IMPACTS OF GRADUATE STUDENT CONTENT SPECIALISTS SERVING IN MIDDLE SCHOOL CLASSROOMS ON TEACHERS AND GRADUATE STUDENTS

A Dissertation

by

DIANA L. MOWEN

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

DOCTOR OF PHILOSOPHY

May 2007

Major Subject: Agricultural Education

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Approved by:

Chair of Committee, Julie Harlin
Committee Members, James Lindner
Gary Wingenbach
Larry Johnson
Head of Department, Christine Townsend

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ABSTRACT

Impacts of Graduate Student Content Specialists Serving in Middle School Classrooms on Teachers and Graduate Students. (May 2007)

Diana L. Mowen, B.S., University of Illinois;

M.Ed., North Carolina State University

Chair of Advisory Committee: Dr. Julie Harlin

Improving student achievement is a major concern across the United States. One strategy being implemented to help students achieve in math and science is the partnering of teachers with professionals in math and science careers. One such program is the *Fellows Integrate Math/Science in Rural Middle Schools* program, from which this research stems.

The intent of the program was to match middle school teachers with graduate students preparing for careers in science, technology, mathematics, or engineering fields. The graduate students spent ten hours a week in classrooms, interacting with teachers and students. Improved student performance in math and science, improved teacher content knowledge, and improved graduate student communication skills were expected program outcomes. This research assessed the impact of program participation on the teachers and graduate students involved.

Data were collected from 33 middle school teachers and 33 graduate students over the course of two years of program participation. Questionnaires included a pre-

post measurement of knowledge, experience, and comfort level with education related groups and issues and summative program evaluations.

Major findings of the research included:

1. Teacher knowledge, experience, and comfort levels with education related groups and issues did not change significantly because of participation in the program.
2. Graduate students experienced a decrease in knowledge, experience, and comfort level with several education related groups and issues from the beginning of the school year to the end. Knowledge decreases were noted with the following groups and issues:

    a. High school students

    b. Teaching college students

    c. Theories of learning

    d. Planning a project

    e. Following through on project tasks

    Experience level decreases were noted with the following groups and issues:

    a. Science education reform

    b. Current issues in K-12 education

    c. Teaching college students

    d. Theories of learning

    e. Assessing student learning

Comfort level decreases were noted with the following groups and issues:

a. Elementary school students

b. University faculty engaged in K-12 education

c. Science education reform

d. Teaching college students

e. Theories of learning

f. Evaluating educational activities

3. Graduate student gender, race, and age were not found to be predictors of success in this partnership program.

DEDICATION

In memory of Dr. Jeff Moss;

a wonderful mentor

ACKNOWLEDGEMENTS

I would like to thank God for the hand that has guided me to this point. And beyond. Without faith, this never would have been possible.

Thank you to my wonderful husband, Trent. I could never have done this without your encouragement and understanding. Thank you for your love, your support, and for reading New Horizons all those years ago!

Thank you to my committee. Dr. Harlin, you have been a great role model and I hope that I can develop similar traits as I evolve as a teacher educator. Dr. Lindner, Dr. Wingenbach, and Dr. Johnson, thank you for all of your support and guidance through this process.

The Department of Agricultural Leadership, Education, and Communications is a wonderful family to be a part of. I am so thankful to have been a part of the teacher education work group and have the opportunity to work with Dr. Alvin Larke, Dr. Gary Briers, and Dr. Grady Roberts. From our work together I have learned to always work to improve, to appreciate the strengths of others, and how to practice The Diamond Rule. Know that the kindness and support you have shown me will be paid forward with interest.

Everyone has someone that helps keep them sane when they are overwhelmed. For me, that person was Amy Harder. She knew how to make me smile when I wanted to scream, she always laughed at my jokes, and any time I would get too proud of my achievements, she would achieve something bigger and better to motivate me to get back to work. We’ll see who has the last plaque.

Thank you to my family for always believing I could do anything I set my mind to and encouraging me to chase my dreams even when they take me far from home.

Final special thanks goes out to my first and second grade teacher, Mrs. Roberts. It was in her classroom that I learned to love learning. Sometimes I wonder how I got this far, and I know that my success now is due in part to my success then. Thank you for your positive influence.

