

THE DESIGN, IMPLEMENTATION, AND EVALUATION OF A TEACHER TRAINING
WORKSHOP FOR MATHEMATICS GRADUATE TEACHING ASSISTANTS

by

Jerome Charles Trouba

A dissertation submitted in partial fulfillment
of the requirements for the degree

of

Doctor of Philosophy

in

Mathematics

MONTANA STATE UNIVERSITY
Bozeman, Montana

November 2009

©COPYRIGHT

by

Jerome Charles Trouba

2009

All Rights Reserved

APPROVAL

of a dissertation submitted by

Jerome Charles Trouba

This dissertation has been read by each member of the dissertation committee and has been found to be satisfactory regarding content, English usage, format, citation, bibliographic style, and consistency, and is ready for submission to the Division of Graduate Education.

Dr. David Yopp (Chair)

Approved for the Department of Mathematical Sciences

Dr. Ken Bowers

Approved for the Division of Graduate Education

Dr. Carl A. Fox

STATEMENT OF PERMISSION TO USE

In presenting this dissertation in partial fulfillment of the requirements for a doctoral degree at Montana State University, I agree that the Library shall make it available to borrowers under rules of the Library. I further agree that copying of this dissertation is allowable only for scholarly purposes, consistent with "fair use" as prescribed in the U.S. Copyright Law. Requests for extensive copying or reproduction of this dissertation should be referred to ProQuest Information and Learning, 300 North Zeeb Road, Ann Arbor, Michigan 48106, to whom I have granted "the exclusive right to reproduce and distribute my dissertation in and from microform along with the non-exclusive right to reproduce and distribute my abstract in any format in whole or in part."

Jerome Charles Trouba

November 2009

DEDICATION

This work is dedicated first and foremost to my amazing and beautiful wife, Stephanie, in acknowledgement of her support throughout my *many* years of graduate school. I deeply appreciate the enormous sacrifices you have made for me. You never let me lose sight of the things that really matter in life; thank you for being such a wonderful mother to our son Jude. Jude, thanks for filling my life with such joy during my many difficult and tiring months of work on this project, many of my best ideas came while holding you in the late hours of the night.

I'd also like to dedicate this work to my family. Jim, you were always there giving me good advice and pushing me to accomplish more. John, I've always enjoyed our frequent conversations. Cathy, thanks for always loving me so much. Finally, to my parents who have supported me my entire life—thank you mom and dad, for caring so much about me. Dad: I'll never forget the times we spent doing mental multiplication in the car. Mom: thanks for making sure I always did my homework and for being there for me when I came home from school. You were the best parents a kid could ask for—thank you.

ACKNOWLEDGEMENTS

I extend my sincere gratitude to Dr. David Yopp, who after many long months is surely as excited as I am for the completion of this paper. Thank you for your dedication to this work: your words and ideas are present throughout. I would not have been able to finish this project without your diligence. Thank you for being my advisor, my mentor, and my friend; you have had a great impact on my life.

Thank you to the other members of my committee—your time and expertise has been invaluable. I would especially like to thank Dr. Elizabeth Burroughs for her multiple and extremely thorough readings of my paper and for correcting my grammatical mistakes. I'd like to thank Dr. Jennifer Luebeck for teaching me to think and act like a professional educator during her great instruction of research in mathematics education—one of my favorite courses. To Dr. Maurice Burke, though our conversations were few, they were also insightful and fun, thank you. Finally my most mathematical thank you goes to Dr. Warren Esty who taught me that mathematics is not just knowing algorithms and solving problems. You were one tough teacher, but I also worked harder and learned more from you than any other professor, thanks.

I'd especially like to thank the 18 graduate students who gave me so much of their time and allowed me to continue to repeatedly bother them while finishing my dissertation, I owe you one. Finally, special thanks to the MSU Vice Provost Office of Undergraduate Education and Dr. Jeff Adams for providing funding for this project.

TABLE OF CONTENTS

1. STATEMENT OF THE PROBLEM.....	1
Introduction.....	1
Statement of the Problem.....	3
Purpose of the Study.....	4
Research Questions.....	5
Background for the Study	5
Analysis of Past GMTA Workshops.....	8
Theoretical Framework	9
Significance of the Study	12
2. REVIEW OF THE LITERATURE	14
Effective Professional Development	14
Evaluation of Professional Development.....	27
Workshop Content	33
Seminar 2: Reflective Teaching.....	35
Seminar 3: Active Learning	39
Seminar 4: Questioning Techniques.....	43
Seminar 5: Formative Assessment.....	45
Phase 2 – The Classroom Component.....	48
Peer Coaching	49
Classroom Observation.....	52
3. METHODOLOGY	53
Introduction.....	53
Overview of Methodology Used	53
Population and Sample	55
GMTA Population.....	55
GMTA Sample	55
Design of the Study	57
The 2007 Teacher Training Workshop.....	57
Seminar 1.....	58
Seminar 2.....	59
Seminar 3.....	59
Seminar 4.....	59
Seminar 5.....	60
Seminar 6.....	60
Seminar 7.....	61

TABLE OF CONTENTS (CONTINUED)

Seminar 8.....	61
The 2008 Teacher Training Workshop.....	61
Seminar 1: Introductions Concerns, and Policies.....	62
Seminar 2: Reflective Teaching.....	63
Seminar 3: Active Learning.....	63
Seminar 4: Questioning Techniques.....	63
Seminar 5: Formative Assessment.....	64
Seminar 6: Philosophies of Teaching.....	64
Phase 2 – The Classroom Component	65
Peer Coaching.....	68
Observation.....	69
Data Sources	70
Interviews.....	71
Videotapes.....	72
The Reformed Teaching Observation Protocol.....	73
Videotape Coding Protocol.....	74
Constructed Instruments.....	75
Teacher Confidence Inventory.....	75
The Coaching Reflection Instrument.....	76
Coaching Impact Inventory.....	77
The Observation Reflection Form.....	78
End of Treatment Survey.....	78
Workshop Survey.....	78
A Self-Reflection Instrument.....	79
Data Analysis	80
Interviews	81
Videotapes	82
Modified RTOP.....	82
Videotape Coding Protocol.....	85
Triangulation.....	86
Limitations and Assumptions.....	87
Limitations	87
Multiple Treatments.....	87
Comparing Workshops.....	87
Volunteer Participants.....	89
Possible Hawthorne Effect.....	90
Quasi-experimental Design.....	90
Assumptions	91
Changes in Confidence.....	91
Workshop Comparison.....	91

TABLE OF CONTENTS (CONTINUED)

4. RESULTS	93
Introduction.....	93
Introducing the GMTAs from 2008	93
December 2008 Interviews	97
Factors Influencing Teaching Growth.....	97
Targeted Techniques.....	97
Positive Experiences.....	101
Viewpoint of Teaching.....	103
Summary.....	105
Factors Limiting Teaching Growth.....	105
Absent Techniques.....	105
Negative Experiences.....	107
Viewpoint of Teaching.....	108
Summary.....	109
Additional Notable Findings	109
Analysis of RTOP Scores for all 2008 GMTAs.....	111
Coding Analysis of Instruction for all 2008 GMTAs	113
Analysis of Instruction for Individual 2008 GMTAs	115
RTOP Scores.....	115
Qualitative Videotape Analysis.....	117
Summary.....	118
Comparing the 2007 and 2008 GMTA Workshops	120
Introducing the 2007 GMTAs.....	120
2007 GMTA Summary.....	122
2007 and 2008 Workshop Comparison Introduction.....	123
Workshop Survey.....	123
Analysis of the November Videotapes of the 2007 and 2008 GMTAs	125
Interviews	128
2008 Workshop: Phase 2 – The Classroom Component.....	135
Overview	135
Observation	135
Interview Synthesis.....	136
Observation Reflection Form.....	137
Teacher Confidence Inventory.....	140
RTOP.....	141
Peer Coaching.....	141
Interview Synthesis.....	142
Teacher Confidence Inventory.....	143
RTOP.....	144

TABLE OF CONTENTS (CONTINUED)

Analysis of Peer Coaching Pairs	145
Ken and Frank.....	145
Simon and Amy.....	149
Earl and Andy.....	151
Allyson and James.....	153
Pam and Corinne.....	155
Individual 2008 GMTA Summary	157
Summary of Important Results	177
5. CONCLUSIONS.....	180
Introduction.....	180
Addressing the Research Questions.....	181
Research Question 1 – Impact on Teaching Practices.....	181
Research Question 2 – Workshop Comparison.....	182
Research Question 3 – Implementation of Strategies from the 2008 Workshop.....	184
Research Question 4 – Comparing Coaching and Observation.....	185
Additional Conclusions.....	187
A Conceptual Model of Workshop Factors Impacting Teaching.....	187
Constructs Affecting the Effectiveness of Peer Coaching.....	189
Adapting K-12 Professional Development Literature.....	191
Implications for Research and Practice.....	196
Recommendations for Future Research	197
Epilogue.....	198
REFERENCES.....	200
APPENDICES.....	210
APPENDIX A: 2007 Interview Protocol	211
APPENDIX B: 2007 Workshop Active Learning Handout.....	213
APPENDIX C: December 2008 Interview Protocol	215
APPENDIX D: April 2009 Interview Protocol	217
APPENDIX E: Videotape Coding Protocol.....	219
APPENDIX F: Teacher Confidence Inventory.....	221
APPENDIX G: Coaching Reflection Instrument - C	223
APPENDIX H: Coaching Reflection Instrument - T.....	226
APPENDIX I: Coaching Impact Inventory - C.....	229
APPENDIX J: Coaching Impact Inventory - T.....	231
APPENDIX K: Observation Reflection Form.....	233

TABLE OF CONTENTS (CONTINUED)

APPENDIX L: Coaching Survey	235
APPENDIX M: Observation Survey	237
APPENDIX N: Workshop Evaluation Survey 2008	239

LIST OF TABLES

Table	Page
1. Distribution of GMTAs by Year and Course.....	57
2. Distribution of GMTAs by Year and Experience.....	57
3. Distribution of 2008 GMTAs by Course and Experience.....	66
4. Observation / Coaching Divisions by Course and Experience.....	68
5. 2008 GMTA Coded Videotape.....	114
6. Individual RTOP Scores.....	116
7. Individual Changes in the Number of High-level Questions Asked.....	117
8. Individual Changes in the Number of Open-ended Questions Asked.....	117
9. Individual Changes in % of Time Spent in Active Learning.....	118
10. Summary of Individual Changes for the GMTAs from 2008.....	119
11. Summary of Individual GMTAs from 2007.....	123
12. 2007 and 2008 Workshop Surveys.....	124
13. Interval Data Comparison for 2007 and 2008 GMTAs.....	127

LIST OF FIGURES

Figure	Page
1. The Workshop Framework.....	12
2. Box Plots of Modified RTOP Scores over Time.....	112
3. Box Plots of Modified RTOP Scores for the 2007 and 2008 GMTAs.....	126
4. A Conceptual Model of Workshop Factors Impacting Teaching.....	187

GLOSSARY

Active Learning: for this study active learning will be defined according to Prince, “...active learning is introducing student activity into the traditional lecture” (2004, p. 3). Student activity refers to class time given by the instructor for students to work on problems or concepts or to actively think about, discuss, and reflect on ideas, either in groups or individually.

Classroom Component: the peer coaching and observation treatment following the workshop. According to Knight, (2007) professional development is more effective if there is a follow-up classroom component where teachers are asked to implement the strategies they’ve learned. The classroom component will be referred to as Phase 2.

Graduate Mathematics Teaching Assistants (GMTAs): at the researcher’s university, GMTAs have almost total control of the classroom including lecturing, writing and grading quizzes, and grading homework. A course supervisor typically writes exams, the syllabus, and the class schedule. “Graduate” is used to emphasize that these MTAs are graduate students, either seeking a masters or doctoral degree in mathematics or statistics. GMTAs will be labeled as either experienced or inexperienced.

- Experienced GMTA: a GMTA with at least one year of teaching experience
- Inexperienced GMTA: a GMTA with less than one year of teaching experience
(being an undergrad TA does not count towards experience)

Peer Coaching: a process by which two peers work together to improve their teaching. In particular, there is generally a pre-conference meeting before the classroom

observation to discuss the purpose and goals of the lesson, followed by the observation, and then a post-conference to discuss what was observed. Each peer participates both as an observer and a coach. The term “coaching” is a misnomer since the actual role of the coach is to listen to the teacher and facilitate in his or her their reflection.

Professional Development: a process by which a current teacher increases their skills and knowledge through participating in a facilitated learning experience.

Questions: to determine changes in GMTAs use of questioning, a video tape protocol was developed and the questions GMTAs asked were categorized based on audience, level, and type.

Audience:

- Rhetorical – questions asked where no response is expected or no time is given for a response or when the expected response is either yes or no. Examples include: “Does that make sense?” “This function is odd, isn’t it?” “What’s the cosine of sixty degrees? One-half, right?”
- Chorus – simple questions (for which everyone should know the answer) asked of everyone with multiple simultaneous responses expected. Examples include: “And three squared is?” “Nine plus five equals?”
- Volunteer – by far the most common type of question asked, a volunteer question is one where no one is specifically called upon, but not everyone is expected to answer. Usually, only one person is expected to answer and the first correct response ends the question (no other response is expected). Examples

include: “What should we do first?” “What is the formula for the volume of a sphere?” “What is an example of a function?”

- Selected – a question where someone is specifically called upon either before or after the question is asked.

Level:

- Low – questions at the knowledge, comprehension, or simple application levels of Bloom’s Taxonomy, used to evaluate students’ preparation and comprehension. Questions at this level do not require a lot of wait time and can be answered immediately. Examples include: “What is the formula for a volume of a cylinder?” “How do you find the volume of a cylinder?” “How would one find the surface area of a cylinder?”
- High – questions at the analysis, synthesis, or evaluation level of Bloom’s Taxonomy used to help students think more deeply. An appropriate amount of wait time is a critical component to high level questions. Examples include: “Why...?”

Type:

- Open – questions in which there are many acceptable answers. Open-ended questions typically allow the instructor to probe for more understanding or ask for clarification. Examples include: “What is an example of a continuous function?” “Can you describe a function whose right and left handed limits exist, but whose limit does not?”

- Closed – questions in which there is usually only one acceptable answer.

Examples include: “What is the derivative of $5x + 3$?” “What is the slope of this line?”

Reformed Teaching: a movement away from the traditional didactic lecture toward encouraging greater student interaction.

Seminar: a meeting for giving and discussing information. The teacher training workshop contained six seminars and will be referred to as Phase one of the study.

Targeted Teaching Techniques: techniques presented to the GMTAs to be both easy to implement and to have an impact on students. In this study these were active learning, questioning techniques, and formative assessment.

Teacher Training: an initial training for teachers both before and during their first classroom teaching experience to equip them with skills, strategies, and techniques to help them teach.

Workshop: a usually brief intensive educational program for a relatively small group of people that focuses especially on techniques and skills in a particular field. In this study, the workshop consisted of two phases: phase one refers to the six seminars while phase two refers to the classroom component. The whole program the GMTAs went through will be considered “the workshop.”

ABSTRACT

To help train new graduate mathematics teaching assistants (GMTAs), a teacher training workshop was designed based on K-12 literature on the components of effective professional development (Garet, et al., 2001). The workshop consisted of six two-hour seminars over a six week period followed by a classroom feedback component of either peer coaching or observation, for a total time commitment of 18 hours. The content of the workshop addressed teaching techniques specifically targeted to GMTAs. These ideas included elements of reflection, techniques for engaging students through active learning, asking good questions, utilizing wait-time, and using formative assessment techniques. The assessment of the workshop was based on Guskey's (1999) work on the five levels of effective professional development evaluation.

In the mixed-methods design, 18 GMTAs participated in the workshop. Data collection consisted of three sets of videotapes, two sets of interviews, surveys, and coaching and observation forms. Results indicated that a well-designed workshop can impact teaching practices. Through interviews, GMTAs indicated they were more reflective of their teaching, thought more about the questions they asked, and actively involved their students more during lectures. The workshop was considered effective not only because GMTAs said they changed their teaching but because changes were seen in their teaching. For nine GMTAs strong evidence was collected of their change in teaching: they not only mentioned specific changes to their teaching in the interviews, but these specific changes were observed on videotapes of their classroom.

In comparing peer coaching with observation, seven of the ten in the coaching group commented that just watching another's class helped them to improve more than any other part of the coaching process. Only two of the ten coaching participants commented on the helpfulness of the pre and post conference discussions involved with coaching. From the data collected, the possible added benefits of peer coaching may be outweighed by the additional time, organization, and pairing requirements present in a GMTA setting. Five constructs that influenced the effectiveness of the peer coaching experience are discussed. This project contributes to the research base regarding adapting K-12 professional development literature into a collegiate setting.

CHAPTER 1

STATEMENT OF THE PROBLEM

Introduction

Graduate teaching assistants (GTAs) have become an integral part of undergraduate instruction in most universities in the United States. Though their roles vary from lab assistant to discussion leader to full course instructor, GTAs are now a vital part of introductory education. The majority of these GTAs enter teaching with little or no prior teaching experience (Diamond & Gray, 1987). Often, these inexperienced GTAs are assigned to teach courses with minimal pedagogical preparation. To attempt to fill in the gaps in pedagogical knowledge, most universities provide some type of professional development or teacher training in the form of a teaching workshop for new GTAs.

These workshops typically address a wide range of topics and usually last from a few hours to one week—with less than 15% of GTAs receiving training lasting more than one week (Buerkel-Rothfuss & Gray, 1987; Latulippe, 2007; Speer, Gutmann, & Murphy, 2005). During these trainings, GTAs are generally given information about the specific course they are teaching and a list of responsibilities that they are expected to perform. Typically, the content consists of mechanics such as department policies and procedures; topics such as how to write exams and deal with cheating; and only sometimes information about teaching, learning, and interacting with students (Speer et

al., 2005). Seldom do the topics include evidence-based teaching practices that have been shown to work. Follow-up rarely occurs: only about 25% of the time does GTA training go beyond informal meetings or workshops (Edwards, 2006).

Many authors have shown that this form of professional development is unlikely to improve instruction (Desimone, Porter, Garet, Yoon, & Birman, 2002; Garet, Porter, Desimone, Borman, & Yoon, 2001; Knight, 2007). Shortcomings of these training programs include an insufficient duration and intensity, a lack of GTA active participation in their learning, an absence of a classroom follow-up and feedback component, a lack of emphasis on pedagogical content knowledge, and little focus on evidence-based teaching strategies shown to improve student outcomes.

Most notably absent in GTA teacher training workshops is a thorough formative and summative evaluation plan. A review of current literature shows that most GTA training programs limit their evaluation to measuring student reactions and GTA self-perceptions of effectiveness (Young & Bippus, 2008; Latulippe, 2007; Chism & Szabo, 1997). This data based on attitudes and beliefs is often called the “happiness quotient” by education researchers, and authors such as Belnap (2005) have suggested using caution in relying on this type of data alone. While this type of data is important, it is far from sufficient for evaluating the effectiveness of these programs. Since evaluation of the effectiveness of any training program is essential to its improvement, the lack of useful formative and summative assessment data in most GTA training programs is of particular concern.

Based on existing literature there is substantial evidence that a workshop built on a foundation of evidence-based teaching strategies combined with effective professional development, including evaluation of the program, will improve the teaching practices of GTAs. And since research has shown that “Teacher effectiveness is the single largest factor affecting the academic progress of students” (Sanders, as cited in Hill, 2000), it is imperative that GTA workshops utilize evidence-based strategies to prepare GTAs to teach.

Statement of the Problem

As undergraduate enrollment continues to rise, so will the need for teachers; some estimates project half a million new professors will be needed by the year 2014 (Baiocco & DeWaters, 1998). To meet this need, GTAs will be called on to play an even larger role in undergraduate instruction. Therefore, since GTAs are both the faculty of the future and the lecturers of today, there is a great need to prepare them for their responsibilities with quality teacher training programs.

In spite of the number of GTA training programs provided, there is little research addressing the professional development of graduate mathematics teaching assistants (GMTAs) (Belnap, 2005). GMTA teacher training programs at doctorate-granting universities are limited. According to a study by Latulippe (2007), only 24% of Carnegie classified universities with very high research activity offer GMTA teacher training beyond “orientation seminars.” Moreover, because of the lack of thorough evaluation

the actual *quality* of most of these programs is unknown (Chism & Szabo, 1997). In order to determine the effectiveness of GMTA training workshops and understand how to improve them, more research that examines these programs in detail needs to be done (Speer et al., 2005).

Purpose of the Study

The primary purpose of this study was to determine the effectiveness of a teacher training workshop on the teaching practices of participating GMTAs. Though there have been previous GMTA workshops at the researcher's university, little is known about their effectiveness at impacting the teaching practices of the participating GMTAs. The design of this study helped to shed light onto how GMTAs' teaching practices were affected.

The second purpose was to determine the effectiveness of peer coaching and observation as a follow-up classroom component to GMTA teacher training. During the second phase of the study the GMTAs were divided into two groups, one participating in peer coaching and one in observation. These two approaches were used to provide a classroom-based follow-up to the seminars in order to help GMTAs reflect and receive feedback on their teaching. These approaches are analyzed to help determine their influence on GMTAs' teaching practices.

Finally, the third purpose of this study was to determine what adaptations need to be made to K-12 professional development models to work in the GMTA setting. This

question was posed by Speer, Gutmann, and Murphy (2005) in their seminal work on GMTA preparation and development.

Research Questions

The research questions for this study are:

1. To what extent can a teacher training workshop impact the teaching practices of GMTAs?
2. To what extent does the 2008 workshop affect GMTA teaching practice compared to the 2007 workshop?
3. To what extent do GMTAs implement the strategies learned in the seminars, and do they continue to implement the strategies in their teaching practice?
4. How does peer coaching compare to classroom observation as an effective follow-up to GMTA training?

Background for the Study

Much is known about effective K-12 professional development. The two key ideas driving the development of this treatment are presented here: (1) the components of effective professional development and (2) the evaluation of professional development. The discussion regarding the implementation of these ideas in the form of a teacher training workshop follows in the theoretical framework.

In a large-scale research study, Garet, et al., (2001) performed an evaluation of the Eisenhower professional development program and identified six key features of professional development (PD) effective in improving teaching practices. These features are:

1. *A focus on content knowledge* – PD should focus on improving and deepening teachers' content knowledge.
2. *Opportunities for active learning* – PD should allow time for teachers to actively engage in meaningful discussion, have opportunities for observing and being observed, and have time to plan classroom implementation.
3. *Coherence with other learning activities* – PD should be based on learning activities relevant to the participants and coherent with their goals for learning and the goals of their supervisors.
4. *The form of the activity* – PD should consist of teacher study groups or collaboration among teachers.
5. *Collective participation of teachers* – PD should involve groups of teachers from the same school, department, or grade.
6. *The duration of the activity* – PD needs to be sustained over time, not just “one-shot,” and have a number of contact hours. This allows teachers time to think about and implement the strategies learned through PD.

Thomas Guskey has spent much of his career examining the effects of teacher professional development on teacher practices and beliefs. Some of his more influential

work has been on evaluating the impact of teacher professional development programs (Guskey, 2000). With his five critical levels of professional development evaluation, Guskey offers a systematic investigation for measuring a project's merit or worth. These five critical levels of evaluation offer a template for evaluating the effectiveness of professional development efforts. These five levels are as follows:

Level 1 – *Participants' reactions*: Focuses on measuring the level of enjoyment of the participants. This is the most common form of evaluation for professional development.

Level 2 – *Participants' learning*: Focuses on measuring the knowledge and skills that the participants gained.

Level 3 – *Organization support and change*: Focuses on measuring the organizational characteristics and attributes necessary for success. This level describes the support of the institution for the professional development.

Level 4 – *Participants' use of new knowledge and skills*: Focuses on if the new knowledge and skills learned by the participants affected their teaching practice.

Level 5 – *Student learning outcomes*: Focuses on the bottom line: Did it benefit the students?

Analysis of Past GMTA Workshops

As mentioned in the introduction, to combat the problem of ineffective instruction by GMTAs, many graduate schools offer teacher training in the form of a workshop. At the researcher's university, a workshop for new GMTAs has been offered since the fall of 2003. Participation in the workshop is mandatory for new GMTAs. Little has changed since the program started. Each year one seminar has been offered the week before school starts and then continually every one or two weeks after that, concluding around the end of October with six to eight total seminars. The total professional development time has been approximately 16 hours, including 13.5 hours of seminars and 2.5 hours of assignments such as observing classrooms of experienced and inexperienced GMTAs. Seminar topics varied from teaching practices like active learning and assessment tips to balancing graduate teaching and graduate student responsibilities. The typical meeting consisted of open discussion and formal presentation, usually given by an experienced GMTA or faculty member. Discussion topics relied heavily on the discretion of the presenter, with little emphasis placed on whether topics were research-based (M. Burke, personal communication 10/24/07, M. Sojda, personal communication 10/24/07). Each year the evaluation of the effectiveness of the workshop amounted to a participant satisfaction survey. The good news is that the workshop has been continually well received and highly recommended to others by the participants; the bad news is no evidence has been gathered to indicate if the workshop succeeded in its design to prepare GMTAs to teach effectively.

While the most recent GMTA workshop contains some features of professional development likely to impact teaching practices (as identified by Garet et al., 2001), many of the critical components are missing. Two of the six key features have been addressed: a reasonable duration of activities and collective participation by groups of teachers. The other four features were mostly absent. In terms of evaluation, only level one data on the Guskey model, participants' reactions, were collected via a survey. Therefore, it is unknown whether past workshops were effective in improving GMTA teaching practice. Additionally, the lack of formative data makes it difficult to update the workshop to meet GMTAs' needs.

Theoretical Framework

The updated GMTA workshop had a four-part design. The general structure of the workshop followed the six key features of professional development identified by Garet, et al. (2001). The follow-up classroom feedback component consisted of two treatments: peer coaching and observation. The content of the workshop consisted of four evidence-based strategies: reflective teaching, active learning, questioning techniques, and formative assessment. Finally the evaluation of the workshop was based on Guskey's (2000) five-level model.

The updated GMTA workshop was designed with the aforementioned six key features of effective professional development in mind. Feature (2), *opportunities for active learning*, is characterized by professional development that includes a component

for participants to plan implementation of ideas into the classroom and to observe and be observed in a teaching experience. However, observation alone is not enough; essential in improving classroom practices is a component that involves feedback or reflection on these practices.

Feedback during the professional development experience greatly benefits the teacher and the students (Holten & Nilson, 1990). In light of the emerging literature on coaching (Knight, 2007; Brown, Harris, Hodges, & Jernigan, 2006; Ross 1992), coaching appears to be a promising tool for providing this classroom-based feedback. In particular, Knight (2007) found that “teachers reported that they were four times more likely to implement teaching practices they learned during partnership [coaching] sessions than those they learned in traditional [workshop] sessions.” In this study, peer coaching was used as a means to provide feedback to a subset of the participants. To illuminate the value of specific aspects of coaching, a different subset of participants were also part of an observation group and received feedback through self reflection.

Because the workshop focused on targeted teaching techniques for undergraduate mathematics instruction (e.g. active learning, questioning techniques, and formative assessment), key feature (3), *coherence with other learning activities*, was descriptive of the workshop. The workshop encouraged active participation and was more like a collaborative meeting of GMTAs than a workshop; thus, key feature (4), *form of the activity*, was also present. Feature (5), *collective participation*, was inherent since all participants were GMTAs.

Feature (6), *duration of the activity*, consists of two parts: number of contact hours and time span. Although Garet et al. (2001) concluded that professional development should be sustained over time and have a number of contact hours; they prescribe no specific length in terms of contact hours or time span, but only encourage that professional development not be completed in one day, i.e. “one-shot.” Therefore, since the workshop lasted from late August through November, a part of feature (6), time span, was adhered to as well.

Feature (1), *a focus on content knowledge*, was absent. At the time the seminars were presented, it was believed time was best spent discussing teaching techniques. However, it was not until later that the importance of connecting the techniques to the content was discovered. The lack of time spent integrating pedagogical content knowledge could have limited the effectiveness of the workshop.

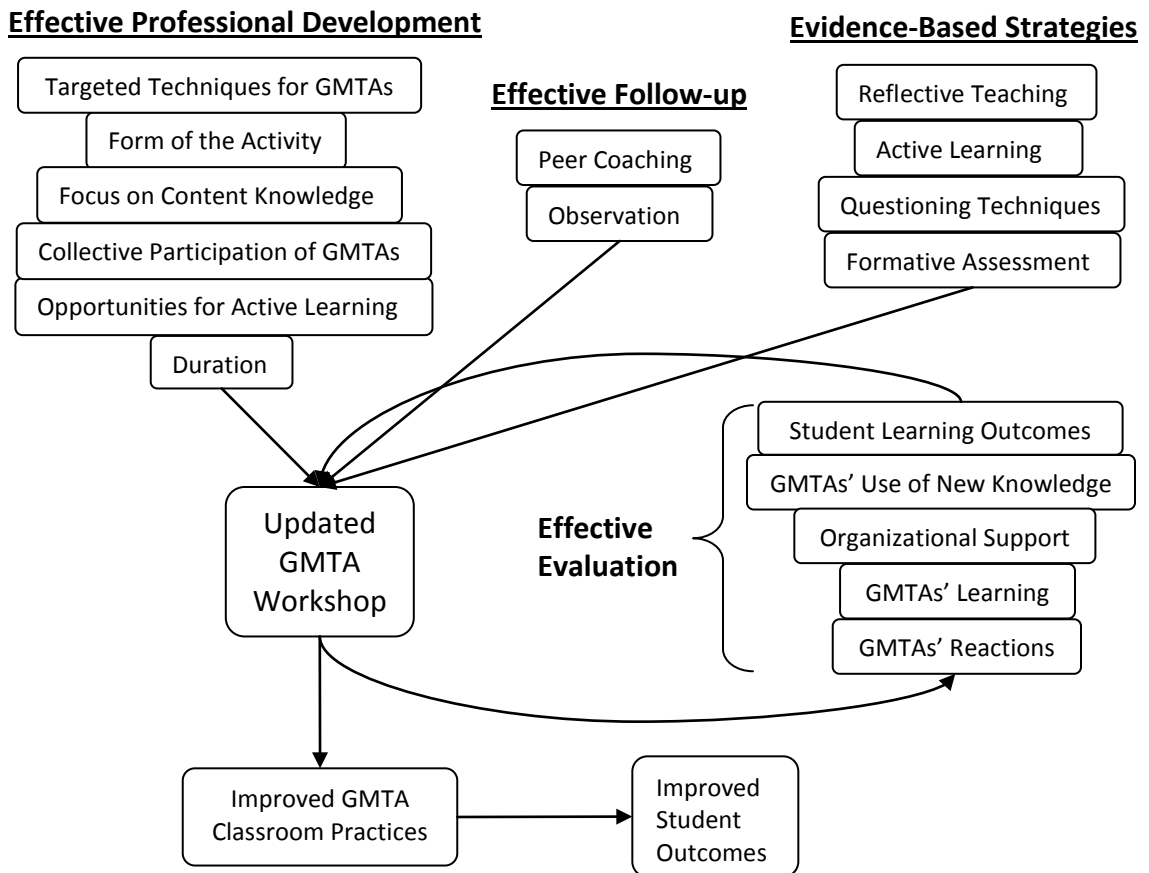
The content discussed in the workshop consisted of four teaching techniques. The techniques chosen for this task were selected after scanning the research literature for evidence-based teaching practices. These techniques included reflective teaching, active learning, questioning techniques, and formative assessment.

Finally, the first four levels of Guskey’s model were used to evaluate the workshop. Though changes in the fifth level, student outcomes, are the essential goal of any professional development, they were not collected in this study. One of the goals of this study was to learn about the impact of the workshop on the participants’ teaching

practices, with the idea that these changes would have an effect on student outcomes.

Figure 1 illustrates the conceptual framework.

Figure 1: The Workshop Framework



Significance of the Study

While existing literature on GMTA teacher training is helpful for the development and implementation of a teacher training program, the relative lack of formative and summative evaluation validating the effectiveness of these programs is troubling. There is a need to know what works when training GMTAs and how training can be improved based on collected evidence. And since “The teaching assistants of

today are the potential faculty members of tomorrow” (Diamond & Gray, 1987, p.1), any efforts made to improve the teaching effectiveness of current GMTAs has an immediate and long term benefit of improving undergraduate education.

In addition, since the effective components of a GMTA teacher training seminar are unknown, a K-12 professional development model was used. Thus, determining the adaptations that need to be made to this model for its use in the GMTA setting is critical. Although this study was conducted solely on GMTAs at a doctorate-granting university (Carnegie classified as very high research activity), the suggested adaptations to this model can still shed light onto the effective components of GTA teacher training. In turn, other universities can use this model for their own professional development of GTAs.

Another aspect of this study explores the ideas of peer coaching in the GMTA setting. Coaching is gaining popularity as a professional development tool. The effectiveness of GMTA peer coaching at the college level and the characteristics that comprise an effective peer coaching pair are unknown. This study sheds light onto the overall usefulness and important components of effective GMTA peer coaching.

Finally, both the researcher’s university and other departments of mathematical sciences at research universities will have a workshop model that can be easily modified and implemented. All seminar outlines were constructed in PowerPoint so that course materials are available to new presenters, in a useable and modifiable way, in years to come.

CHAPTER 2

REVIEW OF THE LITERATURE

This study explored the development, implementation, and evaluation of a GMTA teacher training workshop. As mentioned in the introduction, universities are already implementing GMTA training workshops but are lacking when it comes to evaluation and the knowledge of the participants' use of the information learned through the workshop. This study will go further by focusing on the measurable outcomes of the workshop through a proper evaluation plan.

Effective Professional Development

In 1997 Stanford's faculty senate created a Teaching Assistant Oversight Committee (TAOC) to ensure that departments and faculty were fulfilling their responsibility "to provide TAs with all the necessary training for their teaching duties" (TAOC, p. 1). In 2000, the TAOC issued a set of guidelines on effective TA training; the guidelines emphasized three requirements:

- (1) Each department should designate an Academic Council faculty member to take responsibility for TA training.
- (2) Departments should establish a program that assures TAs of training for, and supervision while, teaching.
- (3) Training should consist of two main elements:

- a. General principles of effective teaching and university policies relevant to teaching
- b. Discipline-specific pedagogy (p. 1).

In 2008, the TAOC presented a collection of departmental implementations of the guidelines in a booklet titled “What’s Working in TA training in 2008.” According to the booklet, the literature on TA training suggests that effective programs often share the following characteristics:

- The program is designed with input from experienced TAs and is modified during its early iterations based on feedback from the TAs themselves.
- The training program is consistent with, and, indeed, buoyed by, a departmental climate of support for teaching.
- The training acknowledges that some TAs start with considerable experience or inherent ability and can contribute to, as well as benefit from, the program. In the same vein, the program progresses through stages so that as TAs gain experience, they can still benefit from advanced elements of the program.
- The training prepares TAs not only for their immediate TA responsibilities, but for their future careers (p. 2).

In a survey of Stanford TA training programs, the TAOC (p. 2, 2008) also found that, the most effective TA training programs shared one or more of the following characteristics:

- Orientation/training seminars at the beginning of the year for new TAs

- A pedagogy course or opportunities for ongoing discussion with peers and faculty during the first year of teaching
- A midterm and end-of-term formative TA evaluation
- A customized departmental TA handbook, online or in print
- An archive system for TA training materials and courses
- Professional development opportunities

Stanford's TAOC's view of effective TA training closely matches that of the K-12 research literature. Much research has been conducted on effective professional development for primary and secondary teachers. Authors such as Loucks-Horsely, Garet, Yoon, and Guskey have published numerous books and articles on professional development. Consequently, much is known about teacher professional development that works. However, most of the professional development literature covers K-12 teachers. Nevertheless, as Prieto & Altmaier (1994) suggest, "...it is not unreasonable to consider the variables affecting the development of teaching effectiveness in GTAs as somewhat parallel to those involved in more traditional teacher training [K-12]" (p. 482).

Many researchers have composed lists of characteristics of effective professional development. The components of effective professional development forming the backbone of this study were developed by Garet, et al. (2001) as part of a national evaluation of the Eisenhower Professional Development Program.

