifications for students with special needs. SD D A SA
- The MTC curriculum makes connections to students' prior knowledge in mathematics. SD D A SA

- The MTC curriculum allows for multiple modes of communication (e.g., teacher-student, student-student, etc.). SD D A SA
- The MTC curriculum includes diverse cultural perspectives in mathematics. SD D A SA
- The MTC curriculum supports gender equity in mathematics. SD D A SA
- The MTC curriculum connects mathematics to applications in everyday life. SD D A SA
- The MTC curriculum encourages students to explore mathematics in diverse career paths (e.g., medicine, engineering, nursing, law, teaching, mechanics, cooking, etc.). SD D A SA
- The MTC curriculum emphasizes the use of interdisciplinary skills (e.g., reading, writing, communication, vocabulary, performance, cooperation, collaboration, etc.) SD D A SA

MTC Training

- Since attending the TOT workshop(s), have you conducted mathematics professional development for others using the MTC materials ___Yes ____No

- If yes, how many mathematics professional development sessions have you conducted? _______
- Approximately how many participants attended all your mathematics professional development sessions? _______

- Please rate yourself on your ability to train others
  ___Ineffective ___ Effective ___Very effective

- Please rate your impressions of the *overall* success of the training workshop(s) you have conducted.
  ___Ineffective ___ Effective ___Very effective

- Please rate the overall quality of assessment and feedback you received during your training.
  ___Ineffective ___ Effective ___Very effective

Other Training

- Have you attended any professional development (PD) besides MTC TOT in last five years?
  _____Yes _____No
- Training session(s) that you have attended in last five years (check all that apply)
  - GeoGebra-Texas Regional Collaboratives (TRC)
  - NCTM E-Workshops/E-Seminars
  - Assessing Children's Algebraic Thinking:K-2 (TRC)
  - Carnegie Learning® PD programs
  - Texas Collaborative for Teaching Excellences PD
  - The Mickelson ExxonMobil Teachers Academy PD
  - Math Solutions PD Courses
  - Mathematics for All Consulting PD
  - Others, please specify____

Open-Ended

- How would you compare the MTC TOT workshop(s) with the other mathematics professional development(s) you have attended? Explain.

- How do you think the MTC curriculum can improve mathematics content and pedagogical content knowledge of teachers? Explain.

- How do you think the MTC curriculum can improve students' achievement in mathematics?

- What are some suggestions that you think will improve students' mathematical learning in the classroom.

APPENDIX B

TEACHER OBSERVATION SCHEDULE

Teacher Observation Schedule: MTC Follow-Up (K-6) School ______________ Teacher ___________ Teacher Sex ____ Grade ____

students in class________ Observer_________ Date _________ Time Began_______ Time Ended_______ Content Area ____________________