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CHAPTER I

INTRODUCTION

Background of the Study

This study stems from the need to improve students' performance in science and mathematics. In the United States, students' performance on math and science assessments has lagged behind those of students in other countries for decades (NSF, 2002). Concern over unsatisfactory levels of student achievement led to the passing of the No Child Left Behind Act, also known as Public Law 107-110, in 2001. While the No Child Left Behind Act encompasses many things, one of the major requirements is an improvement in the quality of teachers that are in classrooms nationwide (USDE, 2001).

Public Law 107-110 states that high quality teachers are a necessity for raising student achievement (USDE, 2001). In order to fulfill this need, teachers need to be well-trained and given the proper tools to teach students. Beyond that, they need to be held accountable for using those tools. This requires not only proper training prior to teacher certification, but also providing professional development opportunities that will allow teachers to grow and improve throughout their careers and add tools to their teacher toolbox (Darling-Hammond, 1998).

This dissertation follows the style of the *Journal of Agricultural Education.*

This study centers around a program implemented to address teacher quality in rural middle schools of Brazos County, Texas. As United States Department of Education statistics continued to show lack of improvement in student achievement, the National Science Foundation (NSF) began funding an initiative to bring more content knowledge into classrooms in an effort to stimulate youth's interest in science and math. The National Science Foundation has funded many programs throughout the nation which have experienced varying degrees of success. The *Fellows Integrate Math/Science in Rural Middle Schools* is an NSF funded program designed to not only kindle excitement in youth about math and science topics and instill an appreciation for public education into graduate students from diverse professional science and mathematics fields, but also improve content knowledge of public education teachers through ongoing, in-classroom, professional development.

Statement of the Problem

One problem facing public school teachers today is that many teachers lack in-depth content knowledge for the subject they teach (NCTAF, 1996) and the majority of teachers have only a bachelor's degree (NCES, 2006). Added to this is the fact that many teachers are teaching subjects in which they did not have a college major or minor (NCES, 2006). This translates to teachers being hired with a broad general knowledge of their subject matter and little specific expertise.

This initial lack of expertise is seldom corrected, as once teachers take a job they often lack the time to update and deepen their content knowledge and revise their curriculum in ways that allow students to meet state and federal education standards.

Lacking the time to pursue needed development on their own, teachers depend on school sponsored inservice activities for their professional growth. Professional development opportunities are often chosen by school administrators and required for all teachers in the school district (Loucks-Horsley, Styles, & Hewson, 1996), regardless of grade or subject taught which minimizes the chance of exposure to teaching skills and curriculum resources specific to any one subject.

While there are resources created by content experts available to aid teachers with incorporating more hard science and math into their curriculum, teachers often do not pursue these resources because of a lack of classroom friendliness. Many curriculum resources are developed at universities or through professional companies or government agencies (USDE, 2006). These resources are designed for teachers to implement in their classrooms as teaching aids that cover basic curriculum material while more deeply incorporating the content in which the university department or professional company specializes. While the intention is for these resources to be immediately useable, often they do not include or even conform to state and federal teaching standards and at times are designed without consideration of what amount of material can actually be covered in a typical class period.

Even if the materials are excellent, teachers often can not use them without first connecting the materials to the appropriate standards and modifying the content to fit the needs of their students (USDE, 2006). Modifications may be needed for students with learning disabilities or language barriers. Activities included with materials need to be economical, doable in a normal class period with time for set-up, clean-up, and reflection, cover necessary curriculum content, and be engaging for all students. For this reason, teachers may not take the time to seek out new materials from academic or professional sources; instead using resources endorsed by the school district and keeping the same curriculum in place for years with very little modification.

This practice of expecting teachers to have a broad general knowledge of the subject matter they will be teaching and not making allowances for continued education and curriculum remodeling is part of problem in public education that has contributed to a large number of students achieving at unacceptable levels. These underachieving students develop poor attitudes toward math and science and fail to pursue further education appropriate for entering academic or professional careers (Anderman & Maehr, 1994). There is also a growing concern from academic and professional sects about the lack of qualified people pursuing careers in the hard sciences, technology, engineering, and mathematics (STEM). However, people in academic and professional settings often lack an understanding of public education problems and the role they may play in improving student achievement.