The study used a national sample of 1,027 mathematics and science teachers who participated in an Eisenhower-assisted professional development program. In particular, the study examined the relationships between specific features of professional development identified in the literature and the self-reported increases in teachers' knowledge, skills, and classroom practices. These features were divided into two categories: core and structural.

The core features were related to teachers' change in classroom practice and included the degree to which the activity had a *content focus* on disciplinary content knowledge, provided opportunities for *active learning* including observing and being observed, and had *coherence* with other learning activities by incorporating experiences consistent with teachers' goals and by encouraging continuing professional development communication among teachers. The structural features were related to teachers' learning and included the *form* of the activity categorized as traditional (e.g. workshops, courses for college credit, conferences) or reform (e.g. teacher study groups, networks, or mentoring), the *duration* of the activity determined by contact hours and time span, and the extent of *collective participation* of groups of teachers from the same school, department, or grade level.

Results of this study indicate that professional development is likely to be of higher quality if it is both sustained (over a period of time) and intensive (many hours). In addition, "professional development that focuses on academic subject matter (content), gives teachers opportunities for "hands-on" work (active learning), and is

integrated into the daily life of the school (coherence), is more likely to produce enhanced knowledge and skills” (p. 935).

Another professional development program was started in 1995 by the National Science Foundation (NSF); called Local Systematic Change (LSC) it involved improving student achievement through enhancing teacher knowledge and skill through professional development. LSC programs funded a total of 88 projects and involved approximately 70,000 mathematics and science teachers. The goal was to provide 130 hours of professional development and typically included summer institutes over a period of one or more weeks, and follow-up support offered during the school year. The LSC programs were guided by a common set of principles to achieve their goal of improving mathematics/science instruction. These principles included the following:

- Using well-prepared professional development providers whose backgrounds include in-depth content understanding and expertise in K–12 mathematics/science education
- Establishing a supportive and collegial professional development culture that facilitates teacher learning
- Providing experiences that deepen teachers’ knowledge of the mathematics/science content in the curriculum and the pedagogy needed to teach this content

- Providing opportunities for teachers to explore and become conversant with high quality instructional materials and the appropriate pedagogy for using these materials in their classrooms
- Providing support for teachers in content, pedagogy, and materials over the course of implementation (Banilower, Boyd, Pasley, & Weiss, 2006)

The program was evaluated by Horizon Research (Banilower et al., 2006). It was viewed as largely successful in that “high-quality” professional development improved instruction and student outcomes. LSC professional development was linked to a number of positive teacher instructional outcomes, in particular: overall improvement in the quality of lessons, enhanced quality of content presented to students, more frequent use of investigative practices, questioning, and sense-making practices, and a greater likelihood that the classroom culture promotes intellectual rigor and student engagement (Banilower et al., 2006, p. 85).

A professional development project specifically aimed at graduate students was initiated in 1993 by the American Association of Colleges and Universities (AAC&U) and the Council of Graduate Schools (CGS), with support from the PEW Charitable Trusts. Called Preparing Future Faculty (PFF) it was a program designed to help introduce and prepare graduate students to be faculty members. Building on PFF, a more recent NSF funded project (1999), called Shaping the Preparation of Future Science and Mathematics Faculty, was initiated jointly by the American Mathematical Society (AMS)

and the Mathematical Association of America (MAA), in collaboration with AAC&U and CGS. The goals of this project were to

- Increase faculty roles in helping graduate students gain knowledge about the professoriate as it pertains to a broad range of academic institutions.
- Develop model programs for the preparation of graduate students for faculty roles and responsibilities and assess their effectiveness.
- Disseminate within the disciplines alternative models and promising practices for reshaping doctoral education for the future professoriate (Rankin, 1999).

Four doctorate-granting departments of mathematics were given grants to create a PFF model at their institution. The PFF website lists these four schools but currently none of the schools have up to date information on their use of PFF (Denecke, 2008).

The literature contains an assortment of GMTA training programs. Some programs are school-wide offering assistance to all GTAs offered by a center for teaching and learning whereas others are departmentally specific and prepared by faculty or graduate students. Length seems to be a large delineating factor with training lasting from a few hours in one day, to many hours over multiple days, to semester long courses. Some programs involve only new GMTAs, some involve new and experienced GMTAs, and others involve only experienced GMTAs. Additionally, each program seems designed to meet the particular needs of a specific department as opposed to reflecting the best ways to train TAs in general (Kinney, 2007). Despite these differences, some commonalities exist.

It seems there are two principal reasons for developing training programs: quality assurance and preparing future faculty (mentioned above), though some programs were created to achieve both goals. Regarding quality assurance, since GMTAs handle a significant amount of instructional responsibility, universities need a way to assure these GMTAs are competent to teach, and GMTA training is a good way to do this. Two examples of programs are described below.

At Duke University, a teacher training program has been in place since the fall of 1987 (Bookman, 2007). For their first year, mathematics graduate students typically serve as lab assistants and work in the math help room. During their second year, GMTAs begin their teaching responsibilities typically teaching a calculus class with 20-35 students.

Through the Duke teacher training program, graduate students are slowly introduced into the teaching role. Before the first week of class, first-year graduate students participate in two days of workshops to prepare them to be lab assistants for calculus lab. Then, during their first year they must participate in a weekly teaching seminar aimed at preparing them to teach an introductory calculus course and introduce education issues. The activities of the seminar include: discussions of what constitutes good teaching and how students learn mathematics including content on what students find difficult; discussions of observed lessons; organizing lessons; making and grading exams; office hours; and two lectures of a calculus class observed by a faculty member and with student feedback (Bookman, 2007).

Once graduate students teach their own class, they are observed once by a faculty member during the second week and during the third week. A discussion follows and if the teaching is satisfactory, no more observations are made, if not, another observation is scheduled. To complete the training, graduate students must write a self-evaluation based on their course evaluations and have one more consultation session with the coordinator of teacher training. If there are no problems, the training ends, otherwise a program is designed to help the graduate student improve on his or her teaching.

The University of Wisconsin-Madison has a GMTA orientation and training program in the mathematics department. This mandatory program begins prior to the start of the semester and provides teaching practice to new GMTAs (Wilson, 2004). The most common GMTA assignment is to teach discussion sections of a calculus or pre-calculus course. The orientation consists of meeting with the lecturer and an assigned GMTA coordinator (who is an experienced GMTA) to go over the lecturer's plans for the course, including grading and GMTA expectations. The GMTA coordinator leads the training session and serves as a mentor to all GMTAs in the same discussion-leading group.

For this part of the training, the coordinator assigns a practice teaching assignment and the new GMTAs are given a few hours time to prepare and then they present and discuss other's presentations. The coordinator then assigns another practice teaching assignment for the next day, in hope that the GMTAs incorporate what

they learned from the first assignment. During the course of the semester, the new GMTAs meet periodically with their coordinator and the course lecturer to discuss any problems.

GMTAs receive formative evaluation through self-evaluation of a videotape of their discussion, and a visit from their GMTA coordinator. Summative evaluation is collected by the department through student evaluations. Additionally, the math department offers an optional seminar on teaching mathematics at the college-level dealing with topics relevant to the problems GMTAs face.

Regarding GMTA training duration at other doctorate-granting universities, Latulippe (2007) surveyed 29 doctorate-granting universities with Carnegie classification of very high research activity. Her survey was sent to mathematics departments and was aimed at discovering perceived departmental support for teaching. One question in her survey asked whether the university had teaching assistant training, with three choices: none, a span of less than five days, and five days or more. For dissemination purposes, none and less than five days were classified as without training and more than five days was classified as with training. The results showed that of the 29 mathematics departments, only 7 had training over five days. Three departments had no training at all, and 19 had training lasting less than five days. If this data can be extrapolated, it says that roughly 10% of mathematics departments at research universities have no GMTA training in place, and approximately 25% have training lasting longer than five days. No data was collected on whether evaluations of the training took place.

The two main methods for GMTA training seem to focus on either pedagogy or case studies. An extensive case-studies design for mathematicians in GMTA teacher training was conducted by Solomon Friedberg. From 1998-2002 he led a major effort for the development of case studies that would be relevant to mathematics graduate students. The project was called the Boston College Mathematics Case Studies Project and had an aim to develop case studies “involving a difficulty or an important decision—that would supplement mathematics graduate students’ experiences and promote the development of good judgment concerning classroom issues” (Friedberg, 2005, p. 844). This research led to the development of fourteen case studies and a book, “Teaching Mathematics in Colleges and Universities: Case Studies for Today’s Classroom.” However, according to Speer, Gutmann, and Murphy, this project was not specifically based on research about teaching assistants or related issues (2005, p. 76). At least one thesis was done on a mathematics graduate course designed to use these case studies (Froman, 2005).

Froman (2005) analyzed five years (2000-2004) of a mathematics pedagogy course offered at Texas Tech University. Friedberg’s case studies were used for three years of the program from 2002-2004. Collecting both surveys and interviews from participating GMTAs, Froman (2005) found that “The case studies seem to have the most impact on attitudes” of GMTAs (p. 52-53). TAs interviewed found the “grading case study” (p. 46) as the most beneficial but had mixed views regarding the other case studies: “some of the case studies weren’t relevant but...the grading exercise was

helpful” (p. 37) and “certain case studies [were] mostly common sense” (p. 43). The grading case study consisted of grading a problem as a group and coming to a consensus as to the number of points to be assigned to the work graded.

Another case study project, “Video cases for novice college mathematics instructor development” is currently in development. Shandy Hauk, the project director said the goal of the project is the creation of a “book-DVD package” that “will have video vignettes captured from actual college mathematics practice along with case-use guides and supporting materials focused on the professional development of novice college mathematics instructors” (MAA Rocky Mt., 2007, p. 8). The project hopes its materials will be useful in a college mathematics teaching course, or as an enhancement to a college teaching workshop or discussion group. According to the MAA, “The materials, essays, and activities that go with video vignettes will support reflection on, inquiry into, and implementation of effective instruction in undergraduate mathematics classes” (p. 8). The first round of materials was developed in 2007 and is currently being field-tested.

Though case studies seem promising, the lack of focus on specific pedagogical techniques may leave GMTAs without the necessary skills needed for teaching. In other words, though GMTAs might be better equipped to handle certain situations that arise, their lack of pedagogical tools would likely affect their ability to effectively present and teach the content.

In recent years there has been a growing body of research supporting the idea of pedagogical content knowledge as an integral part of a teacher's knowledge base.

Pedagogical content knowledge (PCK), or the connection of pedagogy with content knowledge, has been gaining popularity as a teacher-specific domain of knowledge (Ball, Bass, Hill, and Schilling, 2008; Grossman, 1990; Shulman, 1987.) Shulman (1987) believed PCK was focused on the teacher's ability to represent and formulate the content to make it comprehensible to others and on the teacher's understanding of what makes the learning of that content easy or difficult for students.

Corcoran (1995) suggests that professional development that focuses on content and how students learn it may be an important element in changing teaching practice. Heibert et al., (1996) argue that teaching for understanding in mathematics requires "...knowledge of the subject to select tasks that encourage students to wrestle with key ideas and knowledge of students' thinking to select tasks that link with students' experience" (p. 161). Though Garet et al., (2001) mention PCK as an important component of professional development, it was not measured as part of their study. Others have had an equally difficult time measuring it (e.g. Hill, Dean, and Goffney, 2007). Nonetheless, though difficult to measure, the literature suggests PCK should be included as part of professional development (Ball et al., 2008, Garet et al., 2001).

Evaluation of Professional Development

In 2001, Guskey said, “True professional development should be a learning experience for all who are involved... professional development is a purposeful and intentional process designed to enhance the knowledge and skills of educators so that they might, in turn, improve the learning of all students” (p. 121). Guskey’s main impact on professional development has been in evaluation. He believed professional development should be evaluated because evaluation provides evidence of the effectiveness of the program to help it improve and the information provided can help other programs develop. Most importantly, evaluation provides evidence for ineffective programs to get eliminated or at least improved.

Regarding evaluation, he states that one must first decide on an operational definition, of which he states “Evaluation is the systematic investigation of merit or worth” (p. 3) and then on what it allows: “Good evaluations provide information that is sound, meaningful, and sufficiently reliable to use in making thoughtful and responsible decisions about professional development processes and effects” (1999, p. 2). Finally, he mentions three types and purposes of evaluation: planning, formative and summative evaluation.

Planning evaluation takes place before the professional development begins and is designed to give the developers an understanding of “what is to be accomplished, what procedures will be used, and how success will be determined” (p. 5). Through this process of evaluation the developers establish the specified goals of the professional

development, the plan to achieve those goals, and the likelihood that the plan can be achieved within the given time and available resources.

Formative evaluation occurs during the professional development program. Its purpose is to provide the developers with “ongoing information about whether things are going as planned and whether expected progress is being made” (p. 5) Collecting formative data periodically allows the developers to stay on track and can be used to guide improvements and make adjustments to modify the program.

Summative evaluation is collected at the end of program and focuses on the bottom line. It provides the developers with judgments about “the program’s overall merit or worth” (p. 6) and enables them to make decisions regarding the future of the program e.g. should it be continued, expanded, or cancelled? “Summative evaluation describes what was accomplished, what were the consequences (positive or negative), what were the final results (intended and unintended), and, in some cases, did benefits justify the costs.” (p. 6).

The three types of evaluation mentioned above involve the collection and analysis of information. Combining the above ideas, Guskey divides the information collected into five levels of evaluation of professional development: (1) Participants’ reactions, (2) Participants’ learning, (3) Organization support and change, (4) Participants’ use of new knowledge and skills, and (5) Student learning outcomes. Each successive level is more complex than the previous and although “success at an early

level may be necessary for positive results at the next higher one, it's clearly not sufficient."

Participants' reactions is the simplest and most frequently conducted evaluation of professional development. The information considered at this level is concerned with whether the participants liked the experience. Asking questions such as: "Did they feel their time was well spent? Did the material make sense to them? Were the activities meaningful? Was the instructor knowledgeable and helpful? Do they believe what they learned will be helpful?" (Guksey, 1999, p. 8) This information is typically gathered through questionnaires and surveys handed out at the end of the program and can consist of Likert-scale items and open-ended responses. This information is sometimes referred to as the "happiness quotient" because it only measures the entertainment value of the program, not its quality or worth (Guskey, 1999, p. 8). Still, this information aids in the formative assessment of the program.

Participants' Learning "focuses on measuring the knowledge and skills that participants gained" (Guskey, 1999, p. 9). The main question addressed is "Did participants acquire the intended knowledge and skills" (Guskey, 1999, p. 10) and measures should be used to show attainment of these specific learning goals. Guskey (1999) warns against using merely a "standardized form" and urges for openness to "unintended learnings" whether positive or negative (p. 9-10). This information can be gathered in writing or through interviews or demonstrations.

Evaluation at the Organization Support and Change level is meant to determine if the participants' organization's policies support or undermine the implantation efforts of the program. Questions focus on if the activities of the professional development program promote changes that are aligned with the mission of the school and whether the school promotes the changes to the individual. Typically, professional development programs are specifically sought after by the school administrators and thus are supportive of it. However, when teachers seek their own program, organizational support is critical. Information regarding this level can be gathered through interviews with administration, document reviews, and questionnaires.

Participants' Use of New Knowledge and Skills is evaluated through the central question, "Did the new knowledge and skills that participants learn make a difference in their practice?" The collection of this data needs to be based upon clear indicators of both the degree and quality of implementation. Though Guskey believed "The most accurate information is likely to come from direct observations, either with trained observers or by reviewing video or audio tapes (p. 12), he also encouraged the use of questionnaires, interviews, or personal reflections. Evaluation should occur over multiple time intervals and after sufficient time has passed to allow the participants' time to implement and sustain the learned activities into their practice.

The bottom line in all professional development programs is Student Learning Outcomes, which is also the most difficult and time-consuming information to collect. Summatively, this data can provide a quality assurance of the activity and can be used to

estimate the cost effectiveness of such a program. Data collected does not only have to be from student assessments such as grades or standardized examination scores, but also can be from changes in students' attitudes and dispositions. In addition, indicators such as enrollment in advanced classes, and retention or drop-out rates can be considered too.

Cody & Guskey (1997) found that the bulk of professional development was evaluated at Level 1, if at all, with the majority of the rest evaluating at Level 2 (as cited in Guskey, 1999, p. 14). Although success at these early levels may be necessary for results at a higher level, it is not sufficient. Thus each level is important.

After all of this information is collected, one needs to analyze the results to look for improvement. However, Guskey states that "it is nearly impossible to obtain proof of the impact of the [professional development] effort, but it is possible to obtain good evidence" (p. 15). Nevertheless, obtaining this evidence is necessary for program improvement.

Regarding specific TA program evaluation, Chism and Lumpkins (1995) posed four questions that could be asked in evaluating TA programs (as cited in Marincovich, Prostko, and Stout, 1998):

1. What is the extent of program usage?
2. What is the satisfaction level of the TAs themselves?
3. What effects does the program have on the teaching of TAs?
4. What effects does the program have on the learning of the TAs' students?

These four questions formed the framework for a subsequent study by Chism and Szabo (1997) that focused on the extent to which faculty and TA development programs evaluate the effectiveness of their services. In this study, Chism and Szabo sent a survey to 100 schools that belonged to the Professional and Organizational Development Network in Higher Education (POD). The response rate was 45%. Sixty-two percent of the institutions that responded were doctorate-granting universities.

Ninety percent of responses indicated that events “classified as orientations, workshops, conferences, and the like” were evaluated “routinely or sometimes” (p. 56) with 80% indicating that the evaluation was conducted formatively “to improve programs and services” (p. 57). As far as what was being evaluated, about 85% responded that user satisfaction was collected, usually with a survey, and that respondents were “satisfied or extremely satisfied” (p. 58).

Regarding effects on the impacts of the programs on teaching, fewer than 20% of respondents indicated that they “always or usually evaluate the impact on teaching of their users” (p. 58). However, of the ones that did respond, the data collection methods used most regularly was open-ended surveys and personal interviews. Finally, on the effects on student learning, “the response rate...was too small to draw meaningful conclusions” (p. 59).

Workshop Content

Phase 1 of the workshop consisted of six seminars. The content was a fundamental component of Phase 1 of the workshop and will be discussed here. To determine content, a number of sources were consulted including: “The Professional Development of Graduate Teaching Assistants,” by Marinovich, et al., (1998), “The Teaching Assistant Training Handbook,” by Prieto and Meyers (eds.) (2001), “What Should Graduate Teaching Assistants Know about Teaching” by Lowman and Mathie (1993), “Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement” by Marzano, et al., (2001), “Classroom Assessment Techniques” by Angelo and Cross (1993), and discussions with mathematics education professors.

Though research on undergraduate mathematics teaching is relatively scarce, research at the K-12 levels are much more extensive. Much of this research may be relevant at the undergraduate level since a significant part of the mathematics taught in universities is also taught in high school (e.g. Algebra and Precalculus). While there are certainly unique factors to teaching at the college level, it is reasonable to assume that research on teaching this content has relevance to undergraduate teaching (Speer, Hald, 2008, p. 304). Therefore, information will also be drawn from the K-12 literature.

For the proper development of a workshop for incoming teaching assistants, it was necessary to provide training to both GMTAs without prior teaching experience and with prior teaching experience. According to Ronkowski (1998), in the book *The Professional Development of Graduate Teaching Assistants*, “For those new TAs with

little or no classroom experience, it is appropriate to provide training in presentation skills, authority issues in the classroom, principles of student learning, and basic teaching strategies and styles” (p. 48). The techniques chosen for this task were selected after scanning the research literature for evidence-based teaching practices. In the following sections is the literature behind the development of the workshop.

For purposes of time and functionality, the workshop had to be somewhat limited. There was simply no way of offering 40 hours of training. The timeline for the new workshop model was closely based on past years’ timelines. In the past, seminars were offered every one to two weeks through October or early November and were usually 1.5 to 2 hours in length. One seminar was always offered during the week before school started to situate GMTAs with departmental policy and in order to assist those GMTAs who had no prior teaching experience with tips for their first class. Following the professional development literature regarding duration and intensity, it was decided to keep relatively the same schedule as in the past.

The seminar topics include first-day concerns, reflective teaching, active learning, questioning techniques, and formative assessment. In order to discuss each seminar in depth, it is necessary to talk about the overarching principles first. The first seminar was focused on addressing GMTA concerns regarding the first day, creating a syllabus, and presenting a lecture and will not be further mentioned here. The second seminar was focused on reflective teaching and was presented to facilitate GMTAs reflection on their own teaching practices and how the upcoming seminar topics were

relevant to improving that practice. The third, fourth, and fifth seminars focused on evidence-based practices for improving classroom discussion and communication. The sixth seminar gave closure to Phase 1; reviewing topics from previous seminars, providing wrap-up, and addressing any concerns GMTAs brought up over the course of the previous seminars. Since this seminar served as a summary of the previous seminars and was mostly open discussion, it will not be further discussed.

Seminar 2: Reflective Teaching

Most would agree that teachers must know both content and pedagogical knowledge, i.e. what they teach and how to teach it. However, there is more to effective teaching than knowledge of content and possession of "best practices." Effective teachers need to make connections between teaching experiences and their knowledge of practice. Ralph (2001), in an article on the synthesis of research-based practices said that "...all our experts [teachers] have refined their knowledge by reflective experience."

Reflection is an activity where people draw upon an experience, think about it, mull it over, evaluate it, and then repeat the cycle in an effort to improve. Essentially, reflection is a form of learning. John Dewey said "reflection is an active, persistent, and careful consideration of any belief or supposed form of knowledge in light of the grounds supporting it and future conclusions to which it tends" (as cited in Yost, Sentner, & Forlenza-Bailey, 2000, p. 39). In fact, Dewey believed the most important teacher quality was critical reflection.

Regarding its significance to teacher education and training, Loughran (2002) said it is a “crucial aspect of learning about teaching,” Yost et al. (2000), believe that “teacher education programs must designate critical reflection as a primary mission and interweave reflection throughout the teacher education curriculum” (p. 41). Zeichner considered it as one of the most important elements for the development of autonomy and expertise for a novice teacher (1992). Finally, in the book “The Professional Development of Graduate Teaching Assistants,” Nyquist and Sprague (1998) simply state, “Reflection is essential” (p. 82).

According to Hagger, Burn, Mutton, and Brindley (2008), “the most popular model of learning to teach remains that of the reflective practitioner” (pg 161). However, Rodgers (2002) states that “there is no consensus as to what constitutes effective practice.” So, can reflective practice be taught? According to the research, programs with a unified mission are more able to transmit a shared vision to pre-service teachers (Wideen, Mayer-Smith, & Moon, 1998). Two elements necessary for critical reflection to occur were stated by Yost et al. (2000): First, teachers must have supervised practical *experiences* that will serve as a foundation for their reflections [emphasis added]. Second, they must acquire a personally meaningful knowledge base in *pedagogy*, theories of learning, as well as social, political, and historical foundations to which they can connect their experiences [emphasis added].

In the case of GMTAs, these experiences come from day-to-day classroom teaching and the pedagogy [if it comes at all] from some type of training workshop.

Clearly, experience is essential to learning, but experience alone does not cause change. It is in the process of planning, teaching, evaluating, and reflecting that these experiences come together and form meaning (Hagger, et al. 2008). Regarding reflecting on experience, in particular on self-assessment, Artzt, Armour-Thomas, and Curcio in the book "Becoming a Reflective Mathematics Teacher" (2008) state that "Videotaping is a powerful tool that can help [one] develop as a teacher" (p. 113).

Several studies have revealed that feedback from watching oneself on video is associated with improved instruction (Abbott, Wulff, & Szego (1989); Dalgaard (1982); McDaniel (1987); Paulsen & Feldman (1995)). In particular, in Dalgaard's (1982) study on the impact of a teacher training program on the teaching effectiveness of GTAs, the GTAs indicated that the videotape feedback was among the most useful components of the training.

In "The Teaching Assistant Training Handbook," Prieto and Meyers (2001) devote a chapter to "the use of videotape feedback in the training of instructors." In this chapter they offer a number of advantages to using videotape feedback:

(1) *The instructor does not have to rely on the memory or perspective of an observer*

Observers, whether course supervisors or peers, might view only one class, and focus on only a few ideas. An observer's feedback along with the actual facts in the form of a videotape helps the teacher see the perspective of the observer and consolidate their views.

(2) *Video allows for self-evaluation*

Self-reflection, though valuable, is limited if one is able to only think about what they can improve on. With videotape, one is able to see themselves from an entirely new perspective, that of their students! This has the potential to create cognitive dissonance, an inconsistency between one's thoughts and behaviors. In other words, GTAs can compare what they thought they were doing in their teaching to what they were actually doing on tape. Brinko (1993) noted that "feedback is more effective when it creates cognitive dissonance" (p. 580), and Wright (1995) noted that instructors are typically motivated to resolve the differences between what they thought they were doing and what they were doing through adjustments in their teaching.

(3) *The tape can be archived and viewed repeatedly*

A recommendation in the teaching improvement literature is that feedback should be provided in small increments with multiple instances over time. A videotaped lesson can be viewed repeatedly by an instructor and comparisons can be made to future videotapes to demonstrate improvement.

(4) *Videotape feedback can provide validation from other sources of feedback*

Feedback received from other's observations of ones teaching, student evaluations, and self-assessment can be combined with videotape feedback to bring life to the data. Videotape feedback provides concrete evidence of teacher's techniques, behaviors, and styles.

It is not enough to videotape a class and hand over the tape. GTAs must be prepared for what they are going to see, or they might focus only on their voice, clothes, and mannerisms. To help situate the viewing, the Center for Teaching and Learning at the University of North Carolina at Chapel Hill wrote and designed an inventory for GTA videotape self-assessment. According to an email with Iola Peed-Neal, the Associate Director of the Center for Teaching and Learning, “The instrument was based on the research literature and has been used thousands of times at UNC-Chapel Hill” (personal communication, June 5th, 2008). She went on to say, “The handout serves as a tool for self-reflection: the instructor reviews the instrument and watches the tape, hopefully noting classroom teaching techniques that are strengths and weaknesses.”

Seminar 3: Active Learning

Analysis of the research literature on learning led Chickering and Gamson (1987) to produce a pivotal work titled “Seven Principles for Good Practice in Undergraduate Education.” One of the seven principles states that “good practice encourages active learning” (p. 4). Following this principle they write, “Learning is not a spectator sport. Students do not learn much just by sitting in classes listening to teachers, memorizing prepackaged assignments, and spitting out answers. They must talk about what they are learning, write about it, relate it to past experiences and apply it to their daily lives. They must make what they learn part of themselves” (p. 4).

In the research literature, active learning is defined in a number of ways: Bonwell and Eison defined it as any strategy “that involves students in doing things and thinking

about the things they are doing" (1991). Meyers and Jones said it involves providing opportunities for students to meaningfully talk and listen, write, read, and reflect on the content, ideas, issues, and concerns of an academic subject, (1993, p. 6) and Prince (2004) tells us that "Active learning is often contrasted to the traditional lecture where students passively receive information from the instructor" (p. 1).

In actuality, active learning is an idea that encompasses many teaching and learning activities. One issue with analyzing studies on active learning is that many different approaches are labeled as active learning. Techniques such as cooperative learning, collaborative learning, problem-based learning, and even high-level questioning all fall under the overarching category of active learning as they all involve student active participation. For the case of this study, to distinguish active learning from questioning techniques, active learning will be simply defined as was done by Prince in 2004, "...active learning is introducing student activity into the traditional lecture" (p. 3). As mentioned in the glossary, student activity refers to class time given by the instructor for students to work on problems or concepts or to actively think about, discuss, and reflect on ideas, either in groups or individually. That being said, to simply say, "Active learning works," is somewhat problematic. Moreover to talk about the "best" active learning strategy is equally difficult.

There are certainly many different active learning strategies, Paulson and Faust list 29 on their website. To determine the "best" for use in this project, the strategies had to fit into two categories: (1) low complexity – that is, easy to implement, (2) high

impact – that is, have an evidence-based backing for their effectiveness. Three strategies were chosen: think / pair / share, the pause procedure, and the guided lecture as they are all well documented in the literature.

Think-pair-share was first proposed by Dr. Frank Lyman in 1981. It is a combination of wait-time and cooperative learning. The structure of think-pair-share is as follows: Students are given a question and asked to *think* about it before answering and prepare a response, then they are to *pair* with their neighbor to discuss their responses, and finally students are invited to *share* their responses with the teacher and the whole group.

The think-pair-share process gives all students the opportunity to think about and discuss their ideas with their peers. This gives students time to construct their knowledge and to find out both what they know and what their classmates know. According to the National Institute for Science Education (2003) this can lead to more “intellectually concise” responses “since students have had a chance to reflect on their ideas.” Discussing with peers also allows for a group collaboration of an answer. Thus, students are more willing to present their ideas as they themselves will not be singled out if their answer is incorrect. Additionally, the time allotted to students can be used by the instructor to prepare the next concept.

The pause procedure is one of the simplest active learning strategies available. It was first coined by Rowe in 1976. The pause procedure involves incorporating a 2-minute period for discussion or note taking two or three times during a lecture

preferably at 10-15 minute intervals. Ruhl, Hughes, and Schloss (1987) have shown significant results through using this procedure. Their study involved 72 students over two different courses in each of two semesters. The researchers examined the effect of pausing for two minutes three times during each 45-minute lecture. During the pause students worked in groups of two or three and discussed lecture content and asked each other for clarification of concepts or caught up on note taking. No instructor-student interactions occurred during the pauses. The control group received the same lecture from the same instructor, but with no pauses. Short-term retention was assessed by a free-recall exercise where students wrote down all the facts they could remember in three minutes after each lecture with results scored by the number of correct facts. Long-term retention was assessed with a 65 question multiple-choice test given 12 days after the last lecture used in the study.

The short-term retention scores were summed and averaged for each group and a significant difference ($p < .0001$) was obtained in favor of the two groups with the pause procedure scoring an average of 22.972 points better than the no-pause group. The long-term retention scores showed a significant difference ($p < .039$) in favor of the pause procedures with that group scoring an average of 8.685 points better. The authors go on to say “Depending upon the cut-off points, these differences could be the determining factor between two letter grades, even between passing and failing” (Ruhl, et al., 1987).

As a variation of the pause procedure, Bonwell and Eison (1991) described the guided lecture, a process where students listen to a short presentation without taking notes and then are given time to take notes at the end. This process causes students to reflect on what they see as important material and to write only what they feel as important in their notes. Further benefits of this technique include a greater student focus on the material being presented and a built-in pause allowing the students and teacher time to refocus.

Seminar 4: Questioning Techniques

In 1987, Ornstein said, "The essence of good teaching is related to good questioning." In 1988, he went on to say, "Mastering appropriate techniques for asking questions should be a part of every teacher's routine, a habit..." (p. 72). Careful questioning can stimulate student interest, motivate them to search out new knowledge, and challenge students to think (Ornstein 1987). According to the professional teaching standards (NCTM, 1991) the teacher should: pose questions that elicit, engage, and challenge student's thinking; listen carefully to students' ideas and ask them to clarify and justify their ideas; and encourage students to listen to, respond to, and question the teacher and one another.

Teachers spend most of their time asking low-level cognitive questions (Wilens, 1991). Low-level questions concentrate on factual information that can be memorized. These questions are most often used to evaluate students' preparation and comprehension and to review or summarize content (Goodwin, 1980). Low-level

questions are not usually prepared, but are developed as the lesson progresses (Goodwin, 1980). It is widely believed that this type of question can limit students by not helping them to acquire a deep, elaborate understanding of the subject matter.

High-level cognitive questions can be defined as questions that require students to think more deeply or use reasoning skills (Goodwin, 1980). In order to answer high-level questions students must synthesize their factual knowledge. High-level questions are usually prepared before class and can be used at opportune times to facilitate discussion. Frequently, high-level questions can lead to a number of low-level probing response questions (Goodwin, 1980).

One of the simplest techniques a teacher can use to facilitate effective questioning is the use of wait-time. First mentioned by Rowe (1974), wait-time consists of two parts: the time immediately following a question asked by the teacher, and the time following a student's response. Both wait times should ideally be around 3-5 seconds with the first wait-time allowing students time to formulate a response and the second wait-time allowing for students to finish thinking through their response and giving the teacher time to formulate a reply (Rowe, 1974).

Rowe (1974) found that for teachers who increased wait-time the following significant changes occurred: the length of student responses increased, the number of students who failed to respond when called on decreased, the number of responses from "less able" students increased, the number of student-to-student interactions increased, and the number of student questions increased. Waiting forces every

student to think about the question, rather than passively relying on other students to answer.

Seminar 5: Formative Assessment

The practice of summative assessment or “assessment of learning,” typically documents the quantity of learning that has occurred; its purpose is to measure where students’ scores, and therefore grades, place them among the rest of the class (Earl, 2003). This type of assessment dominates classroom instruction (Earl, 2003). Though this idea certainly tells the teacher what the students know and don’t know, the timing of it does not usually allow the teacher to change their practice, or the students to improve and work on what they don’t know.

Formative assessment, on the other hand, is often described as “assessment for learning,” and does less to document learning, but rather delivers information *during* the instructional process, *before* the summative assessment (Earl, 2003). In fact, Black and William (1998), in their meta-analysis of 250 articles related to formative assessment, say that assessment is formative only when it is used to inform teaching and/or influence learning—when the evidence obtained is used to adapt the teaching to meet students’ needs. Simply providing students a score on an assignment is not enough feedback. Feedback is best if it gives specific guidance on strengths/weaknesses and how to improve. In addition, formative assessment should provide opportunities to discuss and develop a common understanding of what constitutes quality work.

In the book *Classroom Assessment Techniques: A Handbook for College Teachers*, Angelo and Cross (1993) include fifty classroom assessment techniques (CATs) that are simple formative assessments that instructors can use to collect feedback to examine how well students are learning. According to Angelo and Cross (1993), a CAT is any pedagogical technique that satisfies five criteria: (1) provides information about what students are learning in the classrooms, (2) focuses on “alterable variables”—aspects of teacher or learner behavior that can be changed to promote better learning, (3) gives teachers and students information they can use to make midcourse changes and corrections, (4) relatively simple to prepare and use, and (5) the results are reasonably quick and easy to analyze. Of the fifty CATs, four were chosen based on the amount of time necessary to implement them. The two that were deemed easiest to implement were called “minute paper” and “muddiest point.” The two that involved a little more preparation were called “documented problem solutions” and “misconception check.”

Minute papers are a powerful assessment tool for continuous improvement of a class (Wilson, 1986). Though it is difficult to attribute the development of the minute paper to any one person, they are believed to be the most widely used CAT in higher education (Angelo and Cross, 1993). Light (1990) noted that the minute paper was the single most successful classroom innovation at Harvard. The research evidence, however, is limited. One study, conducted by Chizmar and Ostrosky (1998) examined the use of the minute paper in economics classes. Using a quasi-experimental pre/post design, they concluded that students in the sections that used minute papers

outperformed those in sections without minute papers in terms of scores on the Test for Understanding of College Economics, independent of GPA.

The muddiest point is an assessment technique which is attributed to Frederick Mosteller (1989). He frequently used it at Harvard while teaching an undergraduate statistics course and found it to be, at least empirically, very successful. The basic idea is to ask students at the end the class period to take a minute to write down the muddiest, or most unclear, point from the day's lecture. The papers are then given to the instructor, usually anonymously. The instructor compiles the information and then during the next class period, addresses the most mentioned points, usually with a well-chosen example problem.

Student misconceptions are usually a barrier to learning. Misconception check enables the instructor to uncover prior knowledge beliefs that may hinder or block further learning. To accomplish this, the instructor designs an un-graded, anonymous quiz covering some key student misconceptions. In a mathematics class, students can be given five choices regarding their level of certainty regarding each question: I'm absolutely certain this is true, I'm pretty sure it is true, I have no idea whether it's true or false, I'm pretty sure it is false, I'm absolutely certain it is false. After collecting and analyzing the data, the instructor will know what misconceptions the class has as a whole and to make sure to address them through well-chosen examples.