(30 second time intervals)	1	2	3	4	5	6	7	8	9	10	Total
INTERACTION (check one)											
1. No interaction											
2. With student(s) – instructional											
3. With student(s) – managerial											
4. With student(s) – social, personal											
5. With student(s) – collaborative											
6. Other ____________________											
SETTING (check one)											
1. Whole class											
2. Small group (more than 2 student)											
3. Dyad (2 students)											
4. Individual											
5. Traveling											
6. Other ____________________											
INSTRUCTIONAL ORIENTATION (check one)											
1. Direct instruction (e.g., lecture)											
2. Seatwork (e.g., worksheets, textbooks)											
3. Learner-centered (e.g., cooperative learning, project-based, inquiry)											
4. Other ____________________											
NATURE OF INTERACTION (check all that are observed)											
1. Questioning											
2. Explaining											
3. Positive Commenting (e.g., 'you look nice today')											
4. Negative Commenting (e.g., 'traffic was terrible this morning')											
5. Neutral Commenting (e.g., general discussion about sports)											
6. Listening											
7. Cueing or prompting (scaffolding)											
8. Modeling/Demonstrating											
9. Other ____________________											
PURPOSE OF INTERACTION (check all that are observed)											
1. Focus on content (e.g., subject area content)											
2. Focus on process											
3. Focus on product (e.g., outcome)											
4. Connect content to other disciplines											
5. Connect content to global communities											
6. Present multiple perspectives on topic											
7. Redirect student thinking											
8. Show interest in student work											
9. Show personal regard for student											
10. Encourage students to help each other											
11. Encourage students to succeed											
12. Encourage students to question											
13. Encourage extended student responses											
14. Encourage student self-management											
15. Praise student behavior											
16. Praise student performance											
17. Correct student behavior											
18. Correct student performance											
19. Assessment											
20. Other ____________________											
INSTRUCTIONAL PRACTICES (check all that are observed)											
1. Uses concrete models (e.g., manipulatives)											
2. Uses pictorial representation (e.g., pictures of quantities)											
3. Uses verbal or written representation (e.g., use of words)											
4. Uses symbolic or numeric representation (e.g., algorithms)											
5. Uses tabular or graphical representation (e.g., tables/graphs)											
6. Uses area models (e.g., colored tiles)											
7. Uses linear models (e.g., number line)											
8. Uses sets models (e.g., ten counting sticks)											
9. Assists students with technology											
10. Uses technology to present material											
11. Uses technology as a communication tool											
12. Uses technology to create											
13. Uses technology to access the Internet											

APPENDIX C

STUDENT OBSERVATION SCHEDULE

Student Observation Schedule: MTC Follow-Up (K-6) School _______________ Teacher ___________ Grade ____ Student Sex ___

Student Ethnicity_____________ Observer_________ Date _________ Time Began_______ Time Ended_______ Content Area _______________

(30 second time intervals)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**Total**
SETTING (check one)											
1. Whole class											
2. Small group (more than 2 students)											
3. Dyad (2 students)											
4. Individual											
MANNER (check one)											
1. On-task											
2. Off-task											
3. Waiting for teacher											
4. Disruptive											
5. Other _______________________											
INTERACTION (check one)											
1. No interaction											
2. With teacher – instructional											
3. With teacher – managerial/social											
4. With other students											
5. Other _______________________											
ACTIVITY TYPES (check all that are observed)											
1. Working on written assignment											
2. Interacting/Instructional (e.g., discussing)											
3. Sharing mathematical thinking with peer (process, solution, etc.)											
4. Participating in student-led discussions											
5. Reading mathematics-related texts											
6. Getting/returning materials											
7. Painting/drawing/creating graphics											
8. Playing mathematics games											
9. Presenting/acting											
10. Experiential/hands-on learning											
11. Tutoring peers											
12. Working kinesthetically											
13. Listening/watching											
14. Distracted											
15. Acting-out (behavior)											
16. No activity/transition											
17. Other _____________________											
CONTENT (check all that apply)											
1. Working with concrete models (e.g., manipulatives)											
2. Working with pictorial representation (e.g., pictures of quantities)											
3. Working with verbal or written representation (e.g., use of words)											
4. Working with symbolic or numeric representation (e.g., algorithms)											
5. Working with tabular or graphical representation (e.g., tables/graphs)											
6. Using area models (e.g., colored tiles)											
7. Using linear models (e.g., number line)											
8. Using sets models (e.g., ten counting sticks)											
9. Verbalizing solution process (e.g., student think-alouds)											
10. Working on basic skills (e.g., 2+2=4)											
TECHNOLOGY (check all that are observed)											
1. MP3 player/iPod											
2. Tape player/radio											
3. Interactive whiteboard (e.g., SMART Board, Promethean Board)											
4. Student response device											
5. Flip camera/video camera											
6. Digital camera											
7. DVDs/CDs & headphones											
8. Skype/video communication											
9. Laptop computer											
10. Desktop computer											
11. Television											
12. Document reader											
13. Overhead projector (traditional)											
14. Handheld game/device											
15. Student timers											
16. Other _____________________											
EDUCATIONAL USE OF TECHNOLOGY (check all that are observed)											
1. Basic skills/drill/practice											
2. Problem solving (e.g., SimCity, Yukon Trail, Carmen Sandiego)											
3. Creativity (e.g., Sketchpad, KidPix)											
4. Individualized/Tracked (e.g., Accelerated Reader)											
5. Word Processing											
6. Internet											
7. Communication tool (e.g., Skype, email											
8. Other _____________________											