Purpose of the Study

The purpose of this study was to describe the impact of an intervention on public education teachers and future professionals in science, technology, engineering, and mathematics related careers. By tracking teachers self-perceived knowledge, experience, and comfort levels over time, changes attributed to the presence of a content specialist (graduate student fellow) in their classroom may be exposed. Impacts may also be noted in the graduate student fellows as they pursue professional careers due to their exposure to the current realities of public education. The general knowledge level of public education math and science teachers and the growing disconnect between public education and professionals in STEM careers are important issues that may have interconnected solutions (Tanner, Chatman, & Allen, 2003). This study sought to look at the interaction of teachers and graduate students to see if future interactions may be part of the solution to providing greater content knowledge for public school teachers and also building appreciation in professionals for the issues present in public schools.

Significance of the Study

This research will be significant for several audiences. Teachers are a major audience for this research. Teachers will be interested in pursuing new resources for their classrooms by collaborating with universities or professionals in science or math careers. By pursuing a relationship, teachers may open themselves to increasing their content knowledge with this professional development tool at little or no cost for themselves.

Administrators will be interested in these opportunities for their teachers. An opportunity to improve teacher content knowledge, confidence, job satisfaction and student achievement with little or no cost to the school district could be intriguing and administrators may be in a position to seek out and encourage these professional development opportunities for groups of teachers within the same district.

Scientists and mathematicians working in university and/or professional settings will look at this research and feel compelled to become involved in similar work. They may see this as an opportunity to share knowledge, find out what is going on in public school and inspire the next generation of scientists and mathematicians.

Finally, teacher educators will also find this research useful. Armed with the knowledge that newly certified teachers will need to continue building content knowledge and pursuing professional development, teacher educators may use this study as an arrow to point teachers toward new and profitable opportunities. Connections may also be established early in teacher preparation programs that can be pursued and built upon over time. Pre-service teachers may be exposed to university resources outside of their immediate department and encouraged to pursue continued contact after taking a teaching position.

Definition of Terms

Content Knowledge: Knowledge of ideas, principles, theories, and laws of science and mathematics.

Fellow: A graduate student enrolled at Texas A&M University in a science, technology, engineering, or mathematics based major and accepted into the NSF-GK-12 program through an application process.

GK-12: Grades kindergarten through 12th grade.

NSF: National Science Foundation

Pedagogical Knowledge: Knowledge of youth development and learning.

Professional Development: Activities undergone by teachers to improve some aspect of their job performance.

Resident Mathematician: A graduate student attending Texas A&M University and pursuing a career where knowledge and practice of mathematic principles are key. A resident mathematician has been accepted into the NSF GK-12 program to work with a middle school math teacher and 6th, 7th, and 8th grade students in their math classroom for 10 hours a week for an entire school year.

Resident Scientist: A graduate student attending Texas A&M University and pursuing a career where knowledge and practice of scientific principles are key. A resident scientist has been accepted into the NSF GK-12 program to work with a middle school science teacher and 6th, 7th, and 8th grade students in their science classroom for 10 hours a week for an entire school year.

STEM: Science, technology, engineering, and mathematics.

Teacher: A person certified to teach in the state of Texas and working with 6th, 7th, and/or 8th graders at schools within a 30 mile radius of College Station, Texas.

Limitations

It is recognized that this study is limited by the following:

1. This study only explores the experiences of graduate students and middle school teachers participating in the *Fellows integrate math and science into rural middle schools* program.
2. The varied personal experiences and backgrounds of participants may have influenced their perceptions.

Delimitations

This study was delimited to include only those individuals involved in the *Fellows integrate math and science into rural middle schools* project during the 2004-2005 and 2005-2006 school years.

CHAPTER II

REVIEW OF LITERATURE

Introduction

In order to best focus on the issue, it is necessary to first look at how teachers are prepared and continue to study the opportunities teachers have for growth and improvement throughout their careers. This literature review seeks to synthesize literature relative to teacher content knowledge, the impact of teacher content knowledge on student achievement, professional development opportunities, possible outcomes of building partnerships with professionals outside of education, and finally, results of recent GK-12 programs supported by the National Science Foundation. First, evidence is provided on teacher training and the elements of content knowledge and pedagogical knowledge that are required. Following content knowledge is a discussion of impacts of teacher content knowledge and professional development activities on the achievement of students. Professional development opportunities available for teachers and their outcomes are discussed followed by professional development opportunities involving partnerships and finally, a more specific description of recent GK-12 programs that have been funded by the National Science Foundation and conducted throughout the United States. These issues combine to tell a story about K-12 teachers and possibilities that may be explored to improve student achievement.