Documented problem solutions are an extension of the common request for students to show their work. The primary emphasis of the technique is on documenting

the specific steps students take when solving problems. To that end, students are given a problem for homework and then are required to show both their work and the reasoning behind their work. According to Angelo and Cross (1993), documented problem solutions have two main aims: (1) to assess how students solve problems and (2) to assess how well students understand and can describe their problem-solving methods (p. 222). Students may often focus only on getting the right answer but this technique encourages them to focus on the process, not the product.

The effects of classroom assessment on students, according to Angelo and Cross (1993) are positive: increases student active involvement in learning, enhances student satisfaction, and improves course completion rates. In fact, “students whose instructors use classroom assessment tend to believe they are learning more and are convinced that their teachers are sincerely committed to improving learning” (p. 375).

Phase 2 – The Classroom Component

Research has shown that traditional forms of professional development—one-shot in-service training with no follow-up—are not effective, “usually getting no better than a 10% implementation rate” of presented techniques (Knight, 2007, p. 1-2).

Levison-Rose and Menges felt that “... most workshops and seminars, even those with specific goals, are unlikely to produce lasting changes in teacher behavior or lasting impact on students unless participants continue skill practice and receive critical

feedback on their efforts” (1981, p. 419). To combat this lack of follow-up two treatments were utilized: peer coaching and observation.

Peer Coaching

The idea of coaching has emerged as a way to provide effective follow-up to professional development. Knight (2007) and Joyce and Showers (2002) found that coaching raised implementation of strategies learned in professional development to more than 90%. Joyce & Showers (2002) found that coaching contributed to the transfer of professional development training in five ways:

1. Coached teachers practiced new strategies more often and with greater skill than their un-coached educators with identical initial training.
2. Strategies were more appropriately adapted by coached teachers to their own goals and contexts more than the un-coached teachers who tended to practice observed or demonstrated lessons.
3. Coached teachers retained and increased their skill over time, while un-coached teachers did not.
4. Teachers that were coached were more likely to explain the new models of teaching to their students, ensuring that students understood the purpose of their strategy and the behaviors expected of them.
5. Coached teachers demonstrated a clearer understanding of the purposes and use of the new strategies. Frequent peer discussions about them, including

lessons and materials design, seemed to enable them to think with the strategies in ways which un-coached teachers did not.

A variety of coaching methods have been developed to help foster teachers' skills. One of the most promising methods, according to Kohler, Crilley, Shearer, and Good, (2001) is peer coaching. Ackland (1991) said peer coaching "enables teachers to observe one another and exchange support, companionship, feedback, and assistance in a coequal or non-threatening fashion (p. 24). Though the word coach typically refers to "one who instructs or trains" (Merriam-Webster), in this case coaching involves a collaborative relationship where teachers focus on the sharing of knowledge and on helping each other. Of peer coaching in general, Pam Robbins (1991) said "Peer coaching is a confidential process through which two or more professional colleagues work together to reflect on current practices; expand, refine, and build new skills; share ideas; teach one another; conduct classroom research; or solve problems in the workplace" (p. 1).

Peer coaching provides instructors with time to reflect and the opportunity to discuss those reflections with a colleague. To help facilitate the process of reflection, Costa and Garmston (2002) offer a useful 3-stage model: pre-conference, observation, and post-conference.

At the pre-conference, the goal is to build trust and rapport between the teacher and the coach, and promote the teacher's reflection of their upcoming lesson. To facilitate this, the coach asks questions to help the teacher think about the lesson to be

taught (e.g. What is your lesson about? What would you like your students to take from the lesson? What strategy do you plan to implement?). The teacher identifies a specific focus for the observation and specifies any data collection they want from the coach. At the conclusion of the pre-conference, the coach summarizes their understanding of the lesson with the teacher providing feedback on the accuracy of the description by the coach.

During the observation, the coach focuses on the data collection asked for by the teacher. Specifically, the coach should focus on the teacher's workshop strategy and the implementation of it. During this time the coach is not evaluating the teacher, but observing what the teacher does.

In the post-conference, the conversation is characterized by a mutual discussion of the observation. The coach asks the inviting teacher to reflect on what happened (e.g. How do you think your lesson went? How did what you actually did in the classroom compare with what you had planned? How do you feel about the implementation of the strategy? What new ideas or insights did you discover about your teaching?) The role of the coach during these questions is one of an active listener. Through the coach's questions, the teacher is able to reflect on their lesson, analyze what happened, and learn from themselves.

Coaching has shown promise as an effective technique for impacting teaching practice in the K-12 literature but little research has been conducted with coaching with

GMTAs. In order to assess the impact of peer coaching as a follow-up to professional development, another method, classroom observation, was also tested.

Classroom Observation

According to Olsen, “Observation of a master teacher is one of the best ways to acquire and refine a student teacher’s skills. A beginning teacher can learn through observation how a successful teacher puts theory into practice” (2008). Classroom observation is typically part of a student teaching experience as a way for pre-service teachers to observe another teacher from a new perspective—as an observer and not as a student.

The classroom observation model used in this study was consistent with the model used in past teacher training workshops at the researcher’s university. This previous model was not specifically research-based, but was similar to many student teaching models where pre-service teachers are asked to observe classrooms and reflect on their observations. This model served as a control both for comparison between the 2007 and 2008 workshops and for evaluating the impact of the peer coaching model on the 2008 participants.

CHAPTER 3

METHODOLOGY

Introduction

This chapter begins by describing the design of the study, including both the quasi-experimental nature of the quantitative component and the semi-structured interviews of the qualitative component. The population and sample are then described, followed by a description of both the 2007 and 2008 teacher training workshops. The remainder of the chapter contains a detailed description of the data collection procedures, including a description of the data analysis methods. Finally, a list of assumptions and limitations pertaining to the study are presented.

Overview of Methodology Used

This study employed mixed methods to examine the relationships between a teacher training workshop and GMTAs' teaching practices. The primary data came from semi-structured interviews of the participants. This data was also used to provide better insights into the results obtained from the quantitative analysis.

The main qualitative data came from semi-structured interviews conducted to ascertain GMTAs' use of the strategies learned in the workshop along with their perceptions of the effectiveness of the six seminars and the follow-up classroom component of the workshop. The researcher developed an interview script to address

these topics. The interviews were conducted by Roger Fischer, a graduate student currently working on his Ph.D. in Mathematics Education in order to increase the validity and reduce researcher bias. Roger was not involved in the development or delivery of the workshop. All eighteen GMTAs were individually interviewed and each interview was recorded, transcribed, and then coded for analysis.

The quantitative component employed a time-series quasi-experimental design using new GMTAs. The data for this component came from three sets of videotapes collected of GMTAs teaching in their classroom. A videotape was collected after the second seminar, in September, another at the conclusion of the six seminars, in October, and the following the completion of Phase 2, in November. The Reformed Teaching Observation Protocol (RTOP) was used to quantitatively measure the level of NCTM standards-based teaching practices of the GMTAs (Piburn & Sawada, 2000). A trained observer was used to rate each videotape using the RTOP.

Data was also collected from the GMTA participants of the 2007 teacher training workshop to aid in comparison with the 2008 workshop. This data consisted of one set of videotapes of the participants, semi-structured interviews, and a workshop evaluation survey.

Population and Sample

GMTA Population

The population of interest for this study consisted of both the 2007 and 2008 new graduate mathematics students at Montana State University (MSU), a university with very high research activity located in the northern Rocky Mountains. These graduate students were paid a stipend and given a tuition waiver in exchange for teaching one section of a mathematics course, usually one of the following: College Algebra, Liberal Arts Mathematics, Precalculus, Survey of Calculus, Calculus and Analytical Geometry, or Elementary Statistics. The student enrollment for each course was between 20 and 40 students. The teaching load was one course per semester and was expected to be around twenty hours a week. GMTAs were responsible for presenting the material, giving quizzes, and grading.

GMTA Sample

This study involves a two part sample. First, in the fall of 2007, twelve new graduate students were admitted into the mathematics department and took on the role of GMTAs and participated in a teacher training workshop. The researcher was not involved in this workshop; it was lead by two other experienced GMTAs. However, to ascertain the effectiveness of that workshop and to have a comparison group for the fall 2008 incoming GMTAs, the researcher received permission from eleven of the twelve 2007 GMTAs to videotape their classroom during the last two weeks of November 2007.

Semi-structured interviews were also conducted with eight of the twelve participants during the last two weeks of March, 2008. It should be noted that these GMTAs volunteered to be videotaped and interviewed. The teaching assignments of the eleven videotaped 2007 GMTAs by course can be seen in Table 1 and their prior teaching experience in Table 2. Six of the GMTAs were pursuing a Masters degree in Mathematics, three were pursuing a Masters in Statistics, two were pursuing a PhD in Statistics, and one a PhD in Mathematics Education.

The second part of the sample consisted of the main treatment group, the new GMTAs that arrived in August of 2008. In all, nineteen new graduate students were admitted into the graduate school to study Mathematics or Statistics. Nineteen participated in the first seminar, but one chose not to participate in the remaining seminars, thus leaving a sample of eighteen. These eighteen were each videotaped three times and participated in two semi-structured interviews. It should again be noted that these GMTAs volunteered to be videotaped and interviewed. The mathematics department's placement of these GMTAs by course can be seen in Table 1 and their prior teaching experience in Table 2. Of these students, ten were pursuing a Masters degree in Mathematics, two were pursuing a Masters in Environmental and Ecological Statistics, one was pursuing a Masters in Statistics, three were pursuing a PhD in Statistics, and two were pursuing a PhD in Mathematics.

Table 1 – Distribution of GMTAs by Year and Course

Course	2007 GMTAs	2008 GMTAs
College Algebra	2	3
Liberal Arts Mathematics	1	2
Precalculus	4	8
Survey of Calculus	2	3
Elementary Statistics	2	2
TOTAL	11	18

Table 2 – Distribution of GMTAs by Year and Experience

Experience	2007 GMTAs	2008 GMTAs
Inexperienced	10	13
Experienced	1	5

Design of the Study

Since the sample involved GMTAs from two different years, it is necessary to discuss the treatment both groups received in order to facilitate comparison between the workshops. To that end, the 2007 workshop will be discussed first followed by the 2008 workshop. The division of the GMTAs from 2008 into the Phase 2 treatment groups will then be discussed.

The 2007 Teacher Training Workshop

The treatment for the twelve 2007 GMTAs consisted of a workshop similar to one that had been running in the mathematics department since 2003. The researcher took no role in the design or implementation of this workshop. The workshop lasted for seven weeks and consisted of eight seminars of approximately 1.5 hours each and two

classroom observations for a total time commitment of approximately 14 hours. It was facilitated by two graduate students, one with two years of experience as a GMTA, and the other with one. These two lead the first and last seminars and relied on six different presenters to cover the remaining workshops. According to one of the workshop presenters:

We looked at what was done the prior year and what topics were addressed, determined which topics were best received by last year's GMTAs (what they felt was most useful) and tried to duplicate the more successful sessions and replace sessions that were not well received. Then based on our own experiences with instructors on campus, we selected people we felt had good teaching practices themselves and would be willing and able to present information on positive or inventive teaching practices to the TAs (G. Fearn, personal communication, March 2009).

After the second seminar, GMTAs were asked to observe a classroom of an experienced GMTA, and after the third were asked to observe a classroom of a new GMTA. At each observation, they filled out an observation form. According to the workshop outline, the goals of this workshop were to "...facilitate Graduate Teaching Assistants' awareness of effective teaching practices, and expose them to various instructional strategies from which they can develop their own teaching framework while incorporating awareness of student needs and differences." What follows is a description of each seminar of the workshop.

Seminar 1: This seminar served as an ice breaker for the new GMTAs to get to know each other and allowed them to ask any questions or address any concerns they might have as new GMTAs.

Seminar 2: A presenter was asked to discuss the Conduct Guidelines and Grievance Procedures for Students from the student handbook. The presenter read from the handbook and explained the university's role in the rights and responsibilities of students and instructors.

Seminar 3: Titled "Techniques for Teaching and Learning," the presenter discussed the topic of engaging students through asking questions and using active learning. According to the presenter, there was a discussion on "What is learning," "How does learning happen," "What is the relationship between brain research and active learning," and "What is it like to engage in active learning" (J. Downey, personal communication, March 2009). At the end of the seminar, the GMTAs worked together on a worksheet the presenter provided, see Appendix B. There was also a short discussion on the classroom observations of experienced GMTAs that the workshop participants did that previous week.

Seminar 4: A panel of three experienced GMTAs was assembled and there was an open forum with the new GMTAs on balancing the responsibilities of being both a GMTA and a graduate student. Discussion relied on the new GMTAs asking questions. There was also a short discussion of the observations of new GMTAs that the workshop participants did that previous week.

Seminar 5: This seminar was titled “Assessment Tips and Strategies.” The presenter had two objectives: providing student feedback through formative assessment and analyzing student tests as a reflective tool. The presenter started with introducing “The Four-Card Problem¹.” The GMTAs attempted the problem and most fared poorly. The presenter then “...pointed out the critical importance of not just giving students a score and shaking your head at how poorly they did” (M. Burke, personal communication, March 2009). The presenter then talked about the need to assess student thinking and use more formative assessment. The GMTAs then “...shared some strategies they used to get more mileage out of tests as far as using various feedback mechanisms so that they learned more about the student thinking and students reflected more on their own performances” (M. Burke, personal communication, March 2009).

Seminar 6: The sixth seminar discussed “Motivating and Engaging Students.” According to the presenter, “The purpose was to show [the GMTAs] how the unexpected can keep people engaged in what they are discussing” (J. Banfield, personal communication, March 2009). There was a discussion about how being an interesting teacher and engaging students with the material would help students become more engaged with the class.

¹ The Four-Card Problem is an exercise in logic. Participants are shown four cards and told: Suppose each card has a number on one side and a letter on the other. Which of these cards would you need to turn over in order to know whether the statement is false? The statements may vary, but one such statement is “If a card has a vowel on one side, then it has an even number on the other side.”

Seminar 7: This seminar was presented around the middle of the semester and was titled “Mid-Course Feedback and Corrections.” The presenter talked about his own personal mid-term evaluation form that he used and the participants were encouraged to modify or make their own in groups and then give it to their class during the following week. There was also discussion on whether an evaluation can detect good teaching (W. Esty, personal communication, March 2009).

Seminar 8: The final seminar started with a short discussion on the evaluation results the participants collected from the previous week. The remainder of the time was spent on open discussion over the whole workshop experience.

The 2008 Teacher Training Workshop

The treatment for the eighteen 2008 GMTAs consisted of two Phases. Phase 1 was a six seminar evidence-based teacher training workshop that took place over a six week period during the first third of the Fall 2008 semester. This was followed by Phase 2, a four week separate treatment phase consisting of an observation, feedback, and reflective component of either classroom observations or peer coaching. A more thorough account of Phase 2 is described following the descriptions of the seminars. Each seminar lasted approximately two hours and the five classroom components each lasted approximately 1.5 hours for a total time commitment of approximately 18 hours. The researcher designed and presented each seminar.

As described in Chapter 2, the six seminars were built based on what's known to be effective in the design of professional development (Darling-Hammond & McLaughlin, 1995; Garet et al., 2001; Loucks-Horsley et al., 2003), including evaluation (Guskey, 1999). The content is a fundamental component of this and will be discussed here. To determine content, a number of sources were consulted including: "The Professional Development of Graduate Teaching Assistants," by Marincovich, et al., (1998), "The Teaching Assistant Training Handbook," by Prieto and Meyers (eds.) (2001), "What Should Graduate Teaching Assistants Know about Teaching" by Lowman and Mathie (1993), "Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement" by Marzano, et al., (2001), "Classroom Assessment Techniques" by Angelo and Cross (1993), and discussions with mathematics education professors.

Seminar 1: Introductions, Concerns, and Policies: The goals of the first workshop were to build social networks, address GMTA concerns, discuss university policy, and to prepare GMTAs for their first day of teaching class. The mathematics department head introduced the workshop and stated its importance. Introductions were made and then GMTAs had a chance to anonymously voice any concerns or questions they had by filling out note cards. These questions and concerns were then addressed.

Following this discussion, GMTAs were given a copy of the "Student Conduct & Instructional Guidelines & Grievance Procedures" for MSU and the key points were discussed. Next, fundamentals for the first day of class were covered such as how to

make a syllabus, techniques for learning student's names, the basic lecture structure, and ways of thinking like students.

Seminar 2: Reflective Teaching: Critical to the development of GMTAs' teaching practice is their ability to reflect. The activities for the second seminar were to define and discuss effective teaching characteristics and reflection, and learn reflective questioning. GMTAs were asked to formulate their view on the characteristics of effective teaching, and the results were discussed in groups. Next, there was a discussion about the value of reflective teaching and its process.

Seminar 3: Active Learning: The activities for this seminar were to identify methods to help students become active in their learning, discuss the implementation of active learning in a common-hour lecture course, and to formulate a plan for the implementation of active learning in GMTAs' classrooms.

First, GMTAs discussed a definition for active learning, and three active learning strategies (think-pair-share, the pause procedure, and the guided lecture) along with their purpose, outcomes, and procedure were discussed. Then, the discussion moved to implementation of that strategy in the classroom. The workshop ended with GMTAs working in heterogeneous groups, based on mutual class taught, on ways to incorporate active learning into upcoming class content.

Seminar 4: Questioning Techniques: The activities for this workshop were to help GMTAs develop a self-consciousness for questioning, discuss wait-time, and to

formulate a plan for the implementation of better questioning in their classroom. First, the phrasing of questions was discussed. Next, questions were analyzed based on type. Distinctions were made both between the level of question asked (low- or high-level) and the type (open-ended or closed). A key concept, wait-time, was discussed along with an overview of how to develop essential questions that cover big ideas. Due to the length of this seminar, there was not time for GMTAs to work with their fellow teachers; instead a worksheet was given for them to describe how they were going to incorporate questioning into their classroom in the following week.

Seminar 5: Formative Assessment: The activities for this workshop were to define formative assessment and compare it to summative assessment, discuss formative assessment ideas, and help GMTAs formulate a plan for the implementation of formative assessment in their classroom. First, the definitions of formative and summative assessment were discussed. Next, four formative assessment techniques adapted from Angelo and Cross's (1993) "Classroom Assessment Techniques" were discussed. These included minute paper, muddiest point, misconception check, and documented problem solutions. The workshop ended with GMTAs working with their fellow teachers to create and implement a plan for using formative assessment in their class in the next week.

Seminar 6: Philosophies of Teaching: Outside of the seminars a number of additional questions were asked by the participants. These were addressed individually

as they came up, but they were also compiled for discussion in the last seminar. Half of this seminar was spent in an open discussion over ideas like writing and grading quizzes, better ways to hand back homework, and limiting the amount of homework questions answered in class. The remainder of the time was spent discussing an assortment of big ideas in teaching. Many of these topics came from a book called “Classroom Instruction that Works” by Marzano, et al. (2001) including teachers’ and students’ efforts and attitudes, praise and recognition, and feedback.

Phase 2 – The Classroom Component

At the conclusion of the last seminar on October 8th, 2008, the eighteen GMTAs were divided into two groups, a peer coaching group and an observation group, in order to assess the impact of these methods on the continued implementation of the techniques presented in the workshop. In configuring the treatment groups an attempt was made to construct the coaching group and observation group in order that they would be similarly matched in prior teaching experience. Table 3 displays GMTA by class before the division into two groups.

In accordance with the requirements of peer coaching, it was necessary for the coaching group to be paired, thus only an even number of participants was allowed. In the observation group, each member observed individually and thus their change in teaching practice depended primarily on their individual effort. In the coaching group, each member was paired and thus their potential change in teaching depended not only on their effort but also on the effort of their partner. As a precautionary measure, in

case of participant attrition, it was decided that the coaching group should contain ten members, five groups of two, and the observation group have eight.

Table 3 – Distribution of 2008 GMTAs by Course and Experience

CLASS	Inexperienced	Experienced
College Algebra	3	0
Liberal Arts Mathematics	2	0
Precalculus	7	1
Survey of Calculus	1	2
Elementary Statistics	0	2
Totals	13	5

To ensure the best possible coaching relationship between paired GMTAs, they were paired based on their mutual class taught (Robbins, 1991). The reason for this was two-fold: first, GMTAs were involved in weekly course meetings with the other members of their course and thus would likely be most familiar and comfortable working with the GMTAs from their same course; second, since each pair taught the same class, the content covered each day was familiar and relevant to each GMTA as they participated in the coaching role. Working together while teaching the same class, GMTAs should have been able to bounce ideas off of one another regarding the best way to teach the content, and form a symbiotic relationship.

In dividing the GMTAs into groups, the first division was concerned with the logistics of GMTAs' schedules. In order for GMTAs to be paired, a GMTA's schedule would have had to allow them to watch their partner and their partner to watch them.

After reviewing all of the GMTAs schedules, it was found that the three GMTAs teaching College Algebra would not be able to watch each other and thus were placed in the observation group. However, all the other GMTAs were still available for pairing.

The second division regarded separating the four instructors with the most experience, all with over two years of university teaching experience, so that two would be in each group. A coin toss determined that the two experienced GMTAs in Business Calculus would participate in coaching and the two in Elementary Statistics would be part of the observation group. This left eight in Precalculus and two in Liberal Arts Mathematics. Placing the two in Liberal Arts Mathematics as part of the observation group would have meant there were only two different classes represented in coaching. To ensure diversity in classes, it was decided that the two GMTAs in Liberal Arts Mathematics should participate in coaching.

The final eight GMTAs in Precalculus were asked through an email to each pick their top three GMTAs in Precalculus to potentially work with in a pairing group. The reason for this is two-fold: a good relationship is the foundation of coaching (Sheppard, 2006) and according to Robbins, "Teachers should select their own partners" (1991). After the data was collected, each GMTA was paired with one of their preferences with every effort made to pair GMTAs with their first choice. This left four groups of two with only three groups needed. A random integer (1-4) was produced and that group became part of the observation group allowing the other three to be part of the coaching group. Table 4 shows the final groupings.

Table 4 – Observation / Coaching Divisions by Course and Experience

CLASS	Inexperienced		Experienced	
	Observation	Coaching	Observation	Coaching
College Algebra	3			
Liberal Arts Mathematics		2		
Precalculus	2	5		1
Survey of Calculus	1			2
Elementary Statistics			2	
TOTAL	6	7	2	3

Peer Coaching: The peer coaching group followed a well-defined process as defined by many experts in instructional coaching (Knight, 2007, Brown et al. 2006, Robbins, 1991). The coaching process consisted of a pre-observation meeting, lasting approximately fifteen minutes, where the instructor discussed his or her lesson plan and goals with the coach, with particular emphasis on the evidence-based strategies to be used. The pre-coaching meeting was followed by a classroom observation, which was followed by a post-observation conference which lasted approximately fifteen minutes. During this conference the instructor received feedback from the coach focusing primarily on the objectives set during the pre-coaching conference. The quality of the coaching experience was documented by the participants with the Coaching Reflection Instrument. The roles were then reversed so that the first instructor became the coach and the coach the instructor, and the above process was repeated.

The coaches were trained on October 15th, 2008 in a two-hour seminar lead by Dr. David Yopp. Dr. Yopp had prior experience training coaches. It should be noted that the training usually takes approximately eight hours, but because of the time constraints of the workshop, only two hours were allowed. Each week thereafter, for four weeks, GMTAs met for approximately 1.5 hours a week. During this time the coaching pairs chose their own schedule on which to meet and complete the pre/post conference and observation.

Observation: The observation group completed observations of GMTAs, adjuncts, and faculty, as has been traditionally done at the teacher training workshop at the researcher's university. This model was consistent with many student teaching models where student teachers are asked to observe classrooms and reflect on their observations. After each observation, participants filled out an Observation Reflection Form regarding what they observed and how it might affect their own teaching practice.

Each week the GMTAs of the observation group watched another teacher as follows:

1. A new inexperienced GMTA and a new experienced GMTA. (Oct. 16th- 22nd)
2. A GMTA who had won a departmental teaching award. (October 23rd-29th)
3. An adjunct faculty member. (October 30th-November 5th)
4. A full professor that was either a mathematics education faculty member or who had won a teaching award. (November 6th-12th)

Before any teacher was potentially observed, the researcher notified and requested permission from that teacher. Additionally, each GMTA notified the teacher to be observed the day they would like to observe in order to ensure that that class day was productive (i.e. no tests or reviews).

To ensure equal time between groups, a total of five observations were conducted: two the first week at the conclusion of the seminars (October 16-21) with one per week for the next three weeks. Each Wednesday (October 22, 29, November 5, 12) the observation group met with the researcher to discuss their observations for that week. This meeting lasted approximately forty to fifty minutes, thus their total time commitment per week was the same as the coaching group's time of 1.5 hours.

GMTAs' level of participation during treatment could have an effect on the post-treatment videotaping, thus two instruments were used to chart GMTAs involvement during this time. For the peer coaching group, the Coaching Reflection Instrument was collected weekly and helped to quantify the level of interaction among the GMTA peer coaching groups. For the observation group, an Observation Reflection Form was required for each classroom observation, and GMTAs also meet weekly with the researcher to talk about and reflect on what they observed.

Data Sources

To address the research questions of the study, data was collected from a number of sources. The two primary sources of data came from videotapes collected of GMTAs' teaching and interviews. The videotapes were collected from both the 2007

GMTAs, in November 2007, and from the 2008 GMTAs, in September, October, and November of 2008. This data was analyzed quantitatively using the RTOP and was also coded in order to observe changes in teaching practice. Qualitative data came from semi-structured interviews which were conducted with the participants of both workshops after the completion of the workshop.

Data was also collected to measure the effect of peer coaching or observation on GMTAs' teaching practice. A number of instruments were used to collect this data including a coaching and observation reflection instrument, the Teacher Confidence Inventory, a coaching impact inventory, a coaching and observation survey, and a workshop evaluation survey.

Interviews: Interviews were collected from both the 2007 and 2008 GMTAs. The researcher developed an interview script which he used to guide the 2007 interviews during the end of March 2008. This interview protocol is available in Appendix A. Eight questions were added onto the 2007 script for the December 2008 interviews. This interview protocol is available in Appendix C. An additional set of interviews was collected during the beginning of April, 2009 in order to have a better comparison with the interviews collected from the 2007 workshop participants. The April, 2009 interview protocol is available in Appendix D. The interviews of the GMTAs from 2008 were conducted by Roger Fischer.

Videotapes: All videotapes were collected by the researcher. GMTAs were notified at least a week in advance of when their classroom would be recorded. Arrangements were made to ensure a recording would not occur on a review or test day. On the day of videotaping, student consent forms were handed out to all students. Those unwilling to participate were asked to sit outside of the camera's line of sight and did not appear on videotape. Permission from GMTAs was also sought, and in 2007, 11 of the 12 GMTAs consented to being videotaped. These tapes were collected over a period of one week from November 13-20, 2007.

In 2008, all 18 GMTAs consented to being videotaped and the first taping took place during the second week of classes, September 11-17, 2008. Preceding the first taping were the first two seminars. Following this collection of data, three seminars were presented that focused on classroom engagement strategies (e.g. active learning, questioning techniques, and formative assessment). GMTAs were videotaped again October 9-15, 2008. This data served two purposes: 1) as a way to measure short-term changes in teaching practice by comparison with the first videotape and 2) to serve as a baseline for measuring growth and implementation during Phase 2 of the study. The GMTAs were videotaped for the last time during the week of November 13-20, 2008.

The Reformed Teaching Observation Protocol: The Reformed Teaching Observation Protocol (RTOP) was used to quantitatively describe GMTAs teaching practice (Piburn & Sawada, 2000). It was designed by the Evaluation Facilitation Group of the Arizona Collaborative for Excellence in the Preparation of Teachers (ACEPT) for

use in science and mathematics classrooms, K-20. It is a 25-item classroom observation protocol that is standards-based, inquiry oriented, and student-centered. It is designed to be completed by a trained observer. Each item is rated on a scale from 0 (not observed) to 4 (very descriptive [of the lesson]). Possible scores range from 0 to 100 points, with higher scores reflecting a greater degree of reform. Examples of some of the items are as follows:

- The teacher's questions triggered divergent modes of thinking
- Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures
- Active participation of students was encouraged and valued

The 25-item RTOP is divided into three domains: Lesson Design and Implementation (5 items), Content (10 items), and Classroom Culture (10 items). The last two domains are each divided into two sub-domains containing five items each: Propositional knowledge and Procedural Knowledge and Communicative Interactions and Student/Teacher Relationships, respectively.

According to the ACEPT report, the instrument showed strong internal reliability with a Cronbach's Alpha of 0.954; other studies have found correlation coefficients ranging from 0.88 to 0.97 (Sawada, et al., 2002). Face, content, and predictive validity were all established by Piburn and Sawada in the ACEPT technical report (2000).

The RTOP was designed to measure the degree of NCTM standards-based teaching practice in a classroom. For the purposes of this study it was used as a valid

and reliable measure to show changes in student-centered teaching in GMTAs. It was not the goal of the workshop to produce reformed teachers but rather to increase teachers' awareness of the level of student involvement in their classroom through presenting strategies like active learning and questioning techniques.

Videotape Coding Protocol: The videotapes were analyzed by first watching all tapes and noting initial ideas. From the interviews and the initial watching of the tapes, it was decided that the tapes would be coded for GMTAs' use of active learning and questioning techniques. These techniques were chosen because they were the most observable in the classroom.

In coding questions, each was recorded based on its audience (rhetorical, chorus, volunteered, or selected), level (high or low), and type (open or closed). Definitions of these terms can be found in the Glossary. Since each GMTA's amount of class time varied, the number of questions asked was divided by the total class time, producing a quotient of questions per hour. Active learning was coded for the total percentage of class time given by the instructor for students to work on problems or concepts or to actively think about, discuss, and reflect on ideas, either in groups or individually. Specifically, this meant the instructor was not lecturing and was either walking around acting as a resource person or silently waiting. The videotape coding protocol is available in Appendix E.

Constructed Instruments

The following six instruments were either constructed or modified for use in this study. Face validity of each instrument was established through consultation with Dr. David Yopp, a mathematics education professor with extensive teaching experience. Each instrument also has content validity in that its design was based on specific content of the study (e.g. active learning, formative assessment, questioning). The reliability of each instrument is also discussed, where appropriate. Since the sample size for the study was low, construct validity could not be assessed.

Teacher Confidence Inventory: This instrument was designed to address teacher's changes in confidence during Phase 2. Both the coaching group and observation group filled this form out before and after Phase 2. The instrument consisted of ten questions with a five point Likert scale with 1 being *Not at All Confident* and 5 being *Very Confident*. Unlike teacher efficacy scales, this instrument looked at a teacher's self-perceived confidence in specific tasks like planning lessons, encouraging student participation, and using formative assessment techniques.

Since this was a new instrument, it was important to assess its reliability. Two measures of reliability were used, test-retest reliability and internal consistency. To assess test-retest reliability, after the 18 GMTAs completed the instrument for the first time, six GMTAs were randomly chosen to complete it again the next day. A Pearson's correlation was computed and the test-retest reliability was found to be $r(60) = 0.71$. This indicated satisfactory test-retest reliability. Cronbach's alpha was computed and

the internal consistency was 0.765, indicating an acceptable reliability of the ten items in measuring the construct of confidence. The Teacher Confidence Inventory is available in Appendix F.

The Coaching Reflection Instrument: The Coaching Reflection Instrument (CRI) was developed by Dr. David Yopp. It consists of two separate instruments, one for a coach and one for a teacher. It was designed as a way to quantitatively measure the amount of mathematics content discussed and the relationship and trust between the coach and the teacher. After each coaching session (pre-conference, observation, post-conference) both the coach and teacher filled out their specific instrument. Both the Coach's CRI (CRI-C) and the Teacher's CRI (CRI-T) ask the same questions, but are phrased to address either the coach or the teacher. The CRI consists of three open-ended questions regarding the topics, goals, and plans discussed and fourteen items on a five point Likert scale. Examples of some of the items are as follows:

- My coach and I have a relationship of trust.
- The teacher and I discussed significant and worthwhile mathematical content.
- My coach and I discussed ways of planning lessons.

This instrument was slightly modified to be more applicable to GMTAs and to address the specific techniques learned in the workshop: active learning, formative assessment, and questioning techniques. The CRI served as a measure of the interactions among peer coaches and as a way to quantitatively measure the value of

each coaching session. This aided the study in determining the role peer coaching played in GMTAs' classroom implementation of strategies learned in the workshops. The CRI-C is available in Appendix G, and the CRI-T is available in Appendix H.

Coaching Impact Inventory: Like the CRI, this instrument had a part for coaches and a part for teachers. It was designed to address the coaches and teacher's view of the impact of coaching on the teacher's instruction. It consisted of nine questions with a five point Likert scale with 1 being *no impact* and 5 being a *very large impact*. At the conclusion of the coaching treatment, each peer coaching participant filled out this instrument on how they believed their coaching impacted their partner's instruction, and how they believed their partner's coaching impacted their teaching instruction.

Correlations between these two ratings varied from low ($r = 0.32$) to high ($r = 0.96$) with the average of all ratings being $r = 0.52$. Though this does not measure inter-rater reliability, it provides a measure of the level of agreement between the peer coaching partners on their perceived impact of peer coaching. The Coaching Impact Inventory for coaches is available in Appendix I. The Coaching Impact Inventory for teachers is available in Appendix J.

The Observation Reflection Form: This form was designed as a qualitative measure for GMTAs in the observation group to fill out as they were observing classroom instruction. The focus of this instrument was three-fold: to observe what general strategies teachers used, to observe specific strategies (e.g. formative

assessment, questioning techniques, active learning) and for the observer to reflect on what they observed to integrate into their own teaching. This form was then brought to the weekly debriefing and discussion time where each observer talked about what they observed and how it affected them. The Observation Reflection Form is available in Appendix K.

End of Treatment Survey: Each treatment group filled out a qualitative survey at the completion of Phase 2. This survey was designed to assess how coaching or observation impacted a GMTA's instruction. Each group was asked how participation in their respective treatment influenced their teaching and use of workshop-specific strategies. The Coaching Survey is available in Appendix L, and the Observation Survey is available in Appendix M.

Workshop Survey: This survey had been used in previous years as the only tool for evaluation of the workshop. The survey used for 2008 was almost identical to the one used in 2007, except for the changes to the titles of the seminars, dates, and the addition of one question regarding the watching of the first videotape. The survey first asked GMTAs to "rate and comment on the following workshops" and consisted of a rating scale of very good, good, okay, neutral, and poor for each of the six seminars with space for comments and then asked five short-answer questions. The 2008 Workshop Survey is available in Appendix N.

A Self-Reflection Instrument: The Center for Teaching and Learning at the University of North Carolina at Chapel Hill wrote and designed an inventory for GMTA self-assessment. “Getting the Most from Your Videotape” is a 46-item self-report measure that is used by GMTAs to self-assess their teaching through watching a videotape of their instruction. GMTAs rate their perceived performance in their ability to carry out effective teaching behaviors on a Likert scale labeled as follows: 1 (Needs improvement), 2 (Satisfactory), and 3 (Well done). Examples of some of the items include:

- Provides written outline of main points for the day’s class
- Relates the day’s material to content from previous classes
- Uses teaching strategies that require that the students do something in class

Five teaching domains are addressed: Clarity of Presentation, Class Structure, Exciting Student Interest, Questioning Techniques, and Verbal and Nonverbal Communication. A sixth domain, Teaching Goals, consists of two parts and is a written item designed for GMTAs to reflect on after they fill out the inventory. The first part, *Teaching Characteristics*, has GMTAs list five techniques they feel they need to work on, and the second part, *Applications*, has them write down how they intend to incorporate these techniques into their teaching style.

According to an email with Iola Peed-Neal, the Associate Director of the Center for Teaching and Learning at the University of North Carolina at Chapel Hill, “The

instrument was based on the research literature and has been used thousands of times at UNC-Chapel Hill” (personal communication, June 2008). She went on to say, “The handout serves as a tool for self-reflection: the instructor reviews the instrument and watches the tape, hopefully noting classroom teaching techniques that are strengths and weaknesses.”

The purpose of using this instrument was to help GMTAs reflect on their initial video tape. This instrument was chosen because it was believed it would help GMTAs improve their teaching through reflection on what they do in the classroom. Note that though this instrument was used, it was not collected, as it was designed only for self-reflection and not analysis.