APPENDIX D

OVERALL MATHEMATICS OBSERVATION

Overall Mathematics Observation: MTC Follow-Up (K-6) School ________________ Teacher ______________ Grade ________

Observer________ Date _________ Time Began_______ Time Ended_______ Content Area ___________________ # students in class________

At the end of the overall classroom observation, indicate to what extent each of the following was used or demonstrated during the observation period.

Rating Scale

1	2	3
Not observed at all	Some extent (once or twice)	Great extent (3 or more times)

TEACHER	1	2	3
1. Teacher actively facilitated students' engagement in activities and lessons to encourage participation			
2. Teacher linked concepts and activities to one another and to previous learning			
3. Teacher applied new concepts to similar situations (elaborated)			
4. Teacher connected ideas and concepts			
5. Teacher initiated experiences, discussions and activities			
6. Teacher developed conceptual understanding			
7. Teacher used multiple representations			
8. Teacher used purposeful questioning for instruction			
9. Teacher acted as coach/facilitator			
10. Teacher allowed students to develop concepts or procedures			
11. Teacher asked many open-ended questions			
12. Teacher provided students opportunities for problem-solving			
13. Teacher provided feedback (answers, information, etc.)			
14. Teacher assisted students to organize thinking (identify and describe patterns)			
15. Teacher assisted students in generalizing learning to other situations, problems, etc.			
16. Teacher facilitated the generation of mathematical "rules" based on generalizations			
17. Teacher integrated calculators into lesson			
18. Teacher integrated software into lesson			
19. Teacher integrated feedback and assessment into instructional cycle			
20. Teacher distributed feedback evenly			
21. Teacher redirected student thinking			
22. Teacher used technology for a non-instructional purpose (e.g., checking email)			
INSTRUCTIONAL USE OF TECHNOLOGY	1	2	3
1. Teacher integrated technology into lesson			
2. Teacher assisted students with technology			
3. Teacher used technology as a communication tool (e.g., Skype, email/chat)			
4. Teacher used technology to create			
5. Teacher used technology to access the Internet			
STUDENT	1	2	3
1. Students initiated and assumed responsibility for learning activities			
2. Students connected ideas and concepts			
3. Students utilized different ways to answer (alternative solutions)			
4. Students participated in problem-solving			
5. Students were engaged in classroom activities			
6. Student activities were learner-centered			
EDUCATIONAL USE OF TECHNOLOGY	1	2	3
1. Students used technology to enhance problem-solving/creativity			
2. Students used technology to learn basic skills (e.g., tutorials, drill & practice)			
3. Students used technology to access the Internet			
4. Students used technology as a communication tool (e.g., Skype, email/chat)			
5. Students used technology for word processing			
6. Students used technology for assessment purposes (e.g., individualized tracking, Accelerated Reader)			
7. Technology was accessible for student use			

TECHNOLOGY	#	1	2	3
1. MP3 player/iPod				
2. Tape player/radio				
3. Interactive whiteboard (e.g., SMART Board, Promethean Board)				
4. Student response device				
5. Flip camera/video camera				
6. Digital camera				
7. DVDs/CDs & headphones				
8. Skype/video communication				
9. Laptop computer				
10. Desktop computer				
11. Television				
12. Document reader				
13. Overhead projector (traditional)				
14. Handheld game/device				
15. Student timers				
16. Other______________________________				

Please record field notes on back of page