Data Analysis

The bulk of the data was analyzed using qualitative methods, specifically the ideas of thematic analysis (Braun and Clarke, 2006). Quantitative analysis was used to analyze the RTOP and the Teacher Confidence Inventory, and *SPSS 11.5 for Windows* was used for most calculations.

The data analysis for this study consisted of a number of different phases. First, the interviews were transcribed, coded, and analyzed. Second, a trained rater, not the researcher, completed the RTOP for each tape collected, and RTOP item scores and cumulative scores were examined. Third, the classroom videotapes were watched and coded by the researcher to determine the level, type, and audience of the questions

asked along with the amount of time spent in active learning. The methods used for each of these components are described separately below.

Interviews

Thematic analysis was used to analyze the interviews. According to Braun and Clarke, “Thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data” (2006, p. 79). In relation to the typical qualitative methods, they consider thematic analysis to be “essentially grounded theory ‘lite’...” (p. 81). They consider the process of thematic analysis to consist of six phases:

- 1) Familiarizing oneself with the data which consists of transcribing and reading and re-reading the data and noting initial ideas.
- 2) Generating initial codes on the interesting features of the data across the entire data set and collating data relevant to each code.
- 3) Searching for themes and collating codes into potential themes.
- 4) Reviewing themes and checking to see if the themes work in relation to the coded extracts and the entire data set.
- 5) Defining and naming themes so as to refine the specifics of each theme.
- 6) Producing the report by providing vivid and compelling examples of the coded extracts and producing a scholarly report of the analysis (p. 87).

These six phases were used to guide the qualitative analysis of this study. To that end, the interviews were first transcribed by the researcher and thoroughly read over while noting ideas for codes. The four transcripts thought to have the richest data were then

reread and coded. When coding, each code represented a GMTA's complete thought, not just individual sentences. Once the codes had been established, a description of each code was developed and the transcripts were recoded according to this description for consistency in codes. These codes were then analyzed across the four interviews and more focused codes were developed by eliminating, combining, or subdividing the codes. Another coder was then asked to read and code one of the transcripts. The coders shared an 80% reliability based on 40 statements and 18 codes. This level of reliability can be considered excellent (Perreault & Leigh, 1989).

After the final coding scheme was developed, all eighteen interviews were coded by the researcher. Upon completion of this coding, all of the quotes were inserted into a master document under their corresponding code and in the context of the interview question asked. The coded data was then reread to verify the quotes fit in with their respective code. Themes were then developed based on the interconnectedness of the coded data. The themes were defined and then refined through comparing with their corresponding codes. When presenting the data, each code is quantified by listing the number of individual GMTAs making comments related to that code along with one or two distinguishing quotes.

Videotapes

Modified RTOP: The RTOP was used as a way to quantify the teaching changes made by GMTAs. In all, 65 videos were collected, 11 from the 2007 GMTAs and 54 from

the 2008 GMTAs. These 54 are divided into three sets of 18 with one set taped before the specific strategies of the workshop were taught, one following the conclusion of the seminars, and one after Phase 2, the classroom component.

The 65 videos were randomly assembled onto three DVDs and a trained rater (not the researcher) was used to complete the RTOP for each tape. The rater was unaware of the treatment any of the participants received. The rater was trained by an experienced rater and trainer of the RTOP using the RTOP training manual. This trained rater then rated the 65 videos while the experienced rater rated seven videos to help establish the reliability of the trained rater. To determine inter-rater reliability, a simple linear regression was conducted on the final RTOP score of both raters using the original 25 items, the correlation of these ratings was $r = 0.87$.

According to the experienced trainer, a difference in rating score of more than one between raters on any item was not adequate. Upon analysis of individual items, it was discovered that the raters differed by more than one on 2 items. These two items were item 6: "The lesson involved fundamental concepts of the subject" and item 8: "The teacher had a solid grasp of the subject matter content inherent in the lesson." Upon discussion with the experienced trainer it was decided that these items should be removed from further analysis. The reason for this was two-fold: first, these items had little to do with the information presented in either the 2007 or 2008 workshop and therefore were not relevant to the study, and second, the likely reason for the discrepancy between raters was due to the educational attainment of each rater. The

experienced rater holds a Doctorate of Arts in Mathematics and had extensive teaching experience in similar courses whereas the trained rater just obtained his Bachelor's degree in Mathematics Education. These gaps in experience lead the raters to view and rate these items differently. Of the remaining items, there were five the raters differed on by more than one, but this happened only once on each of these items.

The discussion with the experienced trainer resulted in additional items being examined for inclusion due to their relevance in the study. This included five other items:

- Item 3: "In this lesson, student exploration preceded formal presentation."
- Item 11: "Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena."
- Item 12: "Students made predications, estimations, and/or hypotheses and devised means for testing them."
- Items 6-10. According to the RTOP Reference Manual (Piburn, M., & Sawada, D., 2000), these five items (6-10) were designated as "propositional knowledge" and "...focuse[d] on the level of significance and abstraction of the content, the teacher's understanding of it, and the connections made with other disciplines and with real life" (p. 35) and were designed to "assess the quality of the content of the lesson" (p. 8).

None of these eight items were addressed in either of the 2007 or 2008 workshop and were therefore removed from further analysis.

In total, eight items were removed from the RTOP, leaving seventeen and changing the maximum attainable score to 68. This modified RTOP was better aligned to the techniques discussed in the workshop. To reassess the instruments internal consistency, Cronbach's alpha was computed. Internal consistency is a measure of the reliability of the items of the instrument to measure the same construct. The alpha for the 17 items was 0.947 indicating a very high reliability. The new inter-rater reliability was $r = 0.88$.

Videotape Coding Protocol: The videotapes were coded using a cyclical analytic process (Jacobs, Kawanaka, Stigler, 1999). This cycle includes watching, coding, and analyzing the data with the goal of transforming the video into interpretable information (Jacobs et al., 1999, p. 718). Following the suggestions of Jacobs et al., a collection of the videos were first watched and ideas for codes were generated. These videos were then re-watched to test the generated codes for consistency and objectivity. The videotape coding protocol was then written up with descriptions for each code (See Appendix F). A new subset of videos was then re-watched to refine the codes.

Using the finalized codes, the 54 videos from 2008 and 11 videos from 2007 were watched and coded by the researcher. The audience, level, and type of each question asked by the instructor were counted and then divided by the total class time to create a quotient of questions asked per hour. Amount of class time spent in active

learning was also documented and recorded as a percentage of total class time. Only one person coded the tapes and inter-rater reliability was not established.

Triangulation

The overall goals of this project were to see the effect a teacher training workshop would have on GMTAs' teaching practice. To help strengthen the validity of the findings, multiple sources of data were used. The primary data used to help answer the research questions came from two sources, interviews and videotapes. The interviews were the main qualitative component and helped to describe what the GMTAs thought they took away from the workshop and how they perceived changes in their teaching. The videotapes served as a way to measure how an outside evaluator viewed changes in GMTAs' teaching practice, and as a measure to validate what was said in the interviews by comparing it to what was being done in the classroom.

A secondary goal of this project was concerned with the effectiveness of two observation, feedback, and reflection treatments. To help distinguish between the effects of observation and peer coaching on GMTAs' teaching practice, additional measures were taken. The interview contained a specific question regarding the perceived effect of the particular treatment.

For coaching, the coaching reflection instrument was used to get an idea of the pair's descriptions of each coaching session. Since both the teacher and the coach filled out this instrument, they helped to validate each other. A coaching impact form was

also used to measure the perceived impact, and the Coaching Survey addressed changes in implementation of workshop techniques.

The observation group filled out an observation form regarding their thoughts from their classroom observation and how it affected their teaching. An observation survey was also completed addressing their perceived changes in teaching practice from participating in observations.

Limitations and Assumptions

Limitations

Multiple Treatments: There was not one specific independent treatment variable in the study. The workshop was the experimental treatment, but GMTAs certainly improved from their time spent teaching in the classroom too. Changes in GMTAs' teaching practices could be attributed to both factors; although it is unlikely the techniques presented in the workshop would be developed on one's own without study or discussion with other GMTAs. As an attempt to distinguish these variables, a variety of data was gathered as evidence to support the effectiveness of the workshop.

Comparing Workshops: The main limitation of this study is in comparing the 2007 and 2008 workshops. A number of issues must be addressed in order to warrant a reasonable comparison. The difficulty with comparing the two groups stems from a

number of factors: teaching experience, number of participants, how techniques were presented, total workshop time, compensation, and when interviews were conducted.

Five of the eighteen 2008 workshop participants, had extensive teaching experience. In 2007, only two of the twelve had extensive teaching experience, though a video was only collected of one of these. It is possible that the presence of additional GMTAs with extensive teaching experience had a positive impact on the inexperienced GMTAs due to the likelihood of them working together both in and out of the workshop.

Interviews were collected from all 18 GMTAs of the 2008 workshop. In 2007, interviews were collected from only eight of the 12 GMTAs. Thus there was much more data from 2008 to accumulate interview quotes. As an attempt to counter this, coded data was quantified by counting the number of participants making a comment and then presenting this data along with the quote (i.e. 10 out of 18 GMTAs made a comment related to active learning).

The techniques presented in the 2008 workshop were very specific and named. This likely helped GMTAs better recall the technique in the interviews (i.e. one could talk about think-pair-share without giving it a name, but the name could help in recall of the idea, even if the idea was not implemented.) In 2007, techniques were not named, thus GMTAs could only talk about the idea and recall could have been affected because of the lack of specific techniques in the workshop. This might have limited the GMTAs comments on such techniques. However, since the named techniques were part of the

design of the 2008 workshop any increase in recall of the techniques should be attributed to the workshop.

The total workshop time differed between years, in 2007 it was approximately 14 hours, and in 2008 it was approximately 18 hours. This difference in time was not from additional seminars, but was due to the second phase of the 2008 study. It did not result in additional instruction. However, the purpose of Phase 2 was to increase the implementation of the ideas learned in the workshop by the GMTAs, therefore it is likely that this additional time had an effect on the continued use of techniques. Although this component of the workshop was not required, GMTAs were paid \$147 for their participation and all participated. The GMTAs from 2007 were not compensated.

The interviews with the GMTAs from 2008 took place in December of 2008, while the interviews of the GMTAs from 2007 took place in late March of 2008. To help alleviate this difference, additional interviews were conducted with the GMTAs from 2008 in early April of 2009.

Volunteer Participants: Both the GMTAs from 2007 and 2008 volunteered to participate. However, in 2007, eight of the twelve GMTAs participated in interviews and eleven of the twelve were videotaped, and in 2008, 18 of 19 GMTAs participated. Since both samples were composed of nearly the entire population, it is unlikely that those GMTAs choosing not to participate significantly detracted from the study.

Possible Hawthorne Effect: A Hawthorne effect refers to a psychological phenomenon by which participants improve simply because they know they are participating in a study (Gliner & Morgan, 2000). In this study, the researcher presented the workshop, and participants knew they were participating in a study. Additionally, the researcher was generally well-liked by the participants. Therefore, GMTAs could have been more motivated to attend seminars and made stronger attempts to implement the teaching strategies. However, it is known from the interviews that some GMTAs were indifferent to the workshop and attended because they were mandated by the Mathematics department. Attendance was likely affected because of a combination of these two aspects. It was therefore deemed unlikely results were substantially influenced by a Hawthorne effect.

Quasi-experimental Design: The study on the 2008 workshop employed a quasi-experimental design using a sample of volunteers, with 18 of 19 GMTAs choosing to participate. However, this situation is mostly the same in university-run GMTA workshops. The graduate students admitted to the institution where this study was conducted were not thought to be greatly different in terms of demographics than graduate students from other similar universities. It should be noted that some GMTAs were deeply interested in improving their teaching and some were indifferent.

Assumptions

Changes in Confidence: As mentioned in the limitations, changes in teaching could be due to workshop effects or classroom teaching time. Similarly, changes in confidence on the Teacher Confidence Inventory could be due to the treatment (coaching or observation), classroom experience, or a combination of both. However, both treatment groups received the same amount of classroom teaching time between the pre and post measures, therefore it is assumed that differences in confidence are from the classroom component, not classroom experience.

Workshop Comparison: As mentioned in the limitations, a number of difficulties arise when attempting to compare the 2007 and 2008 workshops. Still, although these difficulties make comparison complicated, it is not unreasonable to make some comparison between the years.

Interview data from both years is reasonably comparable due to the overlap of questions. Although two sets of interviews were collected from the GMTAs of the 2008 workshop, only the second interview, conducted in early April of 2009, was compared to the 2007 workshop interview conducted in late March of 2008. The additional interview conducted with the 2008 GMTAs is assumed to have little effect on their retention of ideas learned through the workshop.

The most comparable data comes from the workshop survey administered to both groups upon the completion of the workshop. These surveys were almost identical

for both years, and contained the same open-ended questions. Sadly, these surveys are little more than participant's reactions to the workshop, i.e. level 1 data (Guskey, 2000)), and say little about the true effect of the workshop on its participants.

CHAPTER 4

RESULTS

Introduction

This chapter presents the results of the data analysis, and it is divided into six sections. The first section briefly introduces the participants of the study. The second section is a qualitative analysis of the post workshop interview with the GMTAs from 2008. The third section examines the three sets of videotapes collected of the GMTAs from 2008. In the fourth section, the 2007 and 2008 workshops are compared. The fifth section discusses Phase 2 of the 2008 workshop. In the last section, the GMTAs from 2008 are revisited and analyzed individually.

Introducing the GMTAs from 2008

The participants of the 2008 workshop, identified by pseudonym, are presented below. For each GMTA a brief description of his or her teaching experience, career goal, class they were teaching, and degree they were pursuing are presented. For a more complete description of each participant, see the individual analysis on page 157.

- Aiken: Aiken had no prior teaching experience and was teaching College Algebra. He was pursuing a Master's degree in Mathematics and upon completion hoped to work in academia doing both teaching and research.

- Allyson: Allyson had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Ecological and Environmental Statistics and upon completion hoped to get a Ph.D. in Statistics and then go on to do research and teach.
- Amy: Amy was an assistant TA for two semesters as an undergrad and was teaching Liberal Arts Mathematics. She was pursuing a Master's degree in Mathematics and upon completion hoped to get a job outside of academia not teaching.
- Andy: Andy had a Bachelor's degree in Mathematics Education and had student teaching experience. He was pursuing a Master's degree in Mathematics and upon graduating hoped to become a high school teacher or continue on to get his Ph.D. in Mathematics Education. He was teaching Precalculus.
- Bob: Bob was an experienced instructor with three years of university teaching experience. He was pursuing a Ph.D. in Statistics and upon finishing his degree hoped to get a job allowing him to both teach and do some research. He was teaching Elementary Statistics.
- Cathy: Cathy had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Ecological and Environmental Statistics, and upon finishing hoped to work outside of academia.
- Corinne: Corinne had a Bachelor's degree in Mathematics Education and had taught one year of junior high school. She was currently pursuing a Master's

degree in Mathematics and upon finishing hoped to either get a Ph.D. in Mathematics Education or teach at the secondary level. She was teaching Precalculus.

- Dave: Dave had no prior teaching experience, and was pursuing a Master's degree in Statistics. Upon completion of his degree he was hoping to pursue a career outside of teaching. He was teaching College Algebra.
- Earl: Earl had no prior teaching experience and was teaching Precalculus. He was pursuing a Master's degree in Mathematics and upon completion hoped to work in a job outside of academia, not teaching.
- Frank: Frank had two years of university teaching experience and was pursuing a Ph.D. in Mathematics. Upon completion of his degree he was hoping to get a job in academia doing research with some teaching as long as it was higher-level classes. He was teaching Survey of Calculus.
- James: James had no prior teaching experience and was teaching Precalculus. He was pursuing a Master's degree in Mathematics and upon finishing hoped to work in academia doing research and some teaching.
- Kalen: Kalen had no prior teaching experience and was teaching Survey of Calculus. He was pursuing a Master's degree in Ecological and Environmental Statistics and upon finishing hoped to pursue a career outside of teaching.
- Ken: Ken was an experienced instructor with six years of university teaching experience. He was pursuing his Ph.D. in Mathematics and upon graduation

planned to pursue a career both teaching and doing research. He was teaching Survey of Calculus.

- Larry: Larry had the most teaching experience of anyone with 24 years. He was pursuing a Ph.D. in Statistics and upon completion hoped to continue teaching and maybe do some research. He was teaching Elementary Statistics.
- Michelle: Michelle had a Bachelor's degree in Mathematics Education and had student teaching experience. She was also an undergrad TA for two semesters. She was pursuing a Master's degree in Mathematics and upon completion was hoping to teach at a community college and maybe do some research at a lab in the summertime. She was teaching College Algebra.
- Pam: Pam had some previous teaching experience as she was a GMTA for one semester. She was pursuing a Master's degree in Mathematics but did not plan to pursue a career in academia. She was teaching Precalculus.
- Randi: Randi had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Mathematics and upon finishing hoped to enter a career not involved with teaching.
- Simon: Simon had no prior teaching experience and was teaching Liberal Arts Mathematics. He was pursuing a Master's degree in Mathematics and upon finishing hoped to teach at the college or high school level.

December 2008 Interviews

Interviews were analyzed with the goal of understanding the perceived impact the workshop had on GMTAs and their teaching practices as a group. Three themes emerged as workshop factors both influencing and limiting teaching growth: techniques, experiences, and participant's viewpoint of teaching. Each of these themes is analyzed below.

Factors Influencing Teaching Growth

Targeted Techniques: The teaching techniques presented in the workshop formed the backbone for GMTAs' potential teaching growth. After the first seminar, a seminar on reflection was presented followed by seminars for active learning, questioning, and formative assessment.

Reflection was discussed in the second seminar as a way to help GMTAs think about their teaching in order to facilitate improvement. From analysis of the interviews, reflection served both as a technique on its own, in order to reflect on one's teaching, and as a way to assess the successfulness of a new technique. In this way, it seems reflection served as a catalyst for implementation of the other techniques. In most of the GMTAs' comments about workshop techniques, reflection on their teaching is woven in. Thus the evidence suggests reflection played an integral role in the workshop. Fifteen of the 18 GMTAs made comments on how they reflect on their teaching and thought more about what they are doing when they teach. Michelle made

the strongest comment directly about reflection. When asked if the workshop had an impact on her teaching she said:

I definitely reflect more on my teaching. I feel that I reflected on my teaching and I tried to change it if something wasn't, if I didn't feel like something was working. And I guess I've never, even in all my other teaching experiences, I've never done that before.

Kalen made a similar comment: "I try to figure out whether things I did that day were effective or whether they just bombed. I think I'm much more reflective about my teaching then I would have been."

Ideas of active learning were discussed in the third seminar. Three specific techniques related to active learning were discussed: think-pair-share, the pause procedure, and guided lecture. The active learning seminar inspired a number of GMTAs to think about the importance of getting students involved. In the interviews, 10 of the 18 GMTAs talked specifically about how active learning impacted their teaching. Of these ten, five mentioned the think-pair-share technique, two others mentioned the pause procedure, one mentioned guided lecture, and two mentioned group work.

The think-pair-share idea was quite popular among the GMTAs. Corinne was just one of the GMTAs that mentioned using it: "We've been doing a lot of the think-pair-share thing. Ah, where they think about it and then they share with their neighbor and then we talk about it as a big group; we do a lot of that." When asked how she felt that impacted her classroom she added, "I think it's working really well."

Bob reflected on the usefulness of the pause procedure, saying:

Well, I think the pause procedure is really effective. I think as a teacher it's easy to just press forward because you know the material, but if you think back to also being a student and how an hour and 15 minutes or even 50 minutes, a lot of things can get jumbled up in your head. So taking the time for your students to be able to gather their thoughts, I think, is really helpful.

Not everyone mentioned specific active learning techniques they learned through the seminar, but still mentioned how important the ideas of active learning were in general. Two GMTAs mentioned they increased their use of group work. Additionally, two mentioned having students work at the board and another two talked about involving students more with activities. One particular example of the importance of active learning came from Randi who said, "I think [active learning] is the easiest to implement in your classroom and it's the one that I have really taken on and seen a lot of difference in the way I run my class, ... I feel like the more I get them involved the more they speak up, so, it's helped a lot." Pam talked about involving her students more by having them work on problems at their desk saying:

"I'll lecture for a little while and then say okay, why don't you guys try A15 through A17 on page such and such, work with the people next to you, and just, you know, two or three quick questions where they're doing it at their desks as opposed to me doing examples in front of the classroom, it definitely keeps them engaged more."

Questioning techniques were discussed in the fourth seminar, and 14 of the 18 GMTAs positively commented on the role they played in their teaching practice. The seminar focused on different types of questions such as low and high level and open and

closed, rephrasing questions, and also the idea of wait time. Pam commented on how this seminar affected how she asked questions:

What we talked about was more what to do in front of the class, and that certainly helped because we talked about waiting time, rephrasing a question—that was a really big one for me that I changed. [We talked about] knowing exactly what you want the answer to be, so instead of asking a general open-ended question to stop and think about do I really want this to be a general, open-ended question or do I want it to be a quick question where I'm just checking to see if these students are paying attention or understanding?

Ken talked about how he thought more about the questions he asked and how it brought balance into his teaching:

I think about my questions and say well here's an open-ended question and a closed question and try, and even though it's a math class and a lot of questions are closed, I mean 'What is the answer?' is a closed question. But 'Why is that the answer?' is an open question, and I try to keep a little bit more balance there.

Cathy's comments summed up the importance of asking good questions:

I really try and make good questions because I found that workshop to really be an eye opener. It's a regular part of my lesson, its like okay, what questions am I going to ask them today that aren't just easy things? I tend to ask a lot of questions to maintain interaction with the students but I think it's important to have some more in-depth questions, you know, those higher level ones too so that they actually are thinking and not just following.... [Asking questions] encourages them to stay active in the class; they are paying attention to what I'm saying because they know I'm going to ask a question in like a second. And I think it also encourages them to really think about what's been going on and it elicits responses.

Andy took the idea of wait time seriously:

I definitely like deep questions. I like wait-time, giving my students actually a good amount of time maybe up to like 30 seconds. You know like, look at this problem, no really, just look at it and take some time to

process it. As opposed to 'everybody got it, go on' type of thing, which I see everybody gets caught in and it doesn't help anybody.

The fifth seminar discussed a number of formative assessment techniques. The seminar discussed specific techniques such as the minute paper, but it also compared formative assessment to summative assessment. In the interview, 6 of the 18 GMTAs mentioned how they used formative assessment to receive feedback in their classroom. A few GMTAs integrated formative assessment ideas with other techniques learned in the workshop. Cathy talked about incorporating questioning techniques with formative assessment in saying "...if you realize that they're not answering your easy-level questions at all, then you know they haven't picked up on what you taught last time."

Kalen connected active learning with formative assessment to say:

I think if [students are] forced to do problems in class and they can't do them then it shows them what they need to work on. It also shows me whether my teaching is effective or not. ...because if I make them do three problems during class and nobody has any idea how to do any of them then obviously my lecture wasn't very sufficient. So it's good for both of us.

Positive Experiences: The positive experiences GMTAs encountered varied over the course of the workshop. These experiences included time spent teaching in the classroom, social support, the classroom component of peer coaching or observation, and watching a videotape of themselves teaching.

Though not directly mentioned in the interviews, classroom teaching experience during the semester of the workshop appeared to play a role in impacting the teaching practices of the GMTAs. Both those with and without prior teaching experience likely

benefited from their time spent teaching in the classroom, but the influence that time spent in the classroom had on their teaching practice is unknown.

One of the most positive experiences identified by the participants was the social support the workshop provided. Fourteen of the 18 GMTAs commented on how valuable it was “interacting with [their] peers.” Cathy summed up the social experience by saying about the workshop, “I mean, you learn[ed] practical stuff to implement in your classroom like how to be a good teacher, but it also gave you that support network of other first-time teachers who were all trying to fumble through it at the same time.”

The significance of the social experience varied between experienced and inexperienced GMTAs. Experienced GMTAs were more likely to value the interaction with other GMTAs over other components of the workshop, whereas inexperienced GMTAs viewed the interaction more as one of many valuable components. Both groups felt the workshop brought them together.

Phase 2, the classroom feedback component, is more thoroughly addressed under its own heading on page 135. However, for the purpose of this analysis, it will also be briefly summarized here. Seven of the eight in the observation group and nine of the ten in the coaching group commented on how observing others positively influenced their teaching. However, only two of the ten coaching participants commented on the helpfulness of the discussion involved with coaching, the pre and post conferences.

Regarding the effect Phase 2 had on the implementation of strategies learned in the workshop, all eight GMTAs in the observation group and three of the ten coaching participants made comments. One such comment came from Amy, “[Coaching] has shown me to use [the techniques] more often. The class I watched didn’t really use them and as an observer, I had no clue if the students understood the concepts.”

In the interview, only two GMTAs commented on how watching a videotape of their teaching affected their teaching practice. Allyson said, “And the videotaping helped too. As much as I didn’t like it, it showed me how I was actually teaching. I could actually see myself and change things based on that.” In the workshop survey, 10 of the 18 said they watched their tape.

Viewpoint of Teaching: The viewpoints participants had of teaching played a role in the self-perceived outcomes from the workshop. Some GMTAs had a fixed concept of what teaching should look like and believed there was little need to try something new, feeling their teaching was “good enough” and “not much different from [their] peers.” Still, most GMTAs had a desire to improve their teaching and were more willing to try new techniques. GMTAs had views regarding the purpose of the workshop, the effectiveness of the workshop, and made comments of perceived changes in their teaching.

In general, GMTAs viewed the purpose of the workshop as a way “To help us become better teachers.” However, an experienced GMTA felt the purpose was “...to prepare the *new* teaching assistant for, um possibly *their* first time teaching or ah, I

guess, learn more about teaching since *they* haven't had much experience" (emphasis added). Still, most inexperienced GMTAs felt similar to Allyson, feeling the purpose was "To improve *our* teaching, get *us* to reflect on what *we're* doing" (emphasis added).

Seventeen of the 18 participants felt the workshop had an impact on their teaching. The one who didn't feel like the workshop was forced on him, saying: "This semester I felt like I've been pushed to get an education in math education, and I don't want one, I want to be educated in Mathematics."

Of those that felt the workshop impacted their teaching, Kalen said "I think it was a really good introduction into how to teach." Perhaps the most enlightening discussion regarding the impact of the workshop came from James; when asked if he felt the workshop had an impact on his teaching, he responded as follows:

James: Yes, I would say it did because it made me more aware of the fact that you can improve as a teacher, even in a term of just one semester.

Interviewer: So it was because you just saw that it was possible to improve—is there anything more to it than that?

James: Not only that, we also received strategies and ideas about how to actually improve and reflect on teaching and stuff like that, and also different techniques that you can use that really work.

Interviewer: So, it impacted your teaching by giving you some real specific things that you could take a hold of—is that what you're saying?

James: Yeah, it was nice to have specifics instead of just saying 'you can improve, go try to improve.' It was here are some things that you can actually do to improve, so that was useful.

Finally, twelve participants mentioned a perceived change in their teaching due to the workshop. Perhaps the two strongest comments came from inexperienced GMTAs. Kalen said, "I think without the workshop and without having to watch other people, I think I would have been relegated to lecturing for 45 minutes, you know. Um,

so I think classroom strategies were definitely really helpful.” Allyson also made a similar comment:

Before the workshop I just had a lecture and then got up there and I presented the material. And now I’m thinking about how they’re receiving it and how I can get them to participate in the lesson. I have them work with each other a little more. They weren’t doing in the beginning because I didn’t know how to do that.

Summary: From the interviews, three themes emerged as influential factors in impacting teaching practice: targeted techniques, positive experiences, and participant’s viewpoint of teaching. The interview responses suggest that the workshop played a large role in providing GMTAs with new teaching techniques. GMTAs also felt the workshop helped to build social connections with their fellow peers. Questioning techniques were the most discussed technique of the workshop. Two GMTAs felt that without the workshop experience, they “would have been relegated to lecturing.”

Factors Limiting Teaching Growth

Absent Techniques: Just as the techniques presented in the workshop influenced teaching growth, absent techniques limited the potential teaching growth of GMTAs. As noted by the GMTAs, there were features lacking in the workshop, changes desired for the workshop, and difficulties implementing and/or understanding techniques.

Seven GMTAs mentioned features they felt were lacking or missing from the workshop. The most comments were made on the lack of instruction about lesson

planning with four making comments similar to Kalen's: "I had never written a lesson plan before this semester and there was never a point where anybody was like 'Here's a lesson plan.' That was something concrete that would have been pretty nice to know." A brief introduction to lesson planning was presented in the first seminar, though it seems it not sufficient. It is not surprising that inexperienced GMTAs would want instruction on planning lessons; clearly more was needed.

A variety of comments were made concerning changes desired for the workshop. In all, 11 GMTAs discussed ways they felt the workshop should change, though few comments were similar. Four inexperienced GMTAs wanted shorter seminars, feeling that "Sitting there for two hours was hard." The three GMTAs with the most teaching experience wanted more seminars before school started, but most of those without experience felt it helped to have the seminars spread out since "Before the semester begins we have fewer questions."

In total, six GMTAs discussed their difficulties with understanding or implementing techniques learned in the workshop. There is a subtle difference between the two: A difficulty understanding a technique is most likely due to a poor presentation of the technique in the workshop; whereas a difficulty with implementing a technique could be the workshop's failure to connect the technique to specific mathematics content.

The video recordings of the seminars suggest that the presented techniques were disconnected from mathematics content. Though some time was given for GMTAs

to work together to plan classroom implementation of the techniques learned, this time was not well spent by the participants. Garet et al., discuss the need for content-focused planning time as a component of effective professional development (2001). The lack of focus on integrating strategies with content could have limited the effect of the workshop.

Negative Experiences: Not all experiences in the workshop were perceived to be positive by the participants. When GMTAs were asked what they didn't enjoy about the workshop, 13 of the 18 commented on the time commitment. Dave said, "I thought we met a lot more than was necessary. I think we could have done all the same stuff in less time." Though the time commitment was considered large, eight of the 13 still considered the workshop to be worth it overall. James made the comment that "They were long, but they needed to be, so there's no way to avoid that."

Phase 2, the workshop component involving peer coaching and observation, is more thoroughly addressed under its own heading on page 135. However, it will also be briefly mentioned here. Two of the eight in the observation group felt observation did not play a big role in impacting their teaching practice. Dave said, "I just kept teaching the way I had." All ten in the coaching group made negative comments relating to the coaching experience. These fell under two categories: issues related to time and issues related to the peer relationship.

Six GMTAs specifically thought coaching took a lot of time and involved a lot of paperwork. A quote from James sums it up best: "The coaching thing was a good idea,

but there were a lot of forms to fill out and it was hard to meet consistently to do a pre-conference [and] a post-conference.” Though the coaching group’s time commitment was the same as that of the observation group, they felt it took more time. Perhaps this is because the observation group met once a week during the regular seminar time, and the coaching group had to develop their own schedule.

Two of the coaching pairs had problems with the *peer* part of their relationship. Both difficulties had to do with authority. In one pair, a GMTA with a Bachelor’s degree in Mathematics Education was paired with an inexperienced teacher. The experienced teacher felt his peer was not at his teaching level and therefore had little authority to provide him with feedback. In the other pair, one GMTA felt uncomfortable giving negative feedback to his peer and thought a mentor relationship would have been better since the mentor would have the authority to give such feedback.

Some of the coaching group felt like coaching could have been useful, but because of time-constraints and possibly a badly matched peer observer, felt it “...ended up not helping as much as I think they or I would have wanted it to.”

Viewpoint of Teaching: Some GMTAs held viewpoints of teaching that prevented them from taking advantage of the workshop. Two made comments about a specific strategy they didn’t agree with and two others believed their teaching was already “good enough.” One GMTA didn’t like active learning as a student, so didn’t want to use it as a teacher. The other thought formative assessment was a waste of time because “what the students think really doesn’t even matter, it’s not pertinent.”

One believed about the workshop, “If you’ve taught before, it’s not really going to change the way you teach.”

Summary: The three themes analyzed as influential factors were also analyzed as factors limiting teaching growth: absent techniques, negative experiences, and viewpoint of teaching. Many inexperienced GMTAs wanted more in-depth lesson planning, but otherwise felt the workshop was adequate. The failure of the workshop to connect the techniques to the content could have limited the effects of the workshop. The coaching experience was viewed more negatively than observation mostly due to time-constraints and authority issues with peers. Some GMTAs held viewpoints of teaching that prevented their growth as a teacher.

Additional Notable Findings

In the interviews, the seminars on reflection, active learning, questioning techniques, and formative assessment were widely discussed by the GMTAs but the first and last seminar received little discussion. The first seminar served as an icebreaker and university policy was covered, thus the absence of GMTA discussion on this seminar is not surprising. The sixth seminar, titled “Teaching Philosophies,” was only mentioned by one GMTA, who felt “It might have been the least beneficial [seminar].” It seems the lack of presentation of any specific technique caused the seminar to be mostly forgotten, or at least difficult to talk about.

One question in the interview protocol was designed to address career goals. Of the 18 GMTAs, three were planning to pursue a teaching career, eight hoped to be involved in both research and teaching, and seven planned to work outside of academia. It was thought that career goals would be closely linked to the desire to better oneself as a teacher, i.e. those that felt they wanted to go into teaching would work harder to improve their teaching than those that wanted a job outside of academia. However analysis of additional data did not suggest a link between career goal and improvement of teaching.

In particular, one GMTA whose career goal was not teaching said that she wanted to improve simply because she felt she was “no good,” saying, “It’s not fair to students paying tuition to have a bad teacher.” Another GMTA, whose career goal was in academia, felt he was “good enough,” and didn’t need to change since he’d “be doing mostly research anyway.”

Analysis of Videotaped Instruction

Though the interviews revealed participants’ perceived impact of the workshop, an analysis of the video recordings of GMTA instruction provides stronger evidence of the actual change in their teaching practice. The Reformed Teaching Observation Protocol (RTOP) was one measure used to quantify changes in GMTAs’ teaching in the classroom. As was mentioned in Chapter 3, the original 25 RTOP items were cut down to 17 of the most relevant items to this study, producing a modified RTOP. An outside

rater watched and rated each tape with no knowledge of the treatment GMTAs received or whether GMTAs were in the coaching or observation group. As an additional measure, the researcher watched and coded the videotapes for changes in GMTAs' use of active learning and questioning techniques. This analysis focused on these two strategies as they were the most identifiable from the videotapes.

Analysis of RTOP Scores for all 2008 GMTAs

Before the RTOP data was analyzed, it was checked for normality by using QQ-plots and box-plots. These plots revealed that when analyzing the cumulative scores of this instrument, the data could be assumed to be normal, and t-tests could be used. However, when analyzing individual item scores, the data could not be assumed to be normal and typically violated homogeneity of variances between groups. Nonparametric tests were used for this analysis. All analysis is done at a 95% confidence level, using an alpha-level of 0.05.

A one-sample *t*-test was conducted to examine RTOP gain scores for all participants of the 2008 workshop. Gain scores were used to compare RTOP scores from October and November with September's baseline scores. Gain scores were computed by subtracting the RTOP score of September from November or October and dividing by September's score, e.g. $(Nov. - Sept.) / Sept.$ On average, the participants' gain in RTOP scores was 17.7% (SD = 0.61) between September and October and 27.9% (SD = 0.70) from September to November. The *t*-test indicated no significant difference for either gain, $t(17) = 1.249, p = .229$, and $t(17) = 1.694, p = .109$, respectively. This is

not surprising as the average RTOP score in September was 15.5 (SD: 8.1) and in November was 16.6 (SD: 7.1).

The large standard deviations in both the gains analysis (0.61 and 0.70) and mean change (8.1 and 7.1) are an indication of the great variety of RTOP scores among the 2008 GMTAs. Figure 2 displays the data as percentiles in box and whisker plots for September, October, and November.

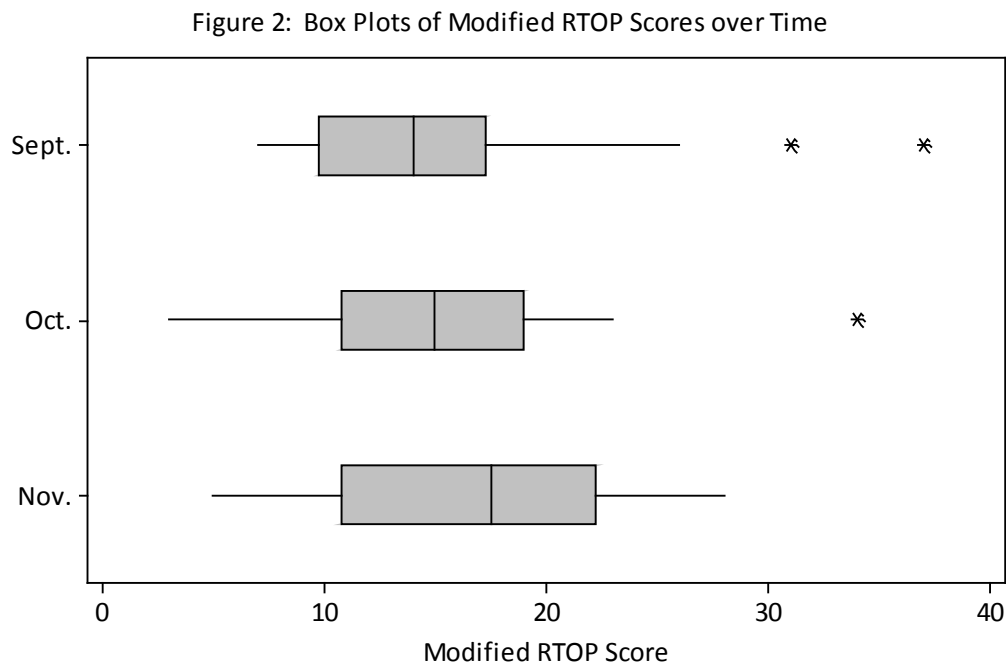


Figure 2 indicates that though the minimum and maximum values had wide variation, the 25th percentile scores (the left end of the box) remained about the same; this is largely due to eight GMTAs whose RTOP score remained steady. However, seven GMTAs had large increases in their RTOP scores, averaging a gain of 10.5 points from September to November. These increases caused both the median and 75th percentile

scores (the right end of the box) to steadily increase, from 14 to 17.5 and from about 17 to 22, respectively. Only three GMTAs had decreasing RTOP scores during the study.

Of the three outliers present in Figure 2, two are from GMTAs who had Bachelor's degrees in Mathematics Education and one was from a GMTA with extensive university teaching experience. Through videotape observation it was discovered that in all three instances, at the beginning of the semester these GMTAs had ample class time to cover the material and thus devoted class time to open discussion and active learning. In later classes, however, all three GMTAs were crunched for time (having to cover a great amount of content) and lectured for most of the period. This shift in pedagogy (away from student-centered learning) produced lower RTOP scores. A more thorough analysis of GMTAs' RTOP scores follows on page 115.

Coding Analysis of Instruction for all 2008 GMTAs

The interviews gave descriptions of participant's perceived change in teaching while the RTOP gave evidence of a quantitative change in teaching. The following analysis provides an in-depth look into specific changes in GMTAs' use of questioning and active learning. Specifically, the questions asked by GMTAs during class time were assembled into categories based on the audience, level, and type. The number of questions was adjusted based on each participant's class length so that the numbers represent the number of questions asked per hour. Active learning was also recorded and was based on the amount of time the teacher had the students working individually or in groups, as a percentage of their class time. This information is presented in Table 5

as median values for the three videotapes with the range of values presented in parentheses.

Table 5 – 2008 GMTA Coded Videotape

	Sept.	Oct.	Nov.
AUDIENCE			
Volunteer	44.0 (5.3 – 118.2)	47.1 (7.8 – 67.5)	50.0 (7.5 – 110.3)
Chorus	1.8 (0 – 50.8)	0.0 (0 – 17.0)	0.0 (0 – 20.4)
Rhetorical	24.5 (4.0 – 68.8)	19.3 (4.5 – 63.8)	13.1 (3.4 – 59.2)
Selected	0.0 (0 – 18.0)	0.0 (0 – 18.9)	0.0 (0 – 7.8)
LEVEL			
Low	55.4 (5.3 – 135.1)	49.7 (7.8 – 66.3)	51.3 (7.5 – 108.0)
High	0.0 (0 – 4.3)	0.0 (0 – 6.3)	0.0 (0 – 11.6)
TYPE			
Open	0.0 (0 – 13.0)	1.2 (0 – 13.7)	3.8 (0 – 23.3)
Closed	52.6 (5.3 – 136.4)	49.8 (7.8 – 71.1)	50.8 (7.5 – 93.1)
ACTIVE LEARNING (% of class time)	0.0% (0 – 9.0%)	3.3% (0 – 19.1%)	5.5% (0 – 39.7%)

As can be seen in Table 5, the median number of volunteer, chorus, and selected questions asked did not change much over the study, but the range of the number of chorus questions asked per hour decreased. In general, inexperienced GMTAs initially asked a large number of rhetorical questions but over time reduced their emphasis on them. There was a slight increase in the amount of open-ended questions asked, although this change was small. The amount of class time spent in active learning also increased, most noticeably in the range of values.

Although Table 5 provides an indication of the group's change in questioning and active learning, it does not indicate any individual change in teaching. The large ranges make it impossible to tell the number of GMTAs who made changes and how large (or small) those changes might have been. Therefore, it is necessary to look at the specific changes of individual GMTAs. This analysis is presented in the next section.

Analysis of Instruction for Individual 2008 GMTAs

The analysis of interviews indicated that many GMTAs felt the workshop impacted their teaching. However, the videotape analysis did not provide much evidence of a global impact on their teaching. This is possibly due to the fact that though most of the GMTAs (14 of the 18) felt the workshop had an impact on their teaching, the impact was not made evident when the data was presented collectively, representing the whole group of GMTAs. To further explore changes GMTAs made in their teaching, the following analysis focuses on specific individual teaching changes made evident through the videotapes.

RTOP Scores: As previously mentioned, seven GMTAs made considerable gains on their RTOP scores over the course of the study, while eight remained relatively steady, and three had scores decrease. Table 6 displays the September, October, and November RTOP scores for the 2008 GMTAs. The seven GMTAs with increasing RTOP scores moved from a mean score of 11.7 (SD = 4.1) in September to 22.1 (SD = 4.5) in November. Of the 11 remaining GMTAs, eight displayed little change in their RTOP

score with a mean score of 14.4 (SD = 5.5) in September and 14.3 (SD = 5.8) in November. Three GMTAs, Andy, Ken, and Simon all had over ten point drops.

Table 6 – Individual RTOP Scores

	Aiken	Allyson	Amy	Andy	Bob	Cathy
September	9	15	26	37	10	11
October	13	13	23	11	10	15
November	23	18	25	18	6	19
	Corinne	Dave	Earl	Frank	James	Kalen
September	18	7	16	13	8	10
October	18	7	19	10	20	17
November	28	11	17	13	18	17
	Ken	Larry	Michelle	Pam	Randi	Simon
September	31	9	15	17	13	15
October	15	15	34	19	17	13
November	7	22	14	28	10	5

Qualitative Videotape Analysis: As the semester progressed, many GMTAs changed the way they asked questions. Most reduced the number of chorus and rhetorical questions they asked. This change can most likely be attributed to maturation, as the workshop did not focus on these types of questions. Of more interest are the GMTAs who increased the number of open-ended and high-level questions they asked, as these were directly addressed in the workshop. Additionally, it is important to observe which GMTAs made changes in the amount of class time spent in active learning, as this too was addressed in the workshop.

Only five GMTAs showed evidence of an increase in the number of high-level questions they asked, and only one of those, Corinne, showed a considerable gain.

Table 7 displays the increases in the number of high-level questions asked (per hour) for seven GMTAs. The remaining eleven GMTAs never asked any high-level questions.

Table 7 – Individual Changes in the Number of High-level Questions Asked

	Allyson	Bob	Corinne	James	Ken	Larry	Pam
September	0	0	0	1.3	0	4.3	0
October	0	2.6	0	6.3	0	1.9	1.6
November	2.0	3.8	11.6	3.4	1.2	3.4	3.2

Over the course of the three videotapes, nine GMTAs increased the number of open-ended questions they asked during their classes while three continued to ask roughly the same number. The remaining six never asked any open-ended questions.

Table 8 displays the increases in the number of open-ended questions asked (per hour) for twelve GMTAs.

Table 8 – Individual Changes in the Number of Open-ended Questions Asked

	Allyson	Amy	Andy	Bob	Cathy	Corinne
September	0	5.4	3.3	0	0	0
October	0	6.0	7.5	0.9	5.1	12.5
November	10.2	5.2	3.9	3.8	5.2	23.3
	Earl	James	Ken	Larry	Pam	Randi
September	0	1.3	0	13.0	5.6	0
October	2.4	10.0	0	13.7	1.6	1.6
November	2.5	12.6	7.1	18.4	6.5	2.0

There was considerable growth in GMTAs' time spent in active learning. Of the seven GMTAs who increased their use of active learning, three devoted over 20% of

their class time to it by the end of the study. In the interviews, all of these seven mentioned the impact active learning had on their teaching. Of the remaining 11 GMTAs, five consistently spent the same amount of time in active learning and six never spent any time in active learning. This data is presented in Table 9.

Table 9 – Individual Changes in % of Time Spent in Active Learning

	Aiken	Allyson	Amy	Bob	Corinne	Frank
September	0%	0%	9.0%	0%	2.7%	3.3%
October	18.5%	3.5%	14.1%	4.3%	0%	19.1%
November	39.7%	28.9%	13.3%	6.3%	20.7%	15.2%
	James	Kalen	Larry	Michelle	Pam	Randi
September	0%	5.6%	2.9%	6.7%	5.7%	0.0%
October	3.5%	10.8%	3.1%	7.6%	0%	8.7%
November	5%	12.4%	4.8%	8.3%	6.7%	0.0%

Summary

In this section, videotaped classroom instruction was analyzed by group and by individual GMTA in order to provide better evidence of the changes made to teaching. Table 10 summarizes the change in practice of all of the 18 GMTAs from 2008. In this table, GMTA changes are labeled in one of four ways: None, Same, Decreased (Dec.), and Increased (Inc.). Here, None means the GMTA never asked that type of question or used active learning. Same means they continued to ask around the same number of questions or spend roughly the same amount of time in active learning. Increased or Decreased refers to how the number of questions or time spent in active learning changed over the three observations.

Table 10 – Summary of Individual Changes for the GMTAs from 2008

	Aiken	Allyson	Amy	Andy	Bob	Cathy
RTOP	Inc.	Same	Same	Dec.	Same	Inc.
High-level ?'s	None	Inc.	None	Same	Inc.	None
Open-ended ?'s	None	Inc.	Same	Same	Inc.	Inc.
Active Learning	Inc.	Inc.	Same	None	Inc.	None
	Corinne	Dave	Earl	Frank	James	Kalen
RTOP	Inc.	Same	Same	Same	Inc.	Inc.
High-level ?'s	Inc.	None	None	None	Inc.	None
Open-ended ?'s	Inc.	None	Inc.	None	Inc.	None
Active Learning	Inc.	None	None	Inc.	Inc.	Inc.
	Ken	Larry	Michelle	Pam	Randi	Simon
RTOP	Dec.	Inc.	Same	Inc.	Same	Dec.
High-level ?'s	Same	Same	Same	Inc.	None	None
Open-ended ?'s	Inc.	Inc.	None	Same	Inc.	None
Active Learning	None	Same	Same	Same	Same	None

As indicated in Table 10, the seven GMTAs who improved their RTOP scores over the three tapes also increased their use of at least one teaching technique. Still, there were six GMTAs who increased their use of at least one teaching technique but did not improve their RTOP scores. A possible explanation for this discrepancy is the videotape coding was non-subjective, if the technique was present in the classroom it was recorded; the RTOP, on the other hand, provided a subjective rating describing the quality of the instruction in the classroom. For four of the seven GMTAs who improved their RTOP score, their amount of time spent in active learning also increased. Of the remaining three, two, Pam and Larry, continued to spend about the same amount of time in active learning. Overall, the teaching practices of 13 of the 18 GMTAs improved with respect to those techniques presented in the workshop.

Comparing the 2007 and 2008 GMTA Workshops

Some data was collected from the GMTAs who participated in the 2007 workshop. This data included 11 videotapes following the completion of the 2007 workshop and eight interviews four months after the 2007 workshop. The video data was used to provide an indication of what the teaching practices of these GMTAs looked like after a workshop and almost a semester of teaching experience. The interview data was used to aid in the development of the 2008 workshop and provide the perceptions of the 2007 GMTAs on their workshop. Before the workshops are compared, the GMTAs from 2007 will be introduced. For each GMTA, a description of their teaching experience, class they were teaching, and degree they were pursuing is presented. The data is incomplete because 12 GMTAs took part in the 2007 workshop and only eight interviews were collected along with 11 videotapes.

Introducing the 2007 GMTAs

- Aaron: Aaron had a Bachelor's degree in Mathematics Education and had student teaching experience. He was pursuing a Master's degree in Mathematics and was teaching College Algebra.
- Arnold: Arnold had no prior teaching experience. He was pursuing a Master's degree in Mathematics and was teaching Precalculus.

- Bruce: Bruce had a Master's degree in Mathematics and was pursuing his Ph.D. in Mathematics. He had five years of university teaching experience and was teaching Calculus.
- Buffy: Buffy had no prior teaching experience. She was pursuing a Master's degree in Statistics and teaching Elementary Statistics.
- Chuck: Chuck had a Bachelor's degree in Mathematics Education and had taught two years of junior high school and two years of college. He was pursuing a Ph.D. in Mathematics Education and teaching Liberal Arts Mathematics.
- Dustin: Dustin had no prior teaching experience. He was pursuing a Master's degree in Statistics and teaching College Algebra.
- Ian: Ian had no prior teaching experience. He was pursuing a Master's degree in Statistics and teaching Precalculus.
- Jake: Jake had no prior teaching experience. He was pursuing a Master's degree in Mathematics and teaching Precalculus.
- Jolie: Jolie had no prior teaching experience. She was pursuing a Master's degree in Mathematics and teaching Precalculus.
- Karl: Karl had a Bachelor's degree in Mathematics Education and had student teaching experience. He was taught the reformed teaching model in his undergraduate work. He was pursuing a Master's degree in Mathematics and was teaching Survey of Calculus.

- Liam: Liam had no prior teaching experience. He was pursuing a Master's degree in Mathematics and teaching Survey of Calculus.
- Valerie: Valerie had no prior teaching experience. She was pursuing a Master's degree in Statistics and teaching Elementary Statistics.

2007 GMTA Summary: The collected interview data from 8 of the 12 GMTAs from 2007 indicated that these eight GMTAs perceived little impact on their teaching from the workshop. Five of the eight interviewed enjoyed the social support of the workshop and research has shown that conversations with peers contribute to the understanding of the teaching process (Wulff, Austin, Nyquist, Sprague, 2004; Staton & Darling, 1989). Thus the socialization the workshop facilitated was important. Still, the goal of the workshop was "to facilitate GTAs' awareness of effective teaching practices," and, from the evidence gathered, it appeared not to have met that goal.

The RTOP scores and qualitative data from the collected videotapes for 2007 are displayed in Table 11. Table 11 indicates that when the videotapes were collected in November of 2007, most of the GMTAs did not ask high-level questions (8 of 11) or open-ended questions (9 of 11) or spend time in active learning (8 of 11). This data provides some indication of how the teaching practices (with respect to specific questioning and active learning) of these GMTAs developed after nearly one semester of teaching and a workshop.

Table 11 – Summary of Individual GMTAs from 2007

	Aaron	Arnold	Buffy	Chuck	Dustin	Ian
RTOP	4	3	6	17	18	3
High-level ?'s	0	0	0	2.4	0	0
Open-ended ?'s	0	0	0	11.0	0	0
Active Learning	0%	0%	0%	3.0%	9.7%	0%
	Jake	Jolie	Karl	Liam	Valerie	
RTOP	12	9	32	17	8	
High-level ?'s	0	0	3.4	1.2	0	
Open-ended ?'s	0	0	13.8	0	0	
Active Learning	0%	0%	24.9%	0%	0%	

2007 and 2008 Workshop Comparison Introduction

As discussed in the limitations in the methodology, a straight comparison between the 2007 GMTAs and the 2008 GMTAs is difficult. However, some of the collected data are reasonably comparable. The workshop surveys given to both groups were nearly identical. Instruction was videotaped and analyzed for both groups after the completion of their respective workshops. These videotapes should help indicate how the participants differed by year in terms of the questions they asked and the time they spent in active learning at that time in the semester. Finally, the interviews collected from both groups four months after the completion of the workshop consisted of the same questions.

Workshop Survey

The survey administered to both groups was very similar in 2007 and 2008, and was described in Chapter 3. In the survey, GMTAs were asked to rate each seminar on a

five point scale from “poor” to “very good.” For this analysis, these were given numerical ratings from one to five. Results from the survey indicated that the 2007 seminar mean ratings varied from 3 to 4.5 while the 2008 seminar mean ratings varied from 3.6 to 4.5. The mean and standard deviation for each seminar are presented in Table 12. As can be seen from the range of means and the grand mean, no significant differences existed between the workshops based on the ratings given by the GMTAs. This is not surprising as participants could be evaluating the presenters and not the effectiveness of the seminar. Additionally, the rating scale may not mean the same thing to each GMTA, i.e. a “good” rating might mean high impact, well presented, fun, or useful.

Table 12 – 2007 and 2008 Workshop Surveys

2007 Workshop (11 responses)	Mean	SD
Rights and Responsibilities of Students and Instructors	3.0	1.22
Techniques for teaching and learning	4.18	0.75
Question and Answer (TA Panel)	4.18	0.75
Assessment Tips and Strategies	4.09	0.54
Motivating and Engaging Students	4.36	0.67
Evaluations / Language of Mathematics	4.5	0.53
Grand Mean	4.05	
2008 Workshop (18 responses)		
Intro / Concerns	4.11	0.83
Reflective Teaching	4.0	0.84
Active Learning	4.5	0.86
Questioning Techniques	3.67	1.08
Formative Assessment	4.22	0.65
Philosophies of Teaching	3.83	1.04
Grand Mean	4.06	

Respondents to both surveys unanimously believed a similar workshop should be offered to next year’s GMTAs. Both groups believed there should be more seminars

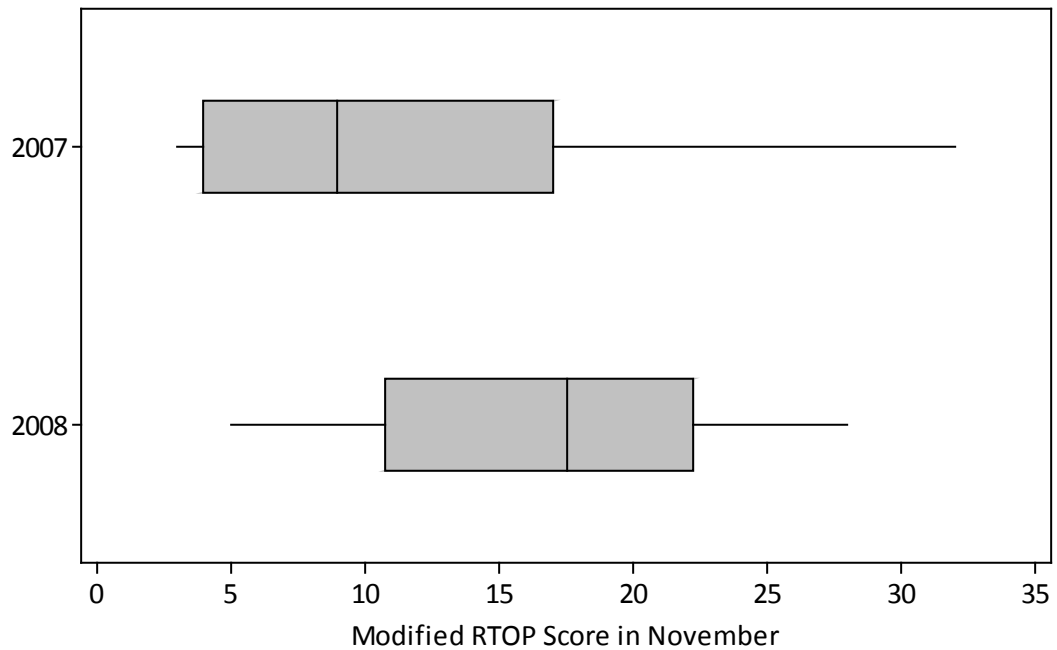
before the semester starts, but there also needed to be some seminars during the year since “there would be no experience to relate” and “before the semester begins we have fewer questions.” Both groups were willing to arrive earlier on campus to attend these earlier seminars.

In summary, from the survey alone it is difficult to tell the actual usefulness of the workshop, and nearly impossible to distinguish between the benefits of each year. It should be noted that the survey was the only data collected at past GMTA workshops. The analysis presented here helped to illustrate the lack of useful information provided by the survey and establish the need for additional data to evaluate the workshops.

Analysis of the November Videotapes of the 2007 and 2008 GMTAs

First, RTOP scores will be compared. Since no pre-treatment videotapes were collected from the GMTAs from 2007, it is impossible to look at gains over time. However, the RTOP scores of the 2007 GMTAs still provide an indication of their level of teaching, defined by their RTOP score, after a workshop and almost a semester of teaching experience. Before a comparison is made, it should be noted there was only one experienced 2007 GMTA compared to five in 2008. The RTOP scores of the 11 GMTAs from 2007 and 18 from 2008 are presented as box plots in Figure 3.

Figure 3: Box Plots of Modified RTOP Scores for the 2007 and 2008 GMTAs



The videotapes collected from the 2007 GMTAs in November of 2007 were also coded using the same coding protocol as the 2008 videos. The individual videotape data for the GMTAs from 2008 was presented on pages 116-119, and the 2007 data on page 123. Table 13 displays this collected data in intervals with the number of GMTAs from each year in each interval along with a percentage of the total number of GMTAs (per year) in parentheses.

Table 13 and Figure 3 both indicate that the RTOP scores of the 2008 GMTAs were consistently higher than the 2007 GMTAs. The coded videotape data also provides some evidence of a difference between years in the number of open-ended questions asked and time spent in active learning. However, without a proper September baseline, it is difficult to draw inferences from these differences.

Table 13 – Interval Data Comparison for 2007 and 2008 GMTAs

	Modified RTOP Scores						
	< 5	[5, 10)	[10, 15)	[15, 20)	[20, 25)	[25, 32)	
2007	3 (27.3%)	2 (18.2%)	1 (9.1%)	3 (27.3%)	0 (0%)	1 (9.1%)	
2008	0 (0%)	3 (16.7%)	4 (22.2%)	6 (33.3%)	2 (11.1%)	3 (16.7%)	
	Number of High-level Questions Asked (per hour)						
	0	(0, 3]	(3, 6]	(6, 11.6]			
2007	8 (72.7%)	2 (18.2%)	1 (9.1%)	0 (0%)			
2008	11 (61.1%)	2 (11.1%)	4 (22.2%)	1 (5.6%)			
	Number of Open-ended Questions Asked (per hour)						
	0	(0, 5]	(5, 10]	(10, 15]	(15, 20]	(20, 25]	
2007	9 (81.8%)	0 (0%)	0 (0%)	2 (18.2%)	0 (0%)	0 (0%)	
2008	6 (33.3%)	4 (22.2%)	4 (22.2%)	1 (5.6%)	2 (11.1%)	1 (5.6%)	
	Percentage of Class Time Spent In Active Learning						
	0%	(0, 5]	(5, 10]	(10,15]	(15, 20]	(20, 25]	(25, 39.7]
2007	8 (72.7%)	1 (9.1%)	1 (9.1%)	0 (0%)	0 (0%)	1 (9.1%)	0 (0%)
2008	8 (44.4%)	1 (5.6%)	3 (16.7%)	2 (11.1%)	1 (5.6%)	1 (5.6%)	2 (11.1%)

Only two of the eleven 2007 GMTAs exhibited any use of open-ended questions during their last collected videotape compared to 12 of the 18 from 2008. At the very best the other nine 2007 GMTAs did not change, and at the very worst they asked fewer open-ended questions from the beginning to the end of the 2007 fall semester. Active learning usage is similar with only three of the eleven 2007 GMTAs spending class time in active learning compared to 10 of the 18 from 2008. This data provides further evidence that the 2008 GMTAs increased their use of teaching techniques similar to techniques presented in the workshop. Finally, it supports the interview data collected from the 2007 GMTAs indicating little perceived change in their teaching practice.

Interviews

The videotape analysis provides an indication of the teaching practices of the 2007 and 2008 GMTAs near the end of the semester. The interviews, conducted in March 2008 and April 2009, respectively, provide a way to look at the perceptions GMTAs had of the usefulness of their workshop after four to five months had passed. As discussed in Chapter 3, the topics addressed in each workshop were similar, but differed in the way they were presented. While the 2008 workshop focused on specific, evidence-based classroom teaching techniques, the 2007 workshop relied on the presenter's discretion, but still under headings representing similar topics to the seminars presented in 2008. From the outlines of each workshop it is evident that both addressed active learning, questioning, formative assessment, university policy, and held a question and answer session, though the 2008 workshop incorporated a seminar specifically on reflection.

The following analysis will focus on the perceived impact of the relevant workshop on each GMTA's teaching practice. The workshop's structure, social support, and content will be discussed first followed by the participants' perceived impact of the workshop and if they felt it was a valuable use of their time.

The 2007 workshop relied on two workshop facilitators and six different presenters (one for each seminar). The facilitators chose the presenters, but the techniques emphasized were based mostly on the presenter's discretion. The viewpoint of each group regarding the structure of the workshop showed clear differences.

Arnold, an inexperienced GMTA from 2007, said, “There wasn’t coordination between talks; I feel like a lot of people repeated what a lot of other people had said.” When asked if he felt the talks were similar, he responded,

Yeah, I mean, a lot of the same things were said, even though they had different presenters. You could tell that they had like ‘this was my topic to talk about,’ like motivating students. In the end, we just had questions that were more revolved around general teaching.

When asked about how he felt the workshop could be improved he replied,

I would think that more structure, like rather than relying on presenters coming in and doing different things, having a structure that would be like, ‘we’re going to talk about this.’ I mean, maybe having one person do more than one of these, so they can build on things that happened before.

It seems the lack of a definitive structure and lack of emphasis on specific teaching techniques hindered the impact of the 2007 workshop. In 2008, the structural issue of purposeful coordination between talks was improved by relying on one presenter, and the content presented was chosen specifically to impact GMTAs’ teaching practice. In addition, the inclusion of a seminar on reflection in the 2008 workshop possibly acted as a catalyst fueling the influence of the other sessions.

The focus on reflection in 2008 seemed to play a large role in influencing teaching practice. In fact, perhaps the biggest difference in the interviews from 2007 to 2008 is how the GMTAs responded. In 2007, responses were more focused on the presenter and a vague idea of the teaching “tricks” that were presented, whereas in 2008 responses centered around reflection on one’s teaching. The following two quotes

demonstrate this idea. Before both responses GMTAs were asked “Do you think the workshop had an impact on your teaching?”

Chuck, an experienced GMTA from 2007, said:

Yeah, especially the one about [presenter’s name], his was awesome. I liked his because it was frickin’ hilarious. And, as I recall the whole crutch of his argument was you need to make whatever you’re presenting relevant to your students and that might take on many different forms. His general idea was good though he didn’t give you as many tools.

James, an inexperienced GMTA from 2008, said:

The workshop provided a lot of techniques that I wasn’t aware of beforehand. Not only that, but it made me think a lot more of my teaching, than I would have had I not attended the workshop. It gave good ideas and things to use in the classroom. It was actual things you could use, not just abstract concepts. It would make me spend time thinking about what I should be doing to improve my teaching instead of just teaching them and not thinking about it.

Both groups remarked that they enjoyed the social support that was part of the workshop experience with four comments made in 2007 and seven in 2008. A few GMTAs from both workshops went so far as to say that the discussions they had with their peers were the most valuable part of the workshop. Corinne, an experienced GMTA from 2008, felt that, “What I really took out of it was getting to know my peers and people around me and stuff and just having those lifelines kind of, so just the networking part of the workshop was the most valuable.” Likewise, Arnold said “I thought it was really helpful just talking to old TAs about what you’re going to experience and what’s unique to being a TA.”

In terms of content, in 2007 questioning ideas were mentioned in three of the eight interviews. Chuck found the questioning presentation valuable, saying the presenter "...talked about some techniques that were really useful and I really appreciated having those." When asked what the presenter talked about, he commented, "I think she talked about some different ways to check for understanding other than 'are there any questions about that' and 'is that clear with you' which are two of the worst questions you can ask your class." He later added that "...it was really useful and I enjoyed it, and it was inspiring. It got me excited about teaching." Bruce, an experienced GMTA from 2007 with teaching experience, appreciated the presenter's organization, adding that "I had thought about some of that stuff, but never, she was just really organized and had good points."

Questioning techniques were commented on by 10 of the 18 GMTAs from 2008. One particular comment described both questioning and a progression of teaching through the workshop. Cathy, an inexperienced GMTA from 2008, was asked "Do you think the workshop was a valuable use of your time?" She responded:

The asking questions seminar, you know, was really particularly useful, because you don't think about [how] the way you pose a question is going to affect the way that a student answers. You don't know what it's like to be a teacher until you're standing on that side of the classroom, and like, the first couple of lectures that I gave they were all over the place, and I wasn't really thinking of what I was doing, I was just trying to give the material in the book, and I think that with, as the workshop went on I got better at, you know, engaging them, and also evoking the response that you want from the students. So I definitely think it was useful.

An active learning emphasis appeared in both the third and the sixth seminar in 2007, but only two of the eight 2007 GMTAs interviewed commented on it. Buffy, an inexperienced GMTA from 2007, said, “[The presenter] was a lot of fun; he made the seminar enjoyable, even though he focused more on stats.” Again, the emphasis is on the presenter, not the content presented.

Active learning was mentioned by seven of the 18 GMTAs from 2008. Pam, an inexperienced GMTA from 2008, commented on involving her students more during class, saying, “I try to break up the class period more, have them do more work in class.” Bob, an experienced GMTA from 2008, said, “...one that I continue to use is like stopping and letting the students catch up and read over their notes and make sure they go through and if they have any questions that need cleared up before I continue on to something, they have that opportunity.” Here, Bob specifically mentions his use of the pause procedure discussed during the active learning seminar.

In 2007, when asked if the workshop had an impact on their teaching, six of the eight said it did with four due to social support, two for techniques and one for both. Dustin, who had no teaching experience, said “Many instructors presented us with these are possible ideas but I’d like to have more specific things, I didn’t get many tips that helped me.” He later added, “...the speakers would give us all these ideas, and just kinda let us go. Like, here you go, good luck.” When Arnold was asked if the workshop impacted his teaching he said, “I don’t know, I think I took away certain tricks, you know, like small ways of presenting the material...what I would have liked to have was

more like, specific things, like, notice that all these topics are like techniques for teaching, and like assessment tips, I didn't get really many specific techniques like this is how you should lecture...." Bruce added that after one of the talks he

...thought more about letting students know what our goals were for each section and letting them know where we were in the material so it doesn't feel like it's like an endless flow of information. [But] in terms of changing my teaching, I mean, I at least thought about some of the things that they presented. But I don't know if I really changed.

No GMTA from 2007 explicitly mentioned that they continued to use the ideas they learned. When Chuck was asked if he still used the ideas he learned in the workshop, he responded: "I think that I kind of slipped back into my own habits and maybe forgot about [the workshop] a little bit." Likewise, Bruce was asked if he could think of any particular ideas that he took away from the workshop to which he responded, "I can't say that I recall any specifically, but I can say that I was impressed enough with the handouts I received for like three months before I threw them away." Together these comments made by the 2007 GMTAs do not point to any specific technique learned. Rather, there is a smattering of non-specific ideas, tips, and tricks mentioned.

In 2008, 14 of the 18 GMTAs felt the workshop impacted their teaching with two saying it did for the social support it provided while 12 mentioned use of techniques. Bob, an experienced GMTA said, "Um, I guess I feel like it made me a better teacher, I feel like I'm doing a better job this semester, even better than last semester. I think that like, you know, even the whole thing over the course of time, kind of made me

realize what I could do better for the next semester.” Cathy said, “I definitely learned a lot from the workshops because I had never been a teacher before, so, you know, just little things that maybe people think are obvious for teachers I learned through doing the workshop.”

The time commitment required for the GMTA workshop was a strong issue for both groups. The number one response to the question “What didn’t you enjoy?” was that the workshop took too much time. Thirteen of the eighteen 2008 GMTAs and six of the eight interviewed GMTAs from 2007 commented on the time requirement. Perhaps the strongest view came from a 2007 GMTA, who said going to the workshop was “a begrudging sort of thing” and later added “I just remember [Bruce] and I would be working on homework or something and I’d be like ‘oh we have to go to the TA thing,’ and he’s like ‘oh God, I hate this,’ everyone said they hated going to it because it was right in the middle of the day.”

Still, when asked if the workshop was a valuable use of their time, 6 of the eight 2007 GMTAs and all 18 of the 2008 GMTAs felt it was. As for why it was valuable, in 2007, four felt it was for social reasons, one for techniques, and one mentioned both, whereas in 2008, it was five for social, 11 for techniques, and two for both. Bruce said:

What was useful about it was getting to know other TAs and some other people and their cohort and some older TAs, you know like social familiarization. It was really good for that. I felt a little more comfortable in the department; it was kind of like you were a part of something.

Randi, a 2008 GMTA with no experience, said, “Um, I had never really taught before and it was just kind of good to get a feel for what you should be doing and ‘implement this

into your classroom,’ and ‘this week try this.’ So, for people who haven’t taught before, I think it’s useful.”

2008 Workshop: Phase 2 – The Classroom Component

Overview

Phase 1 of the 2008 workshop, i.e. the six seminars, took place from August 27th to October 8th. A second, classroom-based workshop component, Phase 2, was used with the intention of supporting the implementation of ideas learned in the workshop. Phase 2 consisted of either a series of classroom observations or peer coaching sessions. The two different treatments were used in order to compare their effect on GMTAs’ teaching practices. Each treatment is addressed separately below.

Observation

As described in Chapter 3, the observation group consisted of eight GMTAs with each observing five teachers. During and after each of the five classroom observations they filled out the Observation Reflection Form with items targeting active learning, formative assessment, and questioning. They also completed the Teacher Confidence Inventory before and after treatment and the Observation Survey. Additionally, in the individual interviews collected in December the participants were asked a question regarding the perceived impact observation had on their teaching practice.

The analysis of the observation data begins with a synopsis of the participants' comments from the December interviews. Following this, a quantitative analysis of changes on the Teacher Confidence Inventory and the RTOP will be presented.

Interview Synthesis: In the observation group, all eight participants made reference to an increased awareness of classroom strategies, and seven of the eight commented on how observation positively influenced their teaching. Michelle discussed why she felt observation was important:

I was more observant of other people's questionings because I thought that that was one of the most interesting things in the workshop. That was one of my favorite parts and the most beneficial. I carried that over into when we were watching and so I feel like I paid attention to that mostly and that's like what I've been trying to improve on the most in my own teaching.

Other, similar comments were made regarding just observing the teacher: "...it doesn't have to be just observing strategies, just how they teach...how they do a problem versus how I do it," and "...watching it rather than just talking about it; I think really helps."

The observation of other teachers' use of questioning techniques was also mentioned by seven of the eight observers. In particular, when asked how observing influenced her use of questioning, Randi said, "I'm asking more questions during examples instead of just doing them. Also, I don't answer my own questions when nobody answers, I'll wait and eventually somebody will offer an answer."

Self-reflection also played a role in the observation group, with five of the eight commenting on how observation made them think about their teaching. Aiken said,

“Because I was put in a situation where I questioned someone else’s teaching, I learned to question my own!” Ultimately, the goal of observation was for GMTAs to become more aware of what they were doing in the classroom by watching what others were doing in the classroom. Randi made a comment along these lines, saying, “...while you’re watching [other teachers], it’s impossible not to compare yourself, and I think that’s kind of the point.”

Two GMTAs mentioned that just watching what others wrote on the board and noticing the size and neatness or sloppiness of another’s handwriting made them rethink how they handled their board work. Cathy said, “I learned a lot about board work from my observations of other teachers. Um, because some people that I went to had way worse board work than I did and other people had really awesome board work.”

Only one of the eight GMTAs indicated that observations didn’t affect their teaching, saying, “I just kept teaching the way I had....I didn’t really take anything from anybody else and use it in my class really.” Additional comments from this individual suggest that he was “comfortable” with his teaching and didn’t feel he needed to change anything.

Observation Reflection Form: This form was designed for GMTAs in the observation group to fill out as they were observing classrooms. This instrument served three purposes: to document the general strategies observed, to document specific 2008 workshop strategies (e.g. formative assessment, questioning techniques, active

learning), to document the observer's reflection on what he or she observed to help integrate into his or her own teaching. In general, it served as a tool for focusing participants on specific outcomes. Each GMTA filled out five forms for a total of 40 forms. The following analysis will shed light onto what GMTAs observed, and more importantly, how they perceived the value of what they observed in the classroom.

The observation forms supported similar connections with what was said in the interviews. When describing the techniques teachers were using, 16 comments were made regarding how the teacher asked good questions, with every GMTA making at least one comment. Eight comments were made regarding the teacher's board work, and six comments were made concerning the use of a lecture format. GMTAs also made comments on how teachers engaged students (6), gave clear explanations (5), called on students by name (4), were enthusiastic (4), and had humor (3).

From this information, it is evident that GMTAs were observant of the way in which teachers asked questions. They were also concerned with the teacher's board work, perhaps because they were reflecting on how their own board work was viewed by students. It seems GMTAs were also more aware when a teacher relied solely on lecturing, possibly due to the effect of the active learning seminar, which focused on student engagement. Other references that help paint a picture of this group's view of effective teaching include: engages students, gives clear explanations, calls on students by name, is enthusiastic, and displays humor.

When participants were asked to document formative assessment, questioning techniques, and active learning, a glimpse into their perception of teachers' uses of these ideas came through. From their comments regarding formative assessment, it is evident there were some misconceptions about its nature and use. Eleven comments about formative assessment referenced the teacher asking general questions such as "Are you with me?" with four GMTAs claiming the question "Does that make sense?" served as formative assessment.

More attention, it seems, was spent on observing questioning techniques. Five comments were made regarding a teacher's good use of wait time with five other comments noting a complete absence of wait time. Evidently, the idea of wait time was valuable to these GMTAs. The level of questions asked was also addressed, with thirteen comments made on a teacher's use of low-level questions and seven comments made on a teacher's use of upper-level questions. A few GMTAs added that the teacher requested "answers with reasons." Eight comments were also made on the typical question being of a "chorus" type and not directed at any one student.

The observation group identified active learning primarily as the teacher engaging their students through student-led problem solving. Five of the GMTAs made such comments with ten total comments made. Three mentioned that the teacher they watched used the think-pair-share technique.

In reflecting on what they learned from their observations, six made comments concerning asking better questions and giving more wait time, and five talked about

improving their board work. Five also mentioned wanting to try to be more energetic when they were teaching.

In summary, the observation reflection form responses support the interview comments made by the observation group about the value they placed on questions in the classroom. The form also shed light on some misconceptions GMTAs had with formative assessment and the value they placed on teachers having clear explanations, good board work, and attempting to engage their students.

Teacher Confidence Inventory: A Wilcoxon signed ranks test was run on items in this inventory to test for changes in confidence over the four weeks of the Phase 2 treatment period. The observation group had a statistically significant increase ($p < .05$) in confidence on three items: (1) the mathematics they teach, (2) their use of questioning techniques, and (3) teaching in general.

The change in confidence in questioning is possibly due to the significance most participants placed on questioning and their ability to observe questioning in the classroom. A few GMTAs remarked that some of the teachers they watched lacked effective questioning and it was noticeable in the classroom. Michelle said, "In particular I saw, I think, one or two people that I, I know for sure asked bad questions with no wait time and I also saw people that were asking really good questions, and so I saw the value questions had."

A possible explanation for increased confidence on the first and third items is due to the combined effects of a month more of teaching experience and the

observation of others. In the Observation Survey, some GMTAs indicated they felt like they were doing a poor job teaching until they saw similar teaching by their peers. In particular, Kalen said, "... [W]atching other GMTAs sort of let me know that I wasn't as bad as I thought."

RTOP: A Wilcoxon signed ranks test was conducted to see if the GMTAs in the observation group had significant changes on RTOP items during Phase 2. The difference in RTOP item scores from October to November were used for the test. There were no statistically significant differences on any RTOP items or cumulative score.

Peer Coaching

The peer coaching group consisted of 10 GMTAs in five groups of two. Since the coaching experience of each pair was different, they will be analyzed separately. The GMTAs were paired as follows: Ken and Frank, Simon and Amy, Earl and Andy, Allyson and James, and Pam and Corinne. The main measure of the coaching experience came from the Coaching Reflection Instrument (CRI), which was filled out by both coach and teacher following each post-conference. The Coaching Impact Inventory was used to measure the perceived impact of coaching on each participant. Similar to the observation group, they also completed the Teacher Confidence Inventory before and after Phase 2 and completed the Coaching Survey. Finally, participant's reactions to coaching were gathered during the December interview.

The analysis of the coaching data will begin with a synopsis of the participants' comments from the interviews. Following this, a short quantitative analysis of changes on the Teacher Confidence Inventory and the RTOP will be examined. Finally, the five coaching pairs will be analyzed in depth.

Interview Synthesis: Similar to the observation group, nine of the ten coaching participants made a comment either in their interview or on their Coaching Survey how watching their coaching partner was helpful to them. Pam said, "...it's really easy to pick out the good qualities from someone else's teaching that you don't have and say, okay, let's try to work on those."

However, only two of the ten coaching participants commented on the helpfulness of the discussion involved with coaching (the pre- and post-conferences). Andy said, "Just being able to talk about classroom goals. Most of the time it was just that someone was there to listen. I was thinking of my own goals, things that I would want to achieve. And we came up with a couple of goals, most of them were pretty long-term, and so we worked toward that."

Regarding the effect coaching had on the implementation of strategies learned in the workshop, only three of the ten coaching participants made any comment. Allyson said, "Being coached helped me plan a better lecture, as I worked harder to implement some of these techniques. Coaching helped as I was able to see [James] try some of these strategies and see which ones were successful and which weren't and why." Amy also commented that "It has shown me to use [strategies] more often. The

class I watched didn't really use them and as an observer, I had no clue if the students understood the concepts."

Interestingly, every member of the coaching group made some type of negative comment related to coaching. There were three recurring comments: it didn't help as much as I would have hoped, it took a lot of time and paperwork, and it might have been more beneficial if it was not a peer but more of a mentor relationship. These comments are more thoroughly discussed in the analysis of the coaching pairs, starting on page 145.

Teacher Confidence Inventory: A Wilcoxon signed ranks test was run on the Teacher Confidence Inventory items to test for changes in confidence following Phase 2. The peer coaching group had a statistically significant increase ($p < .05$) in confidence on four items: (1) the mathematics they teach, (2) lesson planning, (3) encouraging student participation, and (4) teaching in general.

The change in confidence with planning lessons is possibly related to GMTAs working with their partner in planning lessons together during the coaching process and reflecting on what makes an effective lesson in their coaching sessions. Allyson said "It helped to see somebody else teaching the same lesson; that was useful. Especially because I would watch his lecture before I went to mine so I could kind of see how the lesson went and change accordingly." Pam also commented that she worked on lesson planning with her partner Corinne.

The increase in confidence in encouraging student participation is harder to decode. In the interviews, only one GMTA, Allyson, mentioned student participation. She said, "...now I'm thinking about how they're receiving it and how I can get them to participate in the lesson." However, it is not clear from the context whether this quote addressed the coaching experience, the workshop, or a combination of the two. It is possible that when coaching, the coach noticed a lack of student involvement in her or his partner's classroom and discussed with her or his partner ways to make class more exciting by getting the students more involved. It is possible though that this increase is due to a connection with lesson planning. More student participation was possible due to a GMTA planning for more student participation in their lesson.

As with the observation group, a possible explanation for the increase in confidence in the mathematics taught and teaching in general are due to a combination of a month more of teaching experience and the observation of their coaching partner. In the Coaching Survey, GMTAs indicated that watching their peer helped to improve their confidence. Ken said, "[Coaching] has let me see that I am not very different from my peer and that improves my confidence." Pam also talked about an increase in confidence, "[Coaching] gave me more confidence by showing me other GMTAs have the same struggles. Watching another GMTA's classroom and seeing her lesson plans really gave me ideas."

RTOP: A Wilcoxon signed rank test was conducted to see if the GMTAs in the coaching group had significant changes on RTOP items during Phase 2. Differences in

RTOP item scores from October to November were tested. Item 2, “The lesson was designed to engage students as members of a learning community,” had a statistically significant increase ($p = .034$). This evidence helps to validate the reported increase in confidence on lesson plans.

Analysis of Peer Coaching Pairs

The following five coaching pairs are presented in order from what seems to have been the worst experience to the best experience with peer coaching. Each coaching experience was different and fell into categories almost directly corresponding to a bad, poor, moderate, good, and great experience. A possible explanation for each pair’s experience is mentioned following a description of their experience.

The Coaching Reflection Instrument (CRI) is frequently referenced; a copy of the version for coaches (CRI-C) is available in Appendix G and the version for teachers (CRI-T) in Appendix H. The CRI contains both relationship items and content items, the “relationship items” refer to questions 1-6 on the CRI and while the “content items” refer to questions 7-13 on the CRI. Each time a class was observed by a coach two CRI’s would be filled out, one by the coach and one by the teacher. Upon switching roles, another two forms would be filled out for a total of four forms per week.

Ken and Frank: Ken and Frank were both teaching Survey of Calculus and had six years and two years of university teaching experience, respectively. They did not get to choose their partner but were assigned together as a pair.

As coach, Ken mentioned a few things in his first CRI-C that he discussed with his partner, saying he saw approximately half the class arriving fifteen minutes late and leaving early, and saying he gave encouragement to Frank who thought a particular example he gave was "...a bad one." However, Ken also noticed a number of issues with his partner that he did not mention to Frank: "Mathematically unclear, or apparently inaccurate, board work, body language, etc., but I felt I should not mention any of it." Ken went on to say, "Not much to work with when the teacher does not ask for info. Socially it would be very awkward to offer info." In setting goals for their next meeting, Ken asked his partner and was told "None" and no plans were discussed for their next meeting.

When the roles were reversed, Ken was still bothered by his partner's lack of willingness to discuss his teaching. He mentioned on his CRI-T that "This [coaching] technique requires that both coach and teacher have the self-confidence to hear constructive criticism. This is a potential difficulty for this method if the teacher does not 'see' any areas which need improvement." As the coach, Frank mentioned that he only discussed "Moving to the side when pointing things out" with Ken.

In filling out the CRI relationship items the first time, Ken, as the coach, disagreed with almost every item, indicating he felt Frank was not open to discussion or criticism, or willing to reflect on his practice and that Frank did not value his input. This indicates Ken felt his relationship and communication with Frank was very poor. On the other hand, Frank, as the teacher agreed with almost every item, feeling he was

comfortable communicating with Ken and valued his input. After the first meeting, both always indicated an “Agree” or “Strongly Agree” on all six of the relationship items.

From the information given on all four sets of both Ken’s and Frank’s CRI forms, no goals, objectives, or plans for the next visit were ever made. The main topics they discussed consisted of content like exponential and logarithmic equations and optimization problems. In filling out the discussion items, they differed wildly regarding what content was discussed. The pre-observation and post-observation conferences were both consistently twenty minutes in length except the final post-observation conference where they did not meet. They were the only group not to meet for a final post-observation conference.

On the CRI content items, there was little agreement between Ken and Frank on the extent items were discussed with no item being discussed to a great extent. Frank perceived almost no impact on his teaching practice from the coaching, and Ken felt his coaching had no impact on Frank. Frank’s perceived confidence was down two points in active learning. Ken’s confidence was down for both of these items. In fact, Ken had the largest decrease in confidence in the study. Frank was the only other GMTA to show a decrease in confidence.

On the Coaching Survey, a question asked “How has coaching someone else influenced your teaching?” Frank said, “It gave me a new perspective on ideas and how to present them. However, I could have got this from just watching someone teach.” Ken said, “It has let me see that I am not very different from my peer (and he isn’t doing

anything I wouldn't) and that improves my confidence." In terms of coaching influencing the use of strategies learned in the workshop, Frank indicated coaching helped "Not at all." Ken indicated similarly, "Coaching has not influenced these strategies."

The interviews supported this data. Frank felt the coaching would have been more useful if his partner wasn't another graduate student who was as equally busy as him, saying the reason it didn't impact him was "...mainly the fact that it was me and [Ken] working together and we both, you know, had a lot of stuff to do and it's not like we had a whole lot of time to do it, so, going over each other's lecture was about all we really had time for." Ken indicated he liked a few features of the coaching:

...it was nice to have someone to talk with, a colleague, and say this is how this is going, what are you doing? We were lecturing out of the same text; we were on the same section, so that was beneficial. Therefore the student population that we were sampling from was roughly the same. That was about it.

Still, he felt it was difficult to give feedback since his partner was a peer, feeling a mentorship would have been more beneficial:

It would be completely inappropriate for me, if someone doesn't ask the question 'What do you think I could do better,' to suggest corrections. No matter how thoughtful I might phrase them they could easily be viewed as you suck and destroy the dynamic that we have because we are on the same social ladder. A mentor could just say, you need to work on this, and then they would, because they're not peers. Even if they're a really hyper-sensitive person, they're still being told by this person who has their Ph.D. and has been teaching maybe as long as this other person has been alive.

In summary, the coaching partnership between Ken and Frank was hindered for two reasons: time-constraints and a relative lack of feedback/discussion. Their first meeting set the tone for their experience; Ken wanted to give feedback but Frank didn't "see any areas which need[ed] improvement." Since Frank would not ask for feedback and Ken believed he lacked the authority to give feedback without cue—feeling his comments would hurt their social relationship—this led to very little discussion between the pair with virtually no reflection. Compounding this issue was the fact that Frank felt that Ken was too busy to participate. From their Coaching Impact Inventory they both agreed the coaching experience had virtually no impact on their instruction. Overall, the coaching arrangement between Frank and Ken was not productive.

Simon and Amy: Simon and Amy were both teaching Liberal Arts Mathematics. Simon had no prior teaching experience, and Amy was an assistant TA for two semesters as an undergrad. They did not get to choose their partner. Additionally, since both taught a class that met only twice a week, their classes were 75 minutes long. Therefore, to keep the total time commitment similar to the other participants, they only met three times for coaching.

In their coaching sessions they talked about the goals of their lecture for that day, including avoiding mannerisms like having a "hand in pocket" or saying "that was easy," and attempting to "be excited" about the material. The CRI relationship items indicated they both had a good working relationship with each other. Both their pre and post conference meeting times averaged ten minutes.

On the CRI content items there was a relative agreement between the pair on the degree to which the items were discussed, though no item was discussed to a great extent. In the December interview, when Amy was asked to what extent coaching impacted her teaching practice she answered, "It affected [it] more than the seminar stuff, ...[but] nothing to do with confidence, ...more just showing up with the right attitude every day." Simon perceived his confidence changed very little.

In the interview, both mentioned how valuable the observation part of coaching was to them. Amy said, "I was in the coaching group, and it was just nice to see somebody else teach." She later remarked, "I kind of would have liked to see more people teach too." Simon made the comment that

Coaching for me was primarily observing, so observing might have been a better choice for me. But, I mean, when I see what they're doing wrong through the observations, I was coaching them, but in a sense when I told them what they were doing wrong, I'm really thinking about all of things I could improve also...[so] I was actually kind of coaching myself.

Apparently Simon viewed coaching as giving feedback to the teacher by telling them what they were doing wrong.

In summary, Simon and Amy both seemed to be more interested in the ideas of observation than coaching. It seems they mainly discussed upcoming lecture material and concentrated on their level of excitement while teaching and not on any real content or specific teaching technique. Both seemed indifferent to the planning and feedback of the peer coaching experience and therefore might have learned little more than they would have by just observing.

Earl and Andy: Earl and Andy were both teaching Precalculus. Earl had no prior teaching experience and Andy had a degree in mathematics education and had student teaching experience. They were able to select their partner.

When Earl and Andy met for their pre and post conference they discussed the same topics, goals, and plans whether they were acting as teacher or coach. The CRI content items (7-13) verified this as they were quite similar across the four forms. Most of their time was spent discussing ways to improve their classroom culture, with both of them marking "To a great extent" on all but one of their CRI forms. Both their pre and post conference meeting times averaged sixteen minutes. The CRI relationship items indicated they both had a good working relationship with each other.

On the CRI content items there was relative agreements between the pair on the degree items were discussed and both agreed the two items classroom culture and goals and objectives were discussed most, though there was a great variety of discussion. Andy perceived the most impact on his teaching in the areas of active learning, questioning techniques, and classroom culture, but Earl perceived his coaching impacted active learning and classroom culture the most. Earl did not indicate his coaching impacted Andy's teaching in terms of questioning techniques. It is possible that Andy's gain on this item was not from the coaching he received, but rather from observation of Earl's classroom. Perhaps Earl's good (or poor) demonstration of questioning in his classroom influenced Andy to improve upon his use of questioning.

Earl did not perceive much impact on his teaching from Andy's coaching, indicating only a moderate impact on active learning. Andy agreed with this, though felt his coaching greatly impacted most of the other items as well. Earl indicated a two point jump in confidence in encouraging student participation and creating an environment where students listen to one another. In the interview, Earl did not perceive this change came from coaching; perhaps observing Andy's classroom encouraged Earl to better his classroom culture.

The interviews revealed that Earl felt better about making mistakes after seeing his partner make them in his classroom: "I'd see [Andy] make a mistake, and I'm like well, everyone makes mistakes...so [then] I wouldn't hang up on my mistakes." Both enjoyed observing the other's classroom. Andy commented: "...it was also helpful to watch somebody else's class, cause sometimes I could see things that I really liked about that class, and other times I would think, oh, I wouldn't want to do it that way, I would want to do this a little bit differently. And that helped." Still, Earl felt "...the coaching thing was unnecessary. So I got the thing from watching Andy, but as far as us coming together, what should we do next week, blah, blah, blah, that I didn't get too much out of." Andy had similar views and felt like coaching took a lot of time:

The coaching wasn't as helpful as it could have been. I felt like the time requirement was compounded by the issue of having two GMTAs work at the same time, and so we didn't feel like we could put as much effort as we probably should have into the coaching and into the observing. So that ended up not helping as much as I think they or I would have wanted it to.

Andy had an additional concern with his partner:

I really feel that it might have been more beneficial if it was not a peer. ... I've had lots of [teaching] experience and it felt like he didn't have any experience, and he didn't have any experience before this. So, I don't know if he even knew what to look for. ... It's just an experience thing. So maybe pairing students with peers, I mean peers by definition, someone who actually is on your level in the particular area that you were at.

Similar to Ken's feeling of not having enough authority to give feedback, Andy felt Earl's lack of experience didn't give him the authority to give feedback because he didn't know "...what to look for." Though Andy claimed to still "respect" the feedback he received, his view on this possibly affected the coaching relationship he had with Earl.

Allyson and James: Allyson and James were both teaching Precalculus and had no prior teaching experience. They were able to select their peer coaching partner. The CRI relationship items indicated they had a good working relationship with each other. Their average pre-conference meeting time was ten minutes with an average of fifteen minutes spent on their post-conference.

On the Coaching Survey, Allyson said "Being coached helped me feel more confident in my lesson plan and how I delivered it. Talking through my lecture before I gave it, improved the quality of my lesson as I thought about it for awhile again right before." Also, she felt that "Helping coach someone else was helpful as I watched the same lecture I was going to teach be taught in a different way. It helped to see another way to teach the same material and helped to think of ways [James] could improve, and

thus how I could improve.” In the December interview, she made a similar comment: “It helped to see somebody else teaching the same lesson; that was useful. Um, especially because I would watch his lecture before I went to mine so I could kind of see how the lesson went and change accordingly.”

On the CRI content items there was a perfect agreement between the pair on the degree items were discussed. This likely indicates they filled out these forms together. Most of the items were discussed at some point during the four coaching sessions, though the most time was spent on classroom culture. Allyson indicated she felt her classroom culture was strongly impacted by coaching, though she also indicated a large impact on active learning and questioning techniques as well. James indicated his coaching had a similar impact on her teaching in these areas. Her slight increase in confidence on lesson planning provides some evidence to support her interview statement. Allyson had a large increase in confidence in active learning.

When the roles were reversed, Allyson worked with James on students’ difficulty with content such as inequalities and absolute values, logarithms, and trigonometric functions. She addressed this by encouraging his use of formative assessment to immediately gauge students’ understanding of the topics. She also encouraged James to involve his class more by using active learning techniques and to work on his neatness of his board work.

In the interviews, both indicated that coaching took a lot of time. James said, “...the coaching thing was a good idea, but there was a lot of forms to fill out and it was

hard to meet consistently to do like a pre-conference, and a post-conference.” Later he added:

There’s not much time, cause it’s grad school and you’re usually really busy, so it’s hard to consistently get a good like 10 or 15 minute pre-conference in and a good 10 or 15 minute post-conference in and then also fill out the front and backs of two separate forms and write lots of stuff.

When asked what she didn’t enjoy about the workshop, Allyson said, “It was a lot of hours, that’s, I think, the only thing. A lot of time and paperwork at the end, for the coaching.”

In summary, Allyson and James were one of the three pairs that had some choice with whom they were able to pair. They perceived the coaching experience had the biggest impact on their lesson planning, questioning, and classroom culture. Allyson felt she gained the most from watching the same lecture she was going to teach and then changing hers based on that classes’ understanding of it. Overall, their coaching arrangement was adequate, though they both thought it took a lot of time.

Pam and Corinne: Pam and Corinne were both teaching Precalculus. Pam had taught College Algebra once before and Corinne had a degree in Mathematics Education plus a year of classroom experience in junior high school. They were able to select their peer coaching partner. Both indicated they’d rather work with someone else than work alone.

The main discussion point for this pair was on students’ difficulty with content and concepts. When acting as coach, both discussed how well students understood the

material presented by the instructor. When Corinne was coach, she took detailed notes of Pam's lecture and discussed these with her in the post-conference, mainly discussing small mistakes made in the lesson, but also how the students' handled the content. This in turn helped Corinne, who taught later in the day, to decide which topics to spend more time on and what questions to ask to root out misconceptions. Pam, as coach, helped her construct these questions, and during the post-conference they discussed how the students handled the content. They met for an average of eight minutes for their pre-conference and twelve minutes for their post-conference.

On the CRI content items there was relative agreement between the pair on the degree items were discussed and both agreed the items most discussed were active learning, questioning techniques, classroom culture, and goals and objectives set with the coach. Corinne felt Pam's coaching had a large impact on her teaching on all these items. Pam also perceived this impact on Corinne's teaching. Corinne's confidence was up on every item, and increased two points on both active learning and questioning techniques. In the December interview, Corinne mentioned she felt coaching helped her most with questioning. This data provides evidence validating her statement.

Pam felt the goals and objectives she set with Corinne as her coach had a large impact on her teaching. Corinne also perceived this impact. Pam's confidence was up on every item, and increased two points on both items relating to classroom culture. Pam felt a large impact from coaching on classroom management and lesson implementation. Corinne felt her coaching had a small impact on classroom

management, but a large impact on lesson implementation. A possible explanation for the discrepancy in classroom management ratings comes from Pam in the December interview. When asked to what extent coaching impacted her teaching, she responded: “[it] impacted a lot in the sense that...just sitting in on one of [my coach’s] classes was like, whoa. She uses her time so much more efficiently than I do in the classroom...I thought, whoa, I need to start doing this.” She went on to say, “I mean, a lot of it is just seeing someone else teach, and taking all of their good qualities out and trying to implement them.” Thus Pam’s observance of Corinne’s classroom possibly benefited her own classroom management.

In summary, Pam and Corinne had an excellent coaching experience. This is likely to do with the fact that they both wanted to improve their teaching and were both willing to participate in coaching to achieve that goal. Corinne was the only coach to take detailed notes of Pam’s lectures. These notes focused on specific points of the lecture the coach felt might be unclear to the students. They served as a solid point for discussion to help Pam with her teaching.

Individual 2008 GMTA Summary

For each GMTA from 2008, a brief description of their teaching experience, career goal, class they were teaching, and degree they were pursuing are presented. The December and April interview data is presented next in order to provide a description of their perceived change in teaching. Following that, their RTOP scores and videotape coding analysis are presented to provide evidence of an actual change.

Finally, what they perceived changed in their teaching is connected to what actually changed and conclusions are drawn regarding the impact of the workshop on their teaching practice.

- Aiken: Aiken had no prior teaching experience and was teaching College Algebra. He was pursuing a Master's degree in Mathematics and upon completion hoped to work in academia doing both teaching and research. In the December interview, Aiken said he felt the workshop really provided a lot of useful techniques and claimed that using these techniques accounted for a big difference in his students' grades. When asked what workshop content was most beneficial to his teaching, he said, "...the third [seminar], active learning. Active learning is important, [one] cannot learn math passively...you have to be able to think, and to develop mathematical thinking you have to be able to think mathematically—to learn by doing. So active learning, I would argue, is the only way to learn math." He also felt active learning had the biggest impact on his teaching. He thought observing other teachers was incredibly useful because he could see how others handled their classroom. He admitted to reflecting often in his teaching, and attributes this reflection to his growth as a teacher. He considered the workshop very valuable. In the April interview, he felt much the same saying he constantly reflected on his teaching and still was using the techniques he learned.

Aiken showed considerable growth in his modified RTOP score with a 14 point increase, the largest in the study. Though his videotape analysis indicated no change in his number of open-ended or high-level questions, his class time spent in active learning increased dramatically from zero to 18.5% and then to 39.7% during his last taping. His mentioning of active learning in his interview, along with the large increases in his use of active learning and growth of his RTOP score provide strong evidence that Aiken's teaching practice was impacted by the workshop.

- Allyson: Allyson had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Ecological and Environmental Statistics and upon completion hoped to get a Ph.D. in Statistics and then go on to do research and teach. In the December interview, Allyson said she felt the workshop helped her to go from just presenting the material to thinking about how the students were receiving the material. She also reflected about how she could get students to better participate in the lesson by using active learning, feeling it was the most beneficial workshop content. She thought watching another teacher teach the same lesson was the most useful part of coaching, not having discussions. She was one of two GMTAs to comment on the usefulness of watching a videotape of her teaching. In the April interview, she felt the workshop made her more aware of what she was doing and that helped her to teach better.

Allyson's modified RTOP score showed little change over the three tapes. However, her videotape coding analysis did indicate some change on her last taping. She asked about 10 open-ended questions per hour, up from zero on the previous two tapes, and her class time spent in active learning increased from zero time spent to almost 29%. Still, she had the highest incidence of rhetorical questions of anyone in the study asking roughly 60 per hour on all three tapes. She did significantly cut her number of questions aimed at chorus response from roughly 50 to 20 questions per hour, which, in turn, raised her number of volunteer questions from 40 to 65 per hour. On the Teacher Confidence Inventory, she indicated her confidence with active learning increased from a "1" to a "4" during Phase 2. In addition, the interview data indicates Allyson believed her teaching was impacted through active learning and the videotape analysis indicated a large increase in time spent in active learning. This data provides evidence that the workshop had an impact on Allyson's teaching practice.

- Amy: Amy was an assistant TA for two semesters as an undergrad and was teaching Liberal Arts Mathematics. She was pursuing a Master's degree in Mathematics and upon completion hoped to get a job outside of academia not teaching. In the December interview, she expressed liking the time allotted at the beginning of each seminar for open discussion and enjoyed working with her fellow GMTAs. She was the only 2008 participant to make a negative comment

about the questioning seminar, feeling it was something she was already good at. When asked what the most beneficial workshop content was, she said active learning was her *favorite*. She felt the observation part of coaching helped her to see what happens in another's classroom and that made her feel more comfortable in her classroom. However, she felt she gained nothing through the discussions involved with coaching. In the April interview, she said it was fun to go watch another teach.

Amy's modified RTOP score stayed consistent throughout the three tapings. Her videotape analysis indicated that she asked roughly the same number and type of questions, though she did not ask any high-level questions, she did ask around 6 open-ended questions per hour. She spent roughly 10% of each class in active learning. Only the December interview indicates she believed her teaching was impacted. The data indicates Amy's teaching remained consistent and provides no evidence that Amy's teaching practice was impacted by the workshop.

- Andy: Andy had a Bachelor's degree in Mathematics Education and had student teaching experience. He was pursuing a Master's degree in Mathematics and upon graduating hoped to become a high school teacher or continue on to get his Ph.D. in Mathematics Education. He was teaching Precalculus. In the December interview, Andy said he felt the workshop took a lot of time and was sometimes helpful and sometimes a burden. He stated that the workshop

definitely made him think about the way he questioned his class and felt his teaching changed in that regard. He also felt the questioning seminar had the biggest impact on his teaching. He thought coaching would have been better as a mentoring process instead of with a peer, because a mentor is much more knowledgeable about teaching. He did feel that the observation that went along with coaching was very helpful. In the April interview, he felt that the workshop helped him think more about how he asked questions.

Andy's modified RTOP score varied more than any other participant. This is possibly due to his varying the level of student involvement depending on the amount of time he had for the lesson and the amount of material he had to cover. The videotape analysis supports the variation in his RTOP score as it also had a similar variation. There was no indication of a prolonged change in the number of high-level or open-ended questions he asked. He perceived large increases (3 points) in his confidence in both creating an environment where students listen to one another and engaging his students in classroom discussion, but no other data supported this change. Likewise although he felt the way he asked questions was impacted, there was no data to support this change. Only the December interview and the two confidence items indicate he believed his teaching was impacted. Thus the data provides no evidence that Andy's teaching practice was impacted by the workshop.

- Bob: Bob was an experienced instructor with three years of university teaching experience. He was pursuing a Ph.D. in Statistics and upon finishing his degree hoped to get a job allowing him to both teach and do some research. He was teaching Elementary Statistics. In the December interview, Bob said he felt the workshop was very valuable to new GMTAs, and he enjoyed his interaction with them in the workshop. He felt that observation was the most valuable aspect of the workshop and affected his teaching the most. He commented that he liked using the pause procedure because it gave students time to “gather their thoughts.” He’d like it if more content was presented before the school year started, but still wanted the workshop to continue during the school year as he feels it was equally important to talk about issues as they came up in one’s classroom. In the April interview, he again mentioned using the pause procedure and also felt he was a better teacher this semester because the workshop helped him to reflect and made him realize that he could be a better teacher.

Analysis of Bob’s three videotapes indicated that his modified RTOP score remained steady over the workshop period. The videotape analysis indicated that he asked continually more open-ended and high-level questions over the three tapes, with both up from zero to around 4 questions per hour. Active learning steadily increased from zero to 6.3% of class time. He also showed use of the pause procedure on the last two tapes. Though his RTOP score remained

steady, the interview data indicates Bob believed his teaching was impacted through active learning and the videotape analysis indicated clear change in his active learning usage. This data provides evidence that the workshop had some impact on Bob's teaching practice.

- Cathy: Cathy had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Ecological and Environmental Statistics, and upon finishing hoped to work outside of academia. In the December interview, Cathy said she felt the workshop helped her teaching by giving her "skills and ideas." She appreciated working with her fellow GMTAs and learning from them. She mentioned that when she watched her first videotape she felt she asked a lot of rhetorical questions, and so made an effort to change this aspect of her teaching. She said the most beneficial workshop content was questioning techniques "because I never really thought about how the questions that you ask your students can really help them learn." She felt observation helped her most in her board work. In the April interview, she discussed the usefulness of the workshop in helping her to reflect on her teaching through providing useful techniques.

Her modified RTOP score indicated continued improvement over the workshop period. The videotape analysis indicated that though she asked no high-level questions, she did ask roughly 5 open-ended questions per hour on her last two tapes. Moreover, the number of rhetorical questions Cathy asked

per hour was cut in half over the workshop time period. This supports her feeling that she reduced the number of rhetorical questions she asked. This provides some evidence that Cathy's teaching practice was impacted by the workshop.

- Corinne: Corinne had a Bachelor's degree in Mathematics Education and had taught one year of junior high school. She was pursuing a Master's degree in Mathematics and upon finishing hoped to either get a Ph.D. in Mathematics Education or teach at the secondary level. She was teaching Precalculus. In the December interview, Corinne said she felt the workshop was very beneficial to new GMTAs, but was also a good review for her. Questioning techniques stood out as the most beneficial technique presented because she felt she was weakest in that area. She felt coaching helped her to develop her questioning skills, and the observation involved with coaching was equally useful to how she ran her class. In the April interview, she mentioned still using the pause procedure but also felt she got the most out of the workshop because of the social network she built with her peers.

Corinne's modified RTOP score remained the same from September to October, but increased 10 points after the coaching period. The videotape analysis indicated that her questioning and active involvement of students was considerably impacted. The number of low-level questions she asked decreased from 77 per hour to 37 per hour while high-level questions increased from zero

to 11.6 per hour. Likewise the number of closed questions decreased from 77 per hour to 26 per hour while open-ended questions increased from zero to 23.3 per hour. She asked more open-ended and high-level questions than anyone in the study. Additionally, the percentage of class time spent with active learning increased from 2.7% to 20.7%. The data provides evidence that Corinne's teaching practice was impacted by the workshop.

- Dave: Dave had no prior teaching experience, and was pursuing a Master's degree in Statistics. Upon completion of his degree he was hoping to pursue a career outside of teaching. He was teaching College Algebra. In the December interview, Dave said he took very little from the workshop. According to him, his only highlight was discussion with his fellow GMTAs. He thought the workshop took too long and could have been condensed. He felt his teaching assistantship was a means to end—he simply did it because he was being paid a stipend and receiving a tuition waiver. He felt his teaching was good enough to not lose his assistantship and made no effort to improve or change. In the April interview, he still appreciated having had interacted with his fellow GMTAs.

Dave's modified RTOP score stayed consistently low throughout the study; he was in the bottom 10% of the 2008 GMTAs. The videotape analysis was consistent with this as he asked roughly the same number of volunteer and rhetorical questions throughout the study with no high-level or open-ended questions. There was also no indication of active learning. The data provides no

evidence of an impact on Dave's teaching practice from the workshop, though possibly some affect on him through enabling socialization.

- Earl: Earl had no prior teaching experience and was teaching Precalculus. He was pursuing a Master's degree in Mathematics and upon completion hoped to work in a job outside of academia, not teaching. In the December interview, Earl said he appreciated getting to know other GMTAs, but felt the workshop took up too much time. The seminar on questioning techniques made him think about his questioning, though only a little. He felt that the observation during coaching increased his confidence because he learned it was okay to make mistakes, though he felt coaching was unnecessary. He felt the workshop was pushing him to get a degree in Mathematics Education instead of Mathematics, and felt his time would have been better spent in another Mathematics class instead of the workshop. In the April interview, he mentioned that it caused him to think about his teaching, but also that it was a huge time constraint.

Earl's modified RTOP score stayed consistent throughout the study. His videotape analysis was similar, with the only change in adding a few open-ended questions in his last two tapings. The data provides no evidence of an impact on Earl's teaching practice from the workshop.

- Frank: Frank had two years of university teaching experience and was pursuing a Ph.D. in Mathematics. Upon completion of his degree he was hoping to get a job in academia doing research with some teaching as long as it was higher-level

classes. He was teaching Survey of Calculus. In the December interview, Frank expressed the most negative comments about the workshop feeling it would be good for new GMTAs but not for someone with experience since it's "not going to change the way you teach." He specifically mentioned not using high-level questions as it would be over the student's head anyway. He felt coaching was not useful because of a lack of time and felt his partner was not really into it. In the April interview, he still felt the workshop had no impact on his teaching.

Frank's modified RTOP score remained consistently low throughout the study; he was in the bottom 10% of the 2008 GMTAs. He asked the second least number of questions of the 2008 GMTAs, averaging only 15 volunteer questions per hour. His active learning time increased from 3.3% in September to averaging about 17% after the workshop, though he still did not ask for student input. Strangely his perceived confidence with active learning dropped two points during Phase 2. The videotape analysis suggests that Frank increased his use of active learning following Phase 1, but the interview indicates he felt he did not change. Thus there is some evidence to suggest an impact on Frank's teaching practice, though he did not express any change.

- James: James had no prior teaching experience and was teaching Precalculus. He was pursuing a Master's degree in Mathematics and upon finishing hoped to work in academia doing research and some teaching. In the December interview, he expressed appreciation for the workshop offering him ideas about

how to teach and felt the techniques discussed were important. He felt the ideas of questioning techniques and active learning were the most beneficial, though he had particular difficulty with formative assessment feeling it “didn’t work out.” He also felt that the paper work involved with coaching took a long time to complete, though he felt the observation of another peer teaching was helpful. In the April interview, he made three comments about how much the workshop influenced him to think more about his teaching.

The modified RTOP indicated that James showed consistent improvement. The videotape analysis shows drastic changes in James’s teaching over the workshop timeframe. Originally he asked roughly 69 rhetorical questions per hour, but on the second videotape he asked 26 per hour and on the third, only three. He also increased the number of open-ended questions (1.3 to 12.6) he asked and asked slightly more higher-ordered questions (1.3 to 3.4). His usage of active learning was up from 1.3% to 12.6%. Both James’s declaration of benefit from questioning techniques and active learning and his considerable growth in those areas provide strong evidence that his teaching practice was impacted by the workshop.

- Kalen: Kalen had no prior teaching experience and was teaching Survey of Calculus. He was pursuing a Master’s degree in Ecological and Environmental Statistics and upon finishing hoped to pursue a career outside of teaching. In the December interview, Kalen said he felt his teaching had changed because of the

workshop. He felt that without the workshop he would have “followed the [lecture] model” that he had seen as an undergrad and “would have been relegated to lecturing.” He especially enjoyed his time in observation because of the opportunity to observe how other instructors asked questions and managed time on homework. He expressed difficulty with utilizing formative assessment and asking high-level questions, though liked having students work together on problems. He also liked that the workshop brought the GMTAs together as a community. In the April interview, he felt the training he received was good but still had difficulty with implementing the ideas in his class.

Kalen’s modified RTOP score increased following the conclusion of the seminars and stayed at that level after the observation period. The videotape analysis indicated that he asked the lowest number of volunteer questions in the study, averaging only 7 per hour. He consistently asked around 30 rhetorical questions per hour and did not ask any open-ended or high-level questions. He did indicate a two point increase in his confidence in asking questions, but the data revealed no change. His active learning time increased from zero in the beginning to around 5% and then 11% for his last taping. Though Kalen’s use of questioning did not change a great deal, he did increase his time spent in active learning, and felt the workshop impacted his teaching. Thus there is some evidence to suggest an impact on his teaching practice.

- Ken: Ken was an experienced instructor with six years of university teaching experience. He was pursuing his Ph.D. in Mathematics and upon graduation planned to pursue a career both teaching and doing research. He was teaching Survey of Calculus. In the December interview, Ken said he appreciated that the workshop allowed him to interact with the GMTAs without experience as he was able to share stories with them about teaching. He thought the workshop was well done and valuable both to him and the inexperienced GMTAs. He had previous TA training, but felt it was worthless, and he learned more from this training. He also felt the workshop helped to remind him of good teaching techniques. He participated in coaching but felt a mentorship would have been better as a mentor had more authority to give feedback than a peer. In the April interview, he expressed asking “Why?” more frequently after student’s responses and felt the workshop made him realize how much he could learn and improve as a teacher.

Ken’s modified RTOP score showed the biggest decrease of anyone in the study, and he also had the biggest decrease in confidence during Phase 2. The most likely causes are an increase in his workload for his own coursework, leaving less time to prepare for teaching, coupled with being consistently behind in class and having to resort to lecturing and leaving less time for exploring. There was no apparent change in his questioning or amount of student involvement, but he did use formative assessment for both assessing students

and having them assess him. Ken's perceived confidence dropped two points for active learning and questioning techniques and three points for formative assessment. The cause of these drops is unknown. The interview data indicates Ken believed his teaching was impacted, but his RTOP and videotape analysis showed little change. There is no evidence to suggest that the workshop had an impact on Ken's teaching practice.

- Larry: Larry had the most teaching experience of anyone with roughly 24 years. He was pursuing a Ph.D. in Statistics and upon completion hoped to continue teaching and maybe do some research. He was teaching Elementary Statistics. In the December interview, he expressed enjoyment for the opportunity to interact and share teaching knowledge with inexperienced GMTAs. He felt the entire workshop was valuable, especially for the new GMTAs. From his teaching experience he knew about all the techniques presented but still felt the seminar on questioning made him think about the way he asked questions. In the April interview, he still felt the workshop helped to remind him of useful techniques and was glad he had attended.

Surprisingly, in light of his past teaching experience, Larry's modified RTOP score increased 13 points during the study. His videotape analysis indicated that his number of open-ended and high-level questions remained about the same, but his active learning time increased slightly from 3% to 5%. He also showed use of formative assessment and the pause procedure. Though

Larry had extensive prior teaching experience, the workshop likely served as a nice refresher course to remind him of some techniques, and his use of these affected his teaching. The data provides some evidence that Larry's teaching practice was impacted by the workshop.

- Michelle: Michelle had a Bachelor's degree in Mathematics Education and had student teaching experience. She was also an undergrad TA for two semesters. She was pursuing a Master's degree in Mathematics and upon completion was hoping to teach at a community college and maybe do some research at a lab in the summertime. She was teaching College Algebra. In the December interview, Michelle said she felt the workshop served as an excellent refresher and said she worked a lot on her questioning. She also felt that observation was helpful to her questioning. She would have liked to see more time spent on lesson planning—mainly for the new GMTAs—and would have liked more assignments and accountability for completing those assignments. In the April interview, she talked about how she discussed teaching with other GMTAs, especially ones teaching the same class as her, and how much it helped her teaching.

Michelle's modified RTOP score was somewhat strange due to her first and last being about the same and the middle near the highest of the study. From watching the tapes, this is likely due to vastly different lessons based on the amount of material to be covered that particular day. Her level and amount of questions remained about the same, but the time spent on active learning

fluctuated with the RTOP score. The data indicates that though Michelle felt some affect on her teaching from the workshop, the videotapes were inconclusive. Therefore, the impact of the workshop on Michelle's teaching is unknown.

- Pam: Pam had some previous teaching experience as she was a GMTA for one semester. She was pursuing a Master's degree in Mathematics but did not plan to pursue a career in academia. She was teaching Precalculus. In the December interview, Pam said she liked getting to know her fellow GMTAs through participation in the workshop and felt that the seminar on questioning techniques had a big impact on her teaching. She indicated she would like more time spent on lesson planning as she felt working with another Precalculus teacher in preparing a lesson plan was a great benefit to her teaching. She used formative assessment to learn about what she could change in her classroom and her students wanted her to spend less time on homework. She solved this problem through discussion with other GMTAs by having students vote on the problems they most wanted her to do. She felt that the discussions during coaching were the most beneficial part of the workshop helping her to improve her questioning and bettering her classroom environment. In the April interview, she felt she was better at evaluating her own teaching through reflection and felt she used more active learning in class.

Pam's modified RTOP improved throughout the study with her final score up 11 points from her first. The videotape analysis supports these findings as the number of chorus questions decreased from 28 to six per hour, and the number of low-level questions decreased while the number of high-level questions increased. The amount of time spent actively involving students showed a slight increase, and time spent on homework was approximately cut in half. She continued to ask roughly the same number of open-ended questions. She had two-point increases in confidence on three items: questioning, encouraging student participation, and creating an environment where students listen to one another. The data provides evidence that Pam's experiences during coaching impacted her teaching practice.

- Randi: Randi had no prior teaching experience and was teaching Precalculus. She was pursuing a Master's degree in Mathematics and upon finishing hoped to enter a career not involved with teaching. In the December interview, Randi said she appreciated the social support of the workshop, and claimed to implement active learning because it got students involved. She tried to implement high-level questions but would not wait long enough for a response and ended up answering them herself. She felt observation helped build her confidence and made her focus on her board work and level of enthusiasm. In the April interview, she felt the workshop helped her by providing techniques she could use in the classroom.

Randi's modified RTOP remained about the same throughout the study.

The videotape analysis indicated that she increased the number of volunteer questions she asked from 36 to 52 questions per hour, while decreasing the number of rhetorical questions from 25 to 10 questions per hour. She never asked a high-level question or more than one open-ended question. In October, she spent about 9% of her time with active learning, though in September and November she did not spend any time. There is no evidence to suggest that the workshop had an impact on Randi's teaching practice.

- Simon: Simon had no prior teaching experience and was teaching Liberal Arts Mathematics. He was pursuing a Master's degree in Mathematics and upon finishing hoped to teach. In the December interview most of his comments were about how observing a peer teaching the same class helped him to see how his teaching looked from a student's perspective. He felt questioning techniques were the most beneficial part of the workshop and had the most impact on his teaching. Though Simon participated in coaching, he felt observing another teacher was more beneficial than the pre and post conference discussions involved with coaching. In the April interview, he felt the workshop helped him think more about his teaching.

Simon's modified RTOP score decreased over the study and the videotape analysis indicated that his teaching changed very little. Though he felt

questioning techniques impacted his teaching, there is no evidence to suggest that the workshop had an impact on Simon's teaching practice.

2008 GMTA Summary: For nine of the 18 GMTAs, there was evidence that their teaching practice was impacted by the workshop. Specifically, these GMTAs perceived that their teaching change (with respect to some workshop strategy) and the video data provided evidence of their perception. Of these nine, seven had both an increase in RTOP scores and an observable change in their usage of active learning or in their use of questioning. For the remaining two, the RTOP failed to show a change, but they perceived an impact and the video data provided evidence of their change.

Of the remaining 9 GMTAs, there was no evidence linking their perceived change to an observed change. Although in the December interview eight of these said the workshop impacted their teaching practice, there was no indication of their perceived change from the data collected. Finally, five of these eight still felt the workshop had impacted their teaching practice in the April interview, but no other data was collected to validate these comments.

Summary of Important Results

Through analyzing the collected data, this chapter has presented several important results.

1. Three components emerged as factors influencing or limiting teaching growth: techniques, experiences, and viewpoint of teaching. Had any component been

lacking, i.e. the workshop not having sufficient techniques, the participants having negative experiences or having negative viewpoints of teaching, the workshop's influence on GMTAs' teaching practices would have been reduced.

2. The data provides evidence that a well-designed teacher training workshop can impact GMTAs' teaching practices. The interviews collected in December of 2008 indicated that 17 GMTAs felt the workshop impacted their teaching practice and specifically commented on a strategy from the workshop that they integrated into their teaching. The detailed comments GMTAs made indicate the effect the techniques presented in the workshop had on their teaching in the short term. In interviews collected in April of 2009, 14 GMTAs felt the workshop impacted their teaching practice and commented on a workshop strategy they were still using. For nine GMTAs, there is evidence to suggest that the workshop impacted their teaching practice. In the interviews, these nine said they perceived a change in the videotapes provided evidence to substantiate their claims. All 18 GMTAs believed the workshop was a valuable use of their time.
3. The comparison of the interview data between the 2007 and 2008 GMTAs was striking. While the 2008 GMTAs frequently articulated reflection on their teaching, the 2007 GMTAs did not. Though the number of GMTAs who perceived the workshop impacted their teaching was similar for both years, 14 of 18 in 2008, and 6 of 8 in 2007, their reasoning behind this impact was different. In 2008, 12 felt the impact was from the techniques and two from socialization,

whereas in 2007, two felt the impact was from techniques, three from socialization, and one from both. Moreover, those 2007 GMTAs who mentioned an impact from techniques did not mention any specific technique by name or description. In contrast, 2008 GMTAs mentioned specific techniques and elaborated on their use in the classroom. The comparison of the November videotapes from both years indicated that only two of the eleven 2007 GMTAs exhibited any use of open-ended questions compared to 12 of the 18 from 2008. Active learning usage was similar with only 3 of the eleven 2007 GMTAs spending class time in active learning compared to 10 of the 18 from 2008.

CHAPTER 5

CONCLUSIONS

Introduction

It was the goal of this study to determine the effectiveness of a teacher training workshop on the teaching practices of participating GMTAs. Secondary to this goal was to determine the effectiveness of peer coaching and observation as a follow-up observation, feedback, and reflection component to GMTA teacher training. Finally, it was hoped the study would shed light onto possible adaptations to K-12 professional development models to work in the GMTA setting.

Specifically, the workshop was designed to help explore four research questions:

1. To what extent can a teacher training workshop impact the teaching practices of GMTAs?
2. To what extent does the 2008 workshop affect GMTA teaching practice compared to the 2007 workshop?
3. To what extent do GMTAs implement the strategies learned in the seminars, and do they continue to implement the strategies in their teaching practice?
4. How does peer coaching compare to classroom observation as an effective follow-up to GMTA training?

This chapter begins by addressing these four research questions. Additional conclusions are then discussed followed by recommendations for future research. Finally, the epilogue brings closure to the work.

Addressing the Research Questions

Research Question 1 – Impact on Teaching Practices

The analysis of the collected data provides evidence that a well-designed teacher training workshop can impact GMTAs' teaching practices. In the December follow-up interviews, 17 of the 18 GMTAs from 2008 felt the workshop impacted their teaching practice. Of these, 13 mentioned some specific technique that they perceived had the most impact, two thought it was the social connection built with peers, one mentioned observation, and one mentioned coaching. In the April interviews, 14 of the 18 GMTAs still felt the workshop had an impact on their teaching with 12 mentioning a specific technique and two mentioning social support.

In general, GMTAs felt that the techniques presented in the workshop had the greatest impact on their teaching, which was ultimately the goal of the workshop. Regarding specific impact, two GMTAs without prior teaching experience made similar, strong comments, feeling that without the workshop they "...would have been relegated to lecturing." These remarks indicate both a shift in their thought, i.e. lecture alone is not sufficient, and a shift in their teaching style, i.e. not relying on lecture alone.

The analysis of the modified RTOP revealed that seven GMTAs had scores that increased over the study, averaging a gain of 10.5 points from September to November. When the videotapes were analyzed for GMTAs use of questioning and active learning, nine of the 18 GMTAs had considerable changes, including the seven whose RTOP scores increased. In the interviews, all nine of these GMTAs felt the workshop impacted their teaching practice. They each mentioned a specific strategy and their use of this strategy was verified through analysis of the videotapes. The collected data on these nine GMTAs provides evidence that the workshop had an impact on their teaching.

Research Question 2 – Workshop Comparison

The workshops were compared using three sets of data: a workshop survey, an interview, and a videotape analysis. These provided three levels of evaluation of the workshop: participants' reactions, participants' perceived learning and participants' use of new knowledge and skills (Guskey, 2000). The evaluation also provided evidence for the impact the workshops had on the teaching of the participating GMTAs.

The workshop survey given each year provided data about participants' reactions—Guskey's (2000) first level of evaluation of professional development. From the open-ended workshop survey it was evident that GMTAs from both years mostly enjoyed their workshop. The seminars were commonly rated as "good" by the GMTAs though it is unclear if they rated the seminar's impact on their teaching, or the qualities of the presenter. From the surveys alone it is difficult to tell whether the workshops

were effective, and nearly impossible to say if the workshops impacted the teaching of the participating GMTAs.

The interviews collected four months after the conclusion of each workshop help to reveal participants' perceived learning—Guskey's (2000) second level of evaluation of professional development. In these interviews, 16 of the eighteen 2008 GMTAs reported continued use of at least one strategy learned in the workshop compared to none of the 2007 GMTAs. In terms of a perceived impact on their teaching, 14 of 18 in 2008 felt the workshop impacted their teaching compared with 6 of 8 in 2007. However, in 2008, 12 felt the impact was from techniques and two from socialization, whereas in 2007, two felt the impact was from techniques, three from socialization, and one from both. Moreover, those 2007 GMTAs who mentioned an impact from techniques did not mention any specific technique by name or description. In contrast, the 2008 GMTAs mentioned very specific techniques and elaborated on their use in the classroom. Though it is evident some participants perceived a change in their teaching, this perception alone is not enough to indicate an actual impact on their teaching.

In both the December 2008 and April 2009 interviews, it seems reflection played an integral role in the 2008 GMTAs' workshop experience. In these interviews, many of the GMTAs from 2008 made comments focused on the improvement of some specific aspect of their teaching as opposed to the comments made by the 2007 GMTAs which generally focused on the specific seminar presenter. There is nothing to suggest that the 2008 GMTAs were initially more reflective than the 2007 GMTAs, thus it is possible

that the increased use of reflection of the GMTAs from 2008 is due to their experience in the workshop.

The videotape analysis helps to provide data about participants' use of new knowledge and skills—Guskey's fourth level of evaluation of professional development (Guskey, 2000). The comparison of the November videotapes from both years indicated that only two of the eleven 2007 GMTAs exhibited any use of open-ended questions compared to 12 of the 18 GMTAs from 2008. Active learning usage was similar with only 3 of the eleven 2007 GMTAs spending class time in active learning compared to 10 of the 18 GMTAs from 2008.

Together, these data paint a favorable picture of the impact the 2008 workshop had on its participants. Fourteen of the 18 GMTAs from 2008 perceived an impact on their teaching, and for nine of these, a change consistent with their perceived impact was observed on their videotapes. Six of the eight GMTAs from 2007 perceived an impact, but no change consistent with their perceived impact was observed.

Research Question 3 – Implementation of Strategies from the 2008 Workshop

Both sets of interviews (December and April) collected following the completion of the 2008 workshop indicate the 2008 GMTAs continued to use the strategies from the workshop and felt the workshop had an impact on their teaching. Specifically, in the December interviews, 17 of 18 GMTAs indicated they were still using at least one strategy they learned from the workshop, and in the April interviews, 16 of the 18 indicated they were still using at least one strategy.

These remarks suggest that the workshop had both a short and long term effect on GMTAs' classroom teaching practices. However, relying solely on participant's self-reported use of techniques and change in classroom practice is not sufficient.

Observation of GMTAs' classroom teaching provides evidence to validate their self-reported claims. Overall, the level and type of questions asked by GMTAs in class showed marked improvement. Nine GMTAs demonstrated increased use of open-ended questions while four also increased their use of high-level questions. Seven GMTAs spent more class time in active learning.

Research Question 4 – Comparing Coaching and Observation

A secondary goal of this study was to evaluate the effectiveness of peer coaching with GMTAs in a university setting. It was originally hypothesized that peer coaching would be a better classroom feedback component than observation in terms of helping GMTAs to use and continue to use the strategies they learned in the workshop. Overall this turned out not to be the case. This is possibly due to differences between peer coaching in a K-12 setting and in a university setting.

Little research has been done on coaching in a university setting, but the coaching model described in the K-12 literature assumes that teachers *want* to improve. In the case of GMTAs, not all wanted to improve: some were content with the way they currently taught (2 of the 18) and others had no plan of continuing in academia (7 of the 18), with four of these feeling no need to improve.

In comparing observation with peer coaching, a majority from both groups commented on how observing others positively influenced their teaching. In fact, seven of the ten in the coaching group commented that just watching another's class helped them to improve more than any other part of the coaching process. Only two of the ten coaching participants (the two from the most effective pairing) commented on the helpfulness of the discussion involved with coaching, the pre- and post-conferences. These comments suggest that, for the most part, the participants viewed the discussions involved with coaching as less helpful than simply conducting the observation of one's peers.

Participants in the "observation only" treatment ran into similar issues as those involved in coaching: not all participants wanted to improve. Unlike the coaching situation, however, these participants' unwillingness to change did not affect the other members of the observation group. Ultimately, the question remains: Of the two methods, which is most likely to work the best, the most often, for the largest number of participants? From the data collected, the possible added benefits of peer coaching may be outweighed by the additional time, organization, and pairing requirements present in a GMTA setting.

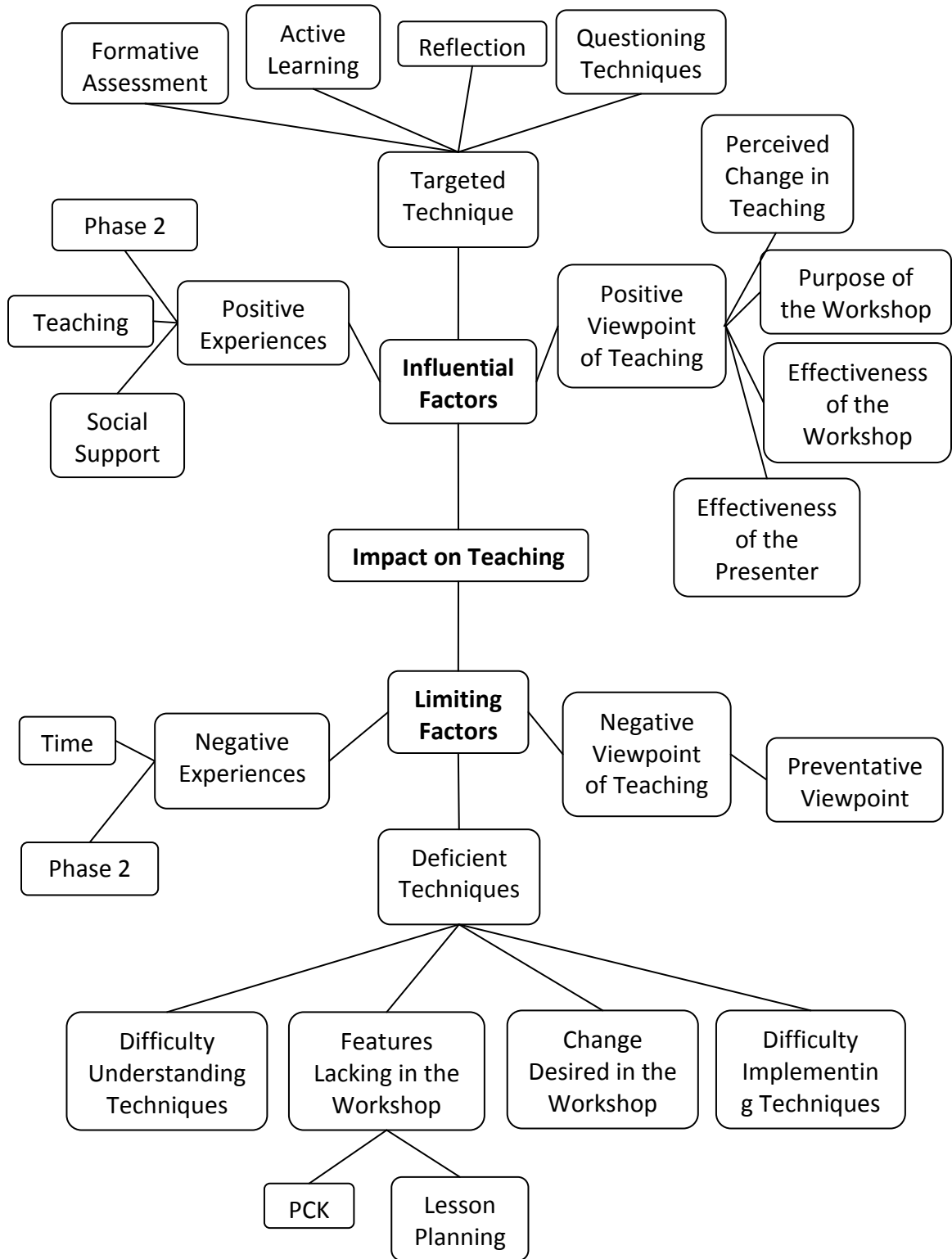
Additional Conclusions

A Conceptual Model of Workshop Factors Impacting Teaching

The December interviews with the 18 GMTAs from 2008 were analyzed with the goal of understanding the GMTAs' perceived impact of the workshop on their teaching practices. Three themes emerged as workshop factors both influencing and limiting teaching growth: techniques, experiences, and participant's viewpoint of teaching. A conceptual model of these themes is presented as Figure 4 below.

In this conceptual model, the influential factors of targeted techniques, positive experiences, and participant's viewpoint of teaching appear to support teaching growth. In other words, the presence of these factors positively influenced GMTAs' teaching practices. The limiting factors of absent techniques, negative experiences, and participant's viewpoint of teaching appear to limit teaching growth. The interaction between these components influenced the effectiveness of the workshop, and in turn the impact on the participants' teaching practice. Had any component been lacking, (i.e. the workshop having a lack of techniques, the participants being exposed to negative experiences or having negative viewpoints of teaching), the effectiveness of the workshop would likely have been reduced.

Figure 4: A Conceptual Model of Workshop Factors Impacting Teaching



Constructs Affecting the Effectiveness of Peer Coaching

Certain constructs seemed to affect the impact of the interactions between the five coaching pairs. Though there were only ten participants, and five pairs, some conclusions can be made into what constructs influenced the effectiveness of the peer coaching experience. The qualitative analysis identified five constructs; four appeared essential to the effectiveness of the pairing, while one appeared to be beneficial to the impact of coaching.

The first of the essential constructs was an *interest in improving one's teaching*. Though typically assumed of teachers participating in peer coaching, a GTA may not view effective teaching as an important part of his or her work in graduate school. From the data collected, it appears to be the most critical component, for without this interest peer coaching was not fully utilized. The participants who were uninterested in improving their teaching put little effort into coaching. In turn, coaching had little to no impact on them and their lack of effort also limited the impact coaching had on their partner.

The second of the essential constructs was a *willingness to work with another to improve*. This construct is consistent with Showers and Joyce's first principle of peer coaching: "All teachers must agree to be members of peer coaching study teams" (p. 14, 1996). GMTAs not interested in improving their teaching through the peer coaching process did not perceive the pre- and post-conference discussion time as important. To

them, peer coaching was not planning, observing, and reflecting, but rather just observing.

The third of the essential constructs contained two parts and was concerned with feedback and authority. Specifically, *participants should be open to giving and receiving feedback and feel both they and their partner have the authority to give feedback*. Although the coach's role is typically to facilitate discussion and encourage reflection, many of the GMTAs of this study viewed the coach's role as providing evaluative feedback². In this case, some participants were not comfortable giving feedback while others were uncomfortable with receiving feedback. Without this discourse, the post-observation discussion period was limited and participants were denied information that could have potentially impacted their teaching. Some participants did not feel they had the authority to give feedback, as they were social equals with their peer. Another felt his partner did not have the authority to give feedback since he had less teaching experience. In both of these cases, the coaching partnership was limited.

The fourth essential construct was a *willingness to schedule and spend time* with coaching. Though some GMTAs who participated in peer coaching were interested in improving their teaching, not all were willing to schedule enough time to complete this task. Without a proper time commitment, the benefits of coaching were lessened.

² Perhaps the lack of time spent in coaching training (only two hours instead of the typical eight) limited the GMTA's understanding of the coach's role in the coaching process.

A good relationship and an opportunity to select a partner appeared to be a beneficial construct to the peer coaching partnership and is consistent with Robbins (1991). The three groups who were allowed to select their own partners had a better peer coaching experience than the two groups who did not. By choosing their own partner, participants were able to select who they were most willing to work with; this in turn might have motivated them to improve their teaching through coaching.

In the most successful coaching pairing of Pam and Corinne, all five of these constructs were present. The other pairings lacked certain constructs, and findings indicate that the more coaching constructs a group shared, the more productive was their coaching experience.

Adapting K-12 Professional Development Literature

Differences exist between the purposes of K-12 professional development and GTA teacher training. K-12 teachers usually attend professional development to improve upon their teaching or learn a new specific skill, computer program, or textbook and can be motivated to attend for a number of reasons including loving teaching, as an administrative requirement, or because teaching is their job. GTA teacher training, on the other hand, exists mainly as an accountability feature for a university—as a way to provide some training for new teachers and GTAs are usually required to attend whether they are motivated to or not. Whereas K-12 teachers have at least two years of educational schooling in pedagogy, many GTAs start out with no such experience and consequently are in much greater need of basic teaching skills.

Therefore the components of professional development assumed to be necessary and effective for K-12 may be different in a GTA teacher training. Still, with only a small body of literature on GTA training, using a K-12 model is likely a good place to start developing a GTA workshop. In what follows, Garet et al.'s (2001) six features of effective professional development are discussed in a GMTA setting.

The first of Garet et al.'s (2001) core features is that professional development should have a focus on improving and deepening teachers' content knowledge. The 2008 GMTA workshop did not place much emphasis on content knowledge. However, content knowledge is not just limited to one's knowledge of the subject there is also knowledge of how to teach that content, i.e. pedagogical content knowledge (PCK). The latter was given much discussion in Garet et al.'s report (2001), but it was not measured as part of their study. Although the current study attempted to connect the teaching techniques presented to the content of the classroom, the attempts were largely unsuccessful. Therefore, it is unknown what impact emphasizing PCK might have on GMTA teacher training. Clearly, more research is needed into incorporating PCK into GMTA teacher training.

The second of the core features was that professional development should allow for teachers to actively engage in meaningful discussion, have opportunities for observing and being observed, and have time to plan classroom implementation. Active engagement was a critical component of this study.

Just as an open discussion can be vital in a classroom, it was important during the workshop. In the interviews, 14 of the 18 GMTAs from 2008 commented that they felt the discussions with their peers during the seminars were valuable. Allowing time for discussion enabled the participants to hash out the different techniques presented and it allowed the experienced GMTAs to voice their opinions and provide insight into the techniques.

Another characteristic of active engagement is the opportunity for observing one another and being observed. Again, this proved to be very valuable to the GMTAs, with a number feeling it was the most helpful feature of the workshop. A few commented that watching a fellow GMTA teach made them feel more confident about their own teaching since what they observed wasn't that different than the way they taught. The time spent in observation also allowed for observance of some of the techniques learned in the workshop. Some commented that after seeing someone else use active learning, or even not use it, they came to realize the importance of it.

Finally, time to plan classroom implementation of the techniques learned in the workshop was of utmost importance. Without time for planning, workshop techniques had the potential to be easily forgotten. Allowing time for planning enabled the participants to prepare a lesson with the technique already interwoven, and thus they were more likely to use the technique.

The third of Garet's core features is that professional development should be based on learning activities relevant to the participants and coherent with their goals for

learning. The results of this study indicate that providing relevant techniques to the participants could impact their teaching practice.

To determine the chosen techniques for this study, a number of sources were consulted (See Chapter 2). In the end, four were chosen: reflection, questioning techniques, active learning, and formative assessment. The first three were well-received by participants and according to the interviews and videotapes, were also well used. It seems that reflection played a vital role, serving as a catalyst for integrating the other techniques. Formative assessment was not presented as a technique to use every day and was viewed by many as difficult to implement. This led to it being the least used of the presented techniques.

The first of Garet's structural features is that professional development should consist of teacher study groups or a collaboration of among teachers, not a traditional workshop. However, in the study by Garet et al. (2001), the form of the activity turned out to be the least significant of the six components. The form for this study was a blend of traditional workshop, i.e. one presenter with listening participants, and collaborative study groups where GMTAs worked together. Whether this form was sufficient or could be improved upon is unknown.

The second of the structural features is that professional development should involve groups of teachers from the same school, department, or grade. This feature was inherently a part of the workshop due to the participants all being part of the mathematics department. This feature played a significant role as a secondary outcome

of the workshop. GMTAs built strong social connections with their peers as a result of the workshop. This had to do with two factors: the participants had the common bond of being all new to the department that year, and 16 of the 18 shared an office, which also helped in building these connections. Hauk, et al., (2009) have suggested that this type of social networking is a key component to happy, healthy GTAs.

The last of Garet's structural features is that professional development should be sustained over time and have a number of contact hours. Time certainly played a role in the 2008 workshop; 18 hours were spent over 10 weeks. Though this is a relatively short duration for a professional development experience according to Garet et al. (2001), with GMTAs' already busy schedules, it would have been difficult to ask much more. Many commented that since the workshop spanned multiple weeks it allowed them to time to discuss and implement techniques. This study supports Belnap's (2006) recommendation of providing professional development both at the beginning and throughout the semester.

An additional feature not included in Garet, et al., is the concept of institutional support, though it was mentioned by Guskey as his third level of evaluation of professional development (2000). In the K-12 setting, professional development is usually encouraged and even funded by the school. In the university setting, however, GTA training can be seen as an additional burden on GTAs, some of whom may not view effective teaching as an important part of their work in graduate school. In this study, GMTAs were told during their first week on campus that while teaching was their

responsibility, it was not their job; their job was being a graduate student. For some GTAs, teaching is just a way to receive a stipend and a tuition waiver; at the end of the day, their own homework assignments are more important than lesson plans. Thus, there are difficulties in implementing a teacher training workshop for GTAs and university and departmental support is critical.

Implications for Research and Practice

K-12 research literature can be helpful in a GMTA setting, but precautions must be taken. GMTAs do not have the same motivations for improving their teaching through participating in professional development as K-12 teachers have. In a K-12 setting, classroom instruction is the chosen job and livelihood of the teachers, whereas most GMTAs attend graduate school primarily to earn a degree.

This study's findings revealed that GMTA teaching practice can be influenced by a workshop, though the extent of the influence varied among each participant. Most GMTAs had observable changes in their teaching in two primary areas: active learning or questioning. However, for the most part, their changes in these areas were small.

More GMTAs were using active learning in their classrooms by the end of the study, but the amount of class time spent in active learning was still relatively low—averaging 5.5%—roughly two and a half minutes per 50 minute lecture. This is not too surprising as it is likely most GMTAs predominantly encountered lecturing during their previous schooling and thus are most comfortable with this method of instruction. Still,

one 2-hour seminar influenced some GMTAs to increase their use of active learning; one might expect greater change if more time were spent providing GMTAs with additional instruction and practice.

More contact hours might be an easy solution, but unless GMTAs are vested in the process—unless they have a desire to reflect and improve upon their teaching—a change in their teaching is likely to be difficult. The institution can (somewhat) help this situation by requiring teacher training workshops, but it is critical that all constituents in the process support the workshop, including professors, administrators, and other graduate students. If GMTAs receive mixed messages about the importance of teaching, they will likely not view it as a great priority. Still, GMTAs are teachers and they are ultimately responsible for teaching mathematics to their students; any training that can be made available to them to help them better their teaching is time well spent.

Recommendations for Future Research

This study focused on GMTAs at a doctorate-granting university (Carnegie classified as very high research activity). Although findings revealed what an effective GMTA teacher training workshop could look like, more research needs to be done. The GMTA participants of this study all volunteered to participate. It would be interesting to investigate the effectiveness of this study's workshop model in a large, randomized setting.

Peer coaching, though not having the desired effect for GMTAs in this study, might work better in a setting where GMTAs are more interested in the process and have a greater desire to improve their teaching. In addition, the five constructs that influenced the effectiveness of a peer coaching pair were indicated through the examination of only five coaching pairs. How critical are these constructs to the effectiveness of peer coaching in a GMTA setting and are there additional constructs? It seems both in this study and in the literature that GMTA peer coaching research is in its infancy.

In this study, pedagogical content knowledge (PCK) was not emphasized. To what extent would GMTAs benefit from more exposure to PCK? Can PCK be effectively taught to GMTAs without classroom experience, or does this lack of classroom experience make them prime candidates for acquiring this knowledge? Would GMTAs with classroom experience benefit more greatly from PCK discussions?

Epilogue

It was the goal of this study to design, implement, and evaluate a GMTA workshop with the purpose of improving the teacher training these GMTAs received. Critical to the design was the evaluation of the workshop in order to improve upon it. A number of sources of data were collected in order to facilitate this evaluation.

In short, the workshop was considered effective not only because GMTAs said they changed their teaching but because changes were *seen* in their teaching. For nine

GMTAs strong evidence was collected: not only did they mention specific changes to their teaching, but these specific changes were observed on videotapes of their classroom teaching.

Still, much remains to be examined. The biggest component missing, it seems, is the 'why' of the techniques. Research has shown active learning is effective, but practitioners need to know why it is relevant to them. Why should GMTAs use active learning in their classrooms? The answer to these questions was not explicitly stated or discussed in any seminar. This integration might have made the difference between noticeable and noteworthy results to significant and spectacular ones.

Finally, through their workshop experiences, GMTAs reflected more on what they were doing in the classroom. This, in turn, led them to consider changes to their teaching. In the end, these changes both directly and indirectly impacted their students which is ultimately the goal of any teacher training.

REFERENCES

- Abbott, R., Wulff, D., Szego, K. (1989). Review of Research on TA Training. *New Directions for Teaching and Learning*. (39), 111-124.
- Ackland, R. (1991). A Review of the Peer Coaching Literature. *Journal of Staff Development*, 12(1), 22-27.
- Angelo, T. & Cross, P. (1993). *Classroom Assessment Technique: A Handbook for College Teachers* (2nd ed.). San Francisco: Jossey-Bass.
- Artzt, A., Armour-Thomas, E., Curcio, F. (2008). *Becoming a Reflective Mathematics Teacher*. (2nd ed.). New York: Lawrence Erlbaum.
- Baiocco, S. & DeWaters, J. (1998). *Successful College Teaching: Problem-solving Strategies of Distinguished Professors*. New Jersey: Allyn & Bacon, Prentice Hall.
- Ball, Bass, Hill, and Schilling. (2008). Unpacking Pedagogical Content Knowledge: Conceptualizing and Measuring Teachers' Topic-Specific Knowledge of Students. *Journal for Research in Mathematics Education*, 39(4), 372-400.
- Banilower, E., Boyd, S., Pasley, J., & Weiss, I. (2006). *Lessons from a Decade of Mathematics and Science Reform: A Capstone Report for the Local Systemic Change through Teacher Enhancement Initiative*. Chapel Hill, NC: Horizon Research.
- Belnap, J. (2006). *Mathematics Teaching Assistants: Determining their Involvement in College Teaching*. Paper presented at the Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Merida, Mexico.
- Belnap, J. (2005). Putting TAs into Context: Understanding the Graduate Mathematics Teaching Assistant (Doctoral dissertation, The University of Arizona, 2005). *Dissertation Abstracts International*, 66(06A), 2142.
- Black, P. & William, D. (1998). Inside the Black Box: Raising Standards through Classroom Assessment. *Phi Delta Kappan*, 80(2), 139-154.
- Bonwell, C. & Eison, J. (1991). *Active learning: Creating Excitement in the Classroom*. ASHE-ERIC Higher Education Report No. 1. Washington, DC: The George Washington University, School of Education and Human Development.
- Bookman, J. (2007). *Training for Teaching Assistants at Duke*. Retrieved July 17, 2008, from <http://www.math.duke.edu/~bookman/grsttr.html>

- Brinko, K. (1991). The Interactions of Teaching Improvement. In M. Theall & J. Franklin (Eds.), *Effective Practice for Improving Teaching* (p. 39-49). San Francisco: Jossey-Bass.
- Brown, A., Harris, K., Hodges, J., & Jernigan, R. (2006). Mathematics Coaching: A next step in the NC-PIMS Mathematics Leadership Initiative. *Annual report: The North Carolina Partnership for Improving Mathematics and Science*.
- Buerkel-Rothfuss, N. & Gray, P. (1989). *Graduate Teaching Assistant (GTA) Training: The View from the Top*. (ERIC Document Reproduction Service No. ED318351).
- Chickering, A., Gamson, Z. (1987). *Seven Principles for Good Practice in Undergraduate Education*. AAHE Bulletin; March 3-7.
- Chism, N. & Szabo, B. (1997). How Faculty Development Programs Evaluate Their Services. *Journal of Staff, Program & Organizational Development*, 15(2), 55-62.
- Chizmar, J. & Ostrosky, A. (1998). The One-Minute Paper: Some Empirical Findings. *Journal of Economic Education*, 29(1), 1-8.
- Corcoran, T. (1995). *Transforming Professional Development for Teachers: A Guide for State Policymakers*. Washington, DC: National Governors' Association.
- Costa, A., Garmston, R. (2002). *Cognitive Coaching: A Foundation for Renaissance Schools*. (2nd ed.). Norwood, MA: Christopher-Gordon Publishers, Inc.
- Dalgaard, K. (1982). Some Effects of Training on Teaching Effectiveness of Untrained University Teaching Assistants. *Research in Higher Education*, 17, 39-50.
- Darling-Hammond, L. & McLaughlin, M. (1995). Policies that Support Professional Development in an Era of Reform. *Phi Delta Kappan*, 76(8), 597-604.
- Denecke, D. (2008). Who's Involved in PFF. Retrieved July 17, 2008, from <http://www.preparing-faculty.org/PFFWeb.History.htm>
- Desimone, L., Porter, A., Garet, M., Yoon, K., & Birman, B. (2002). Effects of Professional Development on Teachers' Instruction: Results from a Three-year Longitudinal Study. *Educational Evaluation and Policy Analysis*, 24(2), 81-112.
- Diamond, R., & Gray, P. (1987). *A national study of teaching assistants*. Paper presented at the Annual Meeting of the Association for the Study of Higher Education, Baltimore, MD.

- Earl, L. (2003). *Assessment as Learning: Using Classroom Assessment to Maximize Student Learning*. Thousand Oaks, CA: Corwin Press
- Edwards, A. (2006). The Training of Future Professors: Supervisors' Views on Doctoral Teaching Assistant Training (Doctoral Dissertation, Texas A&M University, 2006) *Dissertation Abstracts International*, 67(12A), 4515.
- Friedberg, S. (2005). Teaching Mathematics Graduate Students How To Teach. *Notices of the American Mathematical Society*. 52(8), 842-847.
- Friedberg, S. (2001). Using Case Studies in Seminars on College Teaching. Retrieved July 20, 2008, from http://www.bc.edu/bc_org/avp/cas/math/publicprojectPI/MERplenary2001.pdf
- Froman, J. (2005). A Graduate Pedagogy Course for Mathematics Teaching Assistants. (Masters Thesis, Texas Tech University, 2005). Retrieved July 25, 2008 from <http://dspace.lib.ttu.edu/handle/2346/1403>
- Garet, M., Porter, A., Desimone, L., Birman, B., & Yoon, K. (2001). What Makes Professional Development Effective? Results from a national sample of teachers. *American Educational Research Journal*, 38(4), 915-945.
- Gliner, J. & Morgan, G. (2000). *Research Methods in Applied Settings: An Integrated Approach to Design and Analysis*. Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Goodwin, S. (1980). *Effective Classroom Questioning*. Urbana-Champaign, IL: Instructional Development Division.
- Grossman, P. (1990). *The Making of a Teacher: Teacher Knowledge and Teacher Education*. New York: Teachers College Press.
- Guskey, T. (2001). The Effects of Staff Development on Teachers' Perceptions About Effective Teaching. *Journal of Educational Research*, 78(6), 378-381.
- Guskey, T. (2000). *Evaluating professional development*. Thousand Oaks, CA: Corwin.
- Guskey, T. (1999). *New Perspectives on Evaluating Professional Development*. Paper presented at the Annual Meeting of the American Educational Research Association, Montreal.

- Hagger, H., Burn, K., Mutton, T., & Brindley, S. (2008). Practice Makes Perfect? Learning to Learn as a Teacher. *Oxford Review of Education*, 34(2), 159-178.
- Hauk, S., Chamberlin, M., Cribari, R., Judd, B., Deon, R., Tisi, A., Kakakhail, H., (2009). Diary of a graduate teaching assistant. *Journal of Graduate and Professional Student Development*.
- Hainline, L. (2001). Teaching in the University Setting: A Course for Teaching Assistants. In Prieto, L., Meyers, S. (Eds.) *The Teaching Assistant Training Handbook: How To Prepare TAs for Their Responsibilities*. Stillwater, OK: New Forums Press.
- Hiebert, J., Carpenter, T., Fennema, E., Fuson, K., Human, P., Murray, H., Olivier, A., Wearne, D. (1996). Problem solving as a Basis for Reform in Curriculum and Instruction: The Case of Mathematics. *Educational Researcher*, 25(4), 12-21.
- Hill, D. (2000). He's Got Your Number *Teacher Magazine*, 11(8), 42.
- Hill, H., Dean, C., Goffney, I., (2007). Assessing Elemental and Structural Validity: Data from Teachers, Non-teachers, and Mathematicians. *Measurement: Interdisciplinary Research & Perspective*. 5(2-3), 81-92.
- Holten, D. & Nilson, L. (1990). *Graduate Education: Turning Graduate Students into Professors*. University of California-Riverside Project Summary, Riverside, CA. (ERIC Document Reproduction Service No. ED 359 884).
- Jacobs, J., Kawanaka, T., Stigler, J. (1999). Integrating Qualitative and Quantitative Approaches to the Analysis of Video Data on Classroom Teaching. *International Journal of Educational Research*, 31(8), 717-724.
- Joyce, B. & Showers, B. (2002). *Student Achievement through Staff Development*. (3rd ed.). Alexandria, VA: Association for Supervision & Curriculum Development.
- Kinney, T. (2007). The Teaching Assistant Preparation Program (TAPP): A Training Program for Teaching Assistants at the Graduate Level of Psychological Education (Doctoral Dissertation, Chicago School of Professional Psychology, 2007). *Dissertation Abstracts International*, 68(10A), 4224.
- Knight, J. (2007). *Instructional Coaching: A Partnership Approach to Professional Development*. Thousand Oaks, CA: Corwin Press.
- Kohler, F., Crilley, K., Shearer, D., Good, G. (1997). Effects of Peer Coaching on Teacher and Student Outcomes. *Journal of Educational Research*, 90(4), 240-250.

- Latulippe, C. (2007). Environments that Encourage Mathematics Graduate Teaching Assistants: The Effects of Institution Type and Availability of Training (Doctoral Dissertation, Montana State University, 2007). *Dissertation Abstracts International*, 68(02A), 501.
- Levinson-Rose, J., Menges, R. (1981). Improving College Teaching: A Critical Review of Research. *Review of Educational Research*. 51(3), 403-434.
- Light, R. (1990). *The Harvard Assessment Seminars: Explorations with Students and Faculty about Teaching. Learning and Student Life: First Report*, Cambridge: Harvard Graduate School of Education.
- Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing Professional Development for Teachers of Science and Mathematics*. Thousand Oaks, CA: Corwin Press.
- Loughran, J. J. (2002). Effective Reflective Practice: In Search of Meaning in Learning about Teaching. *Journal of Teacher Education*. 53(1), 33-43.
- Lowman, J., & Mathie, V. (1993). What Should Graduate Teaching Assistants Know about Teaching? *Teaching of Psychology*. 20(2), 84-88.
- Ludbrook, J. & Dudley, H. (1998). Why Permutation Tests are Superior to t and F Tests in Biomedical Research. *The American Statistician*, 52, 127-132.
- Lyman, F. (1981). The Responsive Classroom Discussion. In Anderson, A. S. (Ed.), *Mainstreaming Digest*, (p. 109-113). College Park, MD: University of Maryland College of Education.
- Mathematical Association of America, Rocky Mountain Section. (2007). *Spring 2007 Newsletter*. Retrieved July 20, 2008 from <http://clem.msced.edu/~sundbyel/maanews/spring2007news.pdf>
- Marincovich, M., Prostko, J., & Stout, F., (Eds.). (1998). *The Professional Development of Graduate Teaching Assistants*. Bolton, MA: Anker Publishing Company, Inc.
- Marzano, R., Pickering, D., & Pollock, J. (2001). *Classroom Instruction that Works: Research-Based Strategies for Increasing Student Achievement*. Alexandria, VA: Association for Supervision and Curriculum Development.

- McDaniel, E. (1987). Faculty Collaboration for Better Teaching: Adult Learning Principles Applied to Teaching Improvement. *To Improve the Academy*, 6, 94-102.
- Meyers, C., Jones, T. (1993). *Promoting Active Learning. Strategies for the College Classroom*. San Francisco: Jossey-Bass.
- Mosteller, F. (1989). The "Muddiest Point in the Lecture" as a Feedback Device. *On Teaching and Learning: The Journal of the Harvard-Danforth Center*, 3, 10-21.
- National Institute for Science Education. (2003). *Think-pair-share*. Retrieved July 14, 2008 from <http://www.wcer.wisc.edu/archive/CL1/CL/doingcl/thinkps.htm>
- National Council of Teachers of Mathematics (NCTM). (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM.
- Nyquist, J. & Sprague, J. (2001). Thinking Developmentally About TAs. In Marincovich, M., Prostko, J., & Stout, F. (Eds.), *The Professional Development of Graduate Teaching Assistants*. Bolton, MA: Anker.
- Olsen, B. (2008). *Classroom Observation Tips*. Retrieved May 15, 2009, from <http://www.studentteaching.org/id19.html>
- Ornstein, A. C. (1988). Questioning: The Essence of Good Teaching--Part II. *NASSP Bulletin*. 72(505), 72-80.
- Ornstein, A. C. (1987). Questioning: The Essence of Good Teaching. *NASSP Bulletin*. 71(499), 71-79.
- Paulson, D. & Faust, J. (No Date). Active Learning for The College Classroom. Retrieved May 25, 2008 from, <http://www.calstatela.edu/dept/chem/chem2/Active/index.htm>
- Paulsen, M., & Feldman, K. (1995). *Taking Teaching Seriously: Meeting the Challenge of Instructional Improvement*. ASHE-ERIC Report No. 2. Washington, DC: George Washington University.
- Perreault, W. & Leigh, L. (1989). Reliability of Nominal Data Based on Qualitative Judgments. *Journal of Marketing Research*, 26, 135-148.
- Piburn, M., & Swada, D. (2000). Reformed Teaching Observation Protocol (RTOP) Reference Manual. Technical Report. (ERIC Document Reproduction Service No. ED447205).

- Prieto, L. & Altmaier, E. (1994). The Relationship of Prior Training and Previous Teaching Experience to Self-Efficacy Among Graduate Teaching Assistants. *Research in Higher Education*, 35(4), 481-497.
- Prieto, L. & Meyers, S. (Eds.). (2001). *The Teaching Assistant Training Handbook: How To Prepare TAs for Their Responsibilities*. Stillwater, OK: New Forums Press.
- Prince, M. (2004). Does Active Learning Work? A Review of the Research. *Journal of Engineering Education*, 93(3), 223-231.
- Ralph, E. (2001). Effective Instruction: A Synthesis of Research-based Principles for GTAs. *Journal of Graduate Teaching Assistant Development*. 8(1), 13-20.
- Rankin, S. (1999). *AMS-MAA Project Preparing Future Faculty in Mathematics*, Retrieved from <http://www.ams.org/government/PFF-RFP.html>
- Robbins, P. (1991). *How To Plan and Implement a Peer Coaching Program*. Alexandria, VA: Association for Supervision and Curriculum Development.
- Rodgers, C. (2002). Defining Reflection: Another Look at John Dewey and Reflective Thinking. *Teachers College Record*. 104(4), 842-66.
- Ross, J. (1992). Teacher Efficacy and the Effects of Coaching on Student Achievement. *Canadian Journal of Education*, 17(1), 51-65.
- Rowe, M.B. (1976). The pausing principle—Two invitations to inquiry. *Research on College Science Teaching*, 5, 258-259.
- Rowe, M. B. (1974). Reflections on Wait-Time: Some Methodological Questions. *Journal of Research in Science Teaching*. 11(3), 263-279.
- Ruhl, K., Hughes, C., and Schloss, P. (1987). Using the Pause Procedure to Enhance Lecture Recall. *Teacher Education and Special Education*, 10, 14-18.
- Sawada, D., Piburn, D., Judson, E., Turley, J., Falconer, K., Benfrod, R., & Bloom, I. (2002). Measuring Reform Practices in Science and Mathematics Classrooms: The Reform Teaching Observation Protocol. *School Science and Mathematics*. 102(6), 245-254.
- Sheppard, B., Canning, M., & Mellon, L. (2006). *Coaching and Feedback for Performance*. New York: Kaplan Publishing.

- Showers, B. & Joyce, B. (1996). The Evolution of Peer Coaching. *Educational Leadership*, 53(6), 12-16.
- Shulman, L. S. (1987). Knowledge and Teaching: Foundations of the New Reform. *Harvard Educational Review*, 57(1), 1-22.
- Speer, N., Gutmann, T., & Murphy, T. (2005). Mathematics Teaching Assistant Preparation and Development. *Journal of College Teaching*, 53(2), 75-80.
- Speer, N. & Hald, O. (2007). How do Mathematicians Learn to Teach? Implications from Research on Teachers and Teaching for Graduate Student Professional Development. In M. Carlson & C. Rasmussen (Eds.), *Making the connection: Research and practice in undergraduate mathematics education*. (p. 303-315). Washington, DC: Mathematical Association of America.
- Staton, A. & Darling, A. (1989). Socialization of Teaching Assistants. In Nyquist, J., Abbott, R., and Wulff, D., *Teaching Assistant Training in the 1990s*. (p. 15-22). San Francisco: Jossey-Bass.
- TAOC. (2008). *What's Working in TA Training 2008*. Retrieved July 15, 2008, from http://ctl.stanford.edu/TA/whats_working.pdf
- Wideen, M., Mayer-Smith, J., & Moon, B. (1998). A Critical Analysis of the Research on Learning to Teach: Making the Case for an Ecological Perspective on Inquiry. *Review of Educational Research*. 68(2), 130-178.
- Wilens, W. (1991). *Questioning skills for teachers. What Research says to the Teacher*. (3rd ed.). Washington, DC: National Education Association.
- Wilson, R. (2004). *TA Orientation and Training in the Mathematics Department*. Retrieved July 20, 2008, from <http://www.math.wisc.edu/~tacoord/TAttraining.htm>
- Wilson, R. (1986). Improving Faculty Teaching: Effective Use of Student Evaluations and Consultants." *Journal of Higher Education*, 57(2), 196-211.
- Wulff, D., Austin, A., Nyquist, J., Sprague, J. (2004). The Development of Graduate Students as Teaching Scholars. In Wulff, D. & Austin, A. (Eds.) *Paths to the Professorate*. (p. 46-73). San Francisco: Jossey-Bass
- Wright, W. (Ed.) (1995). *Teaching Improvement Practices*. Boston, MA: Anker.

- Yost, D., Sentner, S., & Forlenza-Bailey, A. (2000). An Examination of the Construct of Critical Reflection: Implications for Teacher Education Programming in the 21st Century. *Journal of Teacher Education*, 51(1), 39-49.
- Young, S., & Bippus, A. (2008). Assessment of Graduate Teaching Assistant Training: A Case Study of a Training Program and its Impact on GTAs'. *Communication Teacher*, 22(4), 116-129.
- Zeichner, K. (1992) Rethinking the Practicum in the Professional Development School Partnership, *Journal of Teacher Education*, 43(4), 296–307.

APPENDICES

APPENDIX A

2007 INTERVIEW PROTOCOL

2007 Interview Protocol: [Administered in March of 2008]

I'm going to be in charge of the GTA workshop in the fall, and I was hoping for your input to help in designing it. So, with your permission, I'd like to ask you a few questions. This should take less than fifteen minutes.

What do you think the purpose of the teacher training workshop was?

Do you feel it was successful in that purpose?

What did you find enjoyable about the workshop? (Why/Explain)

What didn't you enjoy? (Why/Explain)

Do you think the workshop had an impact on your teaching?

Was it a valuable use of your time? (Why/Why Not)

What would you change about the workshop or how do you think it could be improved?

APPENDIX B

2007 WORKSHOP ACTIVE LEARNING HANDOUT

Teaching for Active Learning in the College Classroom
Department of Education

Brain-based Principles of Active Learning	Bringing the Principles to Life in the Classroom
Information is stored and retrieved through multiple memory and neural pathways.	
Brains are designed for fluctuations rather than constant attention.	
The brain is meaning-driven – meaning is more important to the brain than information. Patterns and programs drive our understanding; the search for meaning is innate and comes through patterning.	
Emotions are critical to learning – they play a critical role in our attention, health, learning, meaning, and memory.	
Low threat – The impact of serious threat or high stress can alter and impair learning and even kill brain cells.	
High challenge – Complex, challenging experiences with feedback help the brain to strengthen neural connections.	
The brain is a complex and adaptive system – effective change involves the entire complex system.	
Learning is often rich and non-conscious – we process both parts and wholes simultaneously and are affected a great deal by peripheral influences.	
The brain develops better in concert with other brains – intelligence is valued in the context of the society in which we live.	
Learning involves the mind and body – movement, foods, cycles of attention, drugs, and chemicals all have powerful modulating effects on learning.	

APPENDIX C

DECEMBER 2008 INTERVIEW PROTOCOL

2008 Semi-Structured Interview Protocol

In an effort to improve upon the workshop and learn about what was effective in the workshop I've been asked to interview you about your opinions. This interview will be confidential, and your name will not be associated with it. The audiotape will be transcribed. This should take about 20 minutes.

What do you think the purpose of the teacher training workshop was?

Do you feel it was successful in that purpose?

Why did you come to graduate school?

What do you see yourself doing after you graduate?

What did you find enjoyable about the workshop?

What didn't you enjoy?

What workshop content do you believe was most beneficial to your teaching practice?

What workshop content do you believe was the least beneficial to your teaching practice?

Do you think the workshop had an impact on your teaching?

Are there any specific strategies you continue to use that you picked up in the workshop?

Are there any specific strategies that you no longer use?

Were you part of the coaching group or the observation group?

To what extent did coaching/observations impact your teaching practice?

What would you change about the workshop or how do you think it could be improved?

APPENDIX D

APRIL 2009 INTERVIEW PROTOCOL

2009 Semi- Structured Interview Protocol

This is a follow-up interview to last semester's TA workshop that I am conducting for a class I am taking. This interview will be confidential, and your name will not be associated with it. I have just four questions for you, so this should take about 5 minutes.

Do you think the workshop had an impact on your teaching? [why / explain]

Are there any specific strategies you continue to use that you picked up in the workshop?

Are there any specific strategies you were using that you no longer use? [why the change?]

Looking back, do you think the workshop was a valuable use of your time?

APPENDIX E

VIDEOTAPE CODING PROTOCOL

Videotape Coding Protocol

Questions: Audience, level, and type.

Audience:

- Volunteer – A question in which no one was specifically called upon and two or less students answered.
- Chorus – A question asked of the whole class in which no one was specifically called upon and three or more students answered simultaneously.
- Rhetorical – A question asked without any response from any student. A question is also labeled rhetorical if the teacher asks a question and then answers it themselves. [The most frequent rhetorical question asked was “Right?”]
- Selected – A question in which someone was specifically called upon either before or after the question was asked.

Level:

- Low – A question at the knowledge, comprehension, or simple application levels of Bloom’s Taxonomy, i.e. used to evaluate student’s preparation and comprehension. A question at this level does not require a lot of wait time and can be answered immediately. Specifically, wait time was less than ten seconds.
- High – A question at the analysis, synthesis, or evaluation level of Bloom’s Taxonomy, i.e. used to help students think more deeply. At least ten seconds of wait time were required for a question to be labeled as high level.

Type:

- Open – A question in which there are many acceptable answers, i.e. the instructor does not know exactly how a student might respond. For example: What is an example of a continuous function?
- Closed – A question in which the instructor expects only one particular response, although more than one correct response might be possible. For example: When asking “What is $\sin^{-1}(.5)$?” the instructor might expect the student to respond “Thirty degrees” but “Pi/6 radians” or “150 degrees” would also be acceptable answers.

Active Learning:

- Active learning is class time given by the instructor for students to work on problems or concepts or to actively think about, discuss, and reflect on ideas, either in groups or individually. Specifically, the instructor is not lecturing and either walking around acting as a resource person or silently waiting. Time periods of less than 20 seconds were not considered active learning.

APPENDIX F

TEACHER CONFIDENCE INVENTORY

Teacher Confidence Inventory

Name: _____

Please rate the next items on a scale from 1 to 5 based on how confident you are in your classroom, 1 being *not at all confident* and 5 being *very confident*.

	Very Confident		Moderately Confident		Not at All Confident

1. How confident are you with the mathematics you teach?

1	2	3	4	5
---	---	---	---	---

2. How confident are you with the mathematical reasoning behind the mathematics you teach, meaning the understanding *why* we teach it, *how* it relates other mathematics topics, and *why* it is valid?

1	2	3	4	5
---	---	---	---	---

3. How confident do you feel planning lessons?

1	2	3	4	5
---	---	---	---	---

4. How confident do you feel incorporating active learning strategies such as think /pair / share or the pause procedure into your lessons?

1	2	3	4	5
---	---	---	---	---

5. How confident do you feel using questioning strategies such as higher-order questioning and wait time?

1	2	3	4	5
---	---	---	---	---

6. How confident do you feel encouraging student participation?

1	2	3	4	5
---	---	---	---	---

7. How confident do you feel creating an environment where students listen to one another?

1	2	3	4	5
---	---	---	---	---

8. How confident do you feel using formative assessment techniques?

1	2	3	4	5
---	---	---	---	---

9. How confident do you feel engaging your students in classroom discussion?

1	2	3	4	5
---	---	---	---	---

10. How confident do you feel with your teaching in general?

1	2	3	4	5
---	---	---	---	---

[Adapted from D.A. Yopp Consulting, used with permission.]

APPENDIX G

COACHING REFLECTION INSTRUMENT - C

Coaching Reflection Instrument (for coaches to fill out)

Complete this form after each coaching session to help us improve the coaching process.

DUE WEEKLY TO JEROME’S MAILBOX BY END OF DAY FRIDAY (OCT 24, 31, NOV 7, 14)

Observer Name: _____ Teacher Name: _____

Date of visit: _____ Total time spent with teacher: _____

Time spent on: Observing the classroom: _____

Pre-observation coaching: _____

Post-observation coaching: _____

Key topics and observations discussed during coaching (including but not limited to lesson planning, math content, instruction, classroom culture, active learning, questioning techniques, and formative assessment):

Goals and objectives set with teacher: _____

Plans for next visit and other follow-up:

[Adapted from D.A. Yopp Consulting, used with permission.]

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

	SA	A	UN	D	SD
	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree
1. The teacher seemed open to discussion.	SA	A	UN	D	SD
2. The teacher seemed open to criticism.	SA	A	UN	D	SD
3. The teacher seemed willing to reflect on his or her teaching practices.	SA	A	UN	D	SD
4. The teacher seemed to value my input.	SA	A	UN	D	SD
5. The teacher and I have a relationship of trust	SA	A	UN	D	SD
6. The teacher initiated discussion with specific examples from the lesson such as, but not limited to student comments or student work to enhance our dialogue.	SA	A	UN	D	SD

Please rate the next items on a scale from 1 to 5, 1 being *not at all* and 5 being *to a great extent*.

	Not at all				To a great extent
7. The teacher and I discussed significant and worthwhile mathematical content.	1	2	3	4	5
8. The teacher and I discussed ways of planning lessons.	1	2	3	4	5
9. The teacher and I discussed ways of incorporating aspects of active learning like think / pair / share into their lessons.	1	2	3	4	5
10. The teacher and I discussed ways of incorporating the use of questioning strategies into their instruction.	1	2	3	4	5
11. The teacher and I discussed ways to incorporate formative assessment techniques into the lessons.	1	2	3	4	5
12. The teacher and I discussed ways to improve the classroom culture, such as encouraging students to participate or having students listen to one another.	1	2	3	4	5
13. The teacher and I set goals and objectives aimed at implementing ideas and addressing the issues we discussed.	1	2	3	4	5
14. Other: (Please Describe)	1	2	3	4	5

APPENDIX H

COACHING REFLECTION INSTRUMENT - T

Coaching Reflection Instrument (for teachers to fill out)

Complete this form after each coaching session to help us improve the coaching process. **DUE WEEKLY TO JEROME'S MAILBOX BY END OF DAY FRIDAY (OCT 24, 31, NOV 7, 14)**

Teacher Name: _____ Observer Name: _____

Date of visit: _____ Total time spent with Coach: _____

Time coach spent: Observing the classroom: _____

Pre-observation coaching: _____

Post-observation coaching: _____

Key topics and observations discussed during coaching (including but not limited to lesson planning, math content, instruction, classroom culture, active learning, questioning techniques, and formative assessment):

Goals and objectives set with coach: _____

Plans for next visit and other follow-up:

Please indicate the degree to which you agree or disagree with each statement below by circling the appropriate letters to the right of each statement.

SA **A** **UN** **D** **SD**
 Strongly Agree Agree Uncertain Disagree Strongly Disagree

- | | | | | | |
|---|----|---|----|---|----|
| 1. I felt comfortable communicating with my coach. | SA | A | UN | D | SD |
| 2. I feel my coach respects my opinions and understands my situation and the challenges I face. | SA | A | UN | D | SD |
| 3. I feel comfortable with my coach reflecting on my teaching practices and to sharing impressions and perspectives about my instruction. | SA | A | UN | D | SD |
| 4. I value my coach's input. | SA | A | UN | D | SD |
| 5. My coach and I have a relationship of trust | SA | A | UN | D | SD |
| 6. My coach enhanced our dialogue with specific examples from the lesson such as, but not limited to student comments or student work. | SA | A | UN | D | SD |

Please rate the next items on a scale from 1 to 5, 1 being *not at all* and 5 being *to a great extent*.

- | | | | | | |
|---|------------------|---|---|---|-------------------------|
| | Not
at
all | | | | To a
great
extent |
| 7. My coach and I discussed significant and worthwhile mathematical content. | 1 | 2 | 3 | 4 | 5 |
| 8. My coach and I discussed ways of planning lessons. | 1 | 2 | 3 | 4 | 5 |
| 9. My coach and I discussed ways of incorporating aspects of active learning, like think / pair / share into my lessons. | 1 | 2 | 3 | 4 | 5 |
| 10. My coach and I discussed ways of incorporating the use of questioning strategies into my instruction. | 1 | 2 | 3 | 4 | 5 |
| 11. My coach and I discussed ways to incorporate formative assessment techniques into my lessons. | 1 | 2 | 3 | 4 | 5 |
| 12. My coach and I discussed ways to improve the classroom culture, such as encouraging students to participate or having students listen to one another. | 1 | 2 | 3 | 4 | 5 |
| 13. My coach and I set goals and objectives aimed at implementing ideas and addressing the issues we discussed. | 1 | 2 | 3 | 4 | 5 |
| 14. Other: (Please Describe) | 1 | 2 | 3 | 4 | 5 |

[Adapted from D.A. Yopp Consulting, used with permission.]

APPENDIX I

COACHING IMPACT INVENTORY - C

Coaching Impact Inventory - Coach Version

Name: _____

Impact on the Teacher's/Partner's Instruction. Please rate the following items on a scale from 1 to 5, 1 being *no impact* and 5 a very large impact. View the following items as overall assessments of the impact coaching had on the teacher's instruction. This is not a value judgment, but rather a measure of whether the teacher's instruction was changed because of coaching. Keep in mind that you are not averaging individual coaching sessions, but rather encapsulating your overall assessment of the impact coaching had on the teacher's practice over the last month.

	No impact	Small Impact	Moderate Impact	Large Impact	Very large impact
1. The mathematical content the teacher and I discussed.	1	2	3	4	5
2. Discussions with the teacher about ways of planning lessons.	1	2	3	4	5
3. Discussions with the teacher about incorporating active learning strategies into their instruction.	1	2	3	4	5
4. Discussions with the teacher about incorporating questioning strategies into their instruction.	1	2	3	4	5
5. Discussions with the teacher about classroom management issues, such as but not limited to disruptive students.	1	2	3	4	5
6. Discussions with the teacher about lesson implementation issues, such as mistakes made during the lecture.	1	2	3	4	5
7. Discussions with the teacher about incorporating formative assessment techniques into their instruction.	1	2	3	4	5
8. Discussions with the teacher about ways to improve classroom culture, such as but not limited to encouraging students to participate or having students listen to one another.	1	2	3	4	5
9. The goals and objectives the teacher and I set that were aimed at implementing the ideas and addressing the issues we discussed during our pre/post conferences.	1	2	3	4	5
10. Other: (Please Describe)	1	2	3	4	5

[Adapted from D.A. Yopp Consulting, used with permission.]

APPENDIX J

COACHING IMPACT INVENTORY - T

Coaching Impact Inventory - Teacher Version Name: _____

Likely Impact on YOUR Instruction. Please rate the next items on a scale from 1 to 5, 1 being *no impact* and 5 being *very large impact*. View the following items as ratings of overall assessment of the impact coaching had on your instruction. This is not a value judgment, but rather a measure of whether your instruction was changed because of coaching. Keep in mind that you are not averaging individual coaching sessions, but rather encapsulating your overall assessment of the impact of the combined coaching project during the last month. **If you do not remember discussing an item, then rate that item as no impact.**

No impact	Small Impact	Moderate Impact	Large Impact	Very large impact
-----------	--------------	-----------------	--------------	-------------------

1. The mathematics content my coach and I discussed.

1	2	3	4	5
---	---	---	---	---

2. Discussions with my coach about ways of planning my lessons.

1	2	3	4	5
---	---	---	---	---

3. Discussions with my coach about ways to incorporate active learning strategies into my instruction.

1	2	3	4	5
---	---	---	---	---

4. Discussions with my coach about ways to incorporate questioning strategies into my instruction.

1	2	3	4	5
---	---	---	---	---

5. Discussions with my coach about classroom management issues such as, but not limited to, disruptive students.

1	2	3	4	5
---	---	---	---	---

6. Discussions with my coach about lesson implementation issues such as, but not limited to, mistakes made during my lecture.

1	2	3	4	5
---	---	---	---	---

7. Discussions with my coach about ways to incorporate formative assessment techniques into my instruction.

1	2	3	4	5
---	---	---	---	---

8. Discussions with my coach about ways to improve classroom culture, such as encouraging students to participate or having students listen to one another.

1	2	3	4	5
---	---	---	---	---

9. The **goals** and **objectives** my coach and I set that were aimed at implementing the ideas and addressing the issues we discussed during our pre/post conferences.

1	2	3	4	5
---	---	---	---	---

10. Other: (Please Describe)

1	2	3	4	5
---	---	---	---	---

[Adapted from D.A. Yopp Consulting, used with permission.]

APPENDIX K

OBSERVATION REFLECTION FORM

Observation Reflection Form

Observation of: _____ Course: _____ Date: _____

Observed by: _____

What teaching techniques/strategies/ideas did the teacher use? Were they effective?

Specifically, pay attention to the teacher's use of:

Formative assessment (checking students' understandings)

Questioning techniques (how questions are asked and what they evoke)

Active learning (student engagement)

What did you learn from your observation experience? (Describe any techniques or ideas the teacher used that you thought were interesting or informative.)

How will you use what you've learned in your classroom?

APPENDIX L

COACHING SURVEY

APPENDIX M

OBSERVATION SURVEY

APPENDIX N

WORKSHOP EVALUATION SURVEY 2008

Teacher Training Workshop Evaluation 2008

1. Please rate and comment on the following workshops:

Description of Activity	Very Good	Good	Okay	Neutral	Poor	Missed	Comments
Aug. 28 – Introduction, Concerns, the First Day							
Sept. 10 – Reflective Teaching							
Sept. 17 – Active Learning							
Sept. 24 – Questioning Techniques							
Oct. 1 – Formative Assessment							
Oct. 8 – Philosophies of Teaching							

2. What have you learned or gained by participating in this workshop?

3. What did you hope to learn that was not discussed during the workshop? List particular topic areas that you feel should be included in this seminar in the future.

4. Did you watch your video taped lesson? (If “yes,” how did it help? If “no,” why not?)

5. Do you believe a similar seminar should be offered to next year’s new graduate teaching assistants in the department?

- 6. The following questions pertain to the meeting schedule:**
 - a. Given the same amount of meeting time, would it be helpful to have more meetings before classes begin and less during the semester?

 - b. If you answered yes to part (a), would you be willing/able to come to campus (in August) a few days earlier to accomplish this?

 - c. Assuming the total seminar hours will remain the same, how would you arrange the meeting schedule to better accommodate your needs?

7. Please comment on any other aspects regarding the workshop. Any and all feedback is greatly appreciated.

8. Please comment on the effectiveness of the workshop leader.