Content Knowledge

In order for a teacher to enter the classroom, they are expected to meet certain criteria. While these criteria have changed over time, the need for teachers to meet standards has always been in existence. Looking back at examinations teachers were required to take in the late 1800's, the majority of questions were dedicated to general content knowledge, content knowledge specific to the area the teacher was planning to teach and less than 10% of the exam was dedicated to pedagogical knowledge (Shulman, 1986). More recently, in the mid to late 1900's there was a shift in teacher preparation. Teachers were still expected to exhibit content knowledge, pedagogical knowledge, and also meet state and federal standards in order to earn a teaching certificate (Turner-Bisset, 1999). However, the emphasis shifted to more greatly stress pedagogical skills with much less importance put on specific content knowledge (Shulman, 1986).

This shift became recognized as a liability throughout the past decade as student achievement continued to fall short of expectations. In 2001, the No Child Left Behind Act was passed and its provisions created a great demand for "highly qualified teachers" (USDE, 2001) and an "accountability system" (USDE, 2001) to track student achievement. These provisions have resulted in a need for professional development opportunities to increase the strength of teachers' content knowledge.

Grossman and Stodolsky delved into this issue in 1994, searching for a description of how K-12 teachers should be prepared in the disciplines of education to represent those disciplines to students, but found no consensus. What little research existed at that time focused on higher education instead of elementary and secondary grades (Grossman & Stodolsky, 1994). Further study by Grossman and Stodolsky in 1995 found that teachers who study in a particular discipline become part of a subculture and exhibit associated traits when they enter the teaching profession. These traits go beyond content knowledge and actually influence how teachers work with students of different ability levels (i.e., tracking, sequencing). So, evidence suggested some ideas absorbed in discipline related courses bled over into pedagogy to compliment or denigrate the specific pedagogical content taught.

These knowledge bases combine in practice when those seeking teacher certification complete their fieldwork. Commonly, the field experiences of student teachers tests their pedagogical skills. Student teachers are confident in their content knowledge but unskilled in the translation of their knowledge to their students (Grossman & Richert, 1988). This leads to an assumption that student teachers expend their energy practicing pedagogical skills and not on furthering their content knowledge while completing their fieldwork experiences prior to earning their teaching certification. Therefore, the subject matter content knowledge a preservice teacher has before the start of student teaching is very close to the amount they will have if they take a teaching job immediately upon graduating. Increases in teacher content knowledge are likely to be due to experience and professional development activities.

Impacts of Teacher Professional Development on Student Achievement

Currently, all 50 states require a minimum number of hours of professional development be completed by all teachers each year. The purpose of professional development activities is to help teachers further develop both technical and pedagogical skills (Anderson, Barrick, & Hughes, 1992). Professional development hours may include school-wide, school district-wide, or even county-wide inservice activities (Wilson & Berne, 1999) which are delivered in lecture format. This common practice does not follow the findings of Garton and Chung (1996), who stated that beginning teachers prefer workshop style inservice activities.

According to Joyce and Showers (2003), successful professional development activities create knowledge of educational theories, practices, and/or new academic content. Besides creating knowledge, successful professional development activities also result in positive attitude changes, skill development, and transfer of new skills into classroom practice (Joyce & Showers, 2003). Goldhauber (2002) stated that in science and math classes, teacher's subject matter knowledge is associated with higher student performance. This statement echoes the work of Greenald, Hedges, and Laine (1996) where a meta-analysis study revealed a positive relationship between academic preparation of teachers and student achievement. In 1999, Darling-Hammond found that well prepared teachers can impact student achievement more than background factors such as poverty, minority status, and native language. Further support of the impact teacher subject knowledge has on student achievement can be found in Hill, Rowan, and Ball's study of teachers' mathematical knowledge and student achievement (in press) which corroborates evidence that teachers with greater subject knowledge generate higher achievement results in their students.

With proof of how important teacher subject knowledge is, professional development opportunities are more important than ever. Not only do teachers need to have a solid foundation of subject matter knowledge, but they need to keep updated on new findings and methods.

Professional Development for Teachers

Teachers enter the classroom with the content knowledge foundation they gained in previous experiences which often only includes four years of university study. While this is considered insufficient in many other countries (Darling-Hammond, 1998), the education system in the United States finds it acceptable. In fact, many universities are reducing the number of hours required to complete bachelor's degrees, therefore eliminating the need for some of the content courses preservice teachers previously took. For the time that current practices for training and certifying teachers to enter the classroom prevail, the most common way to address what teachers lack is through professional development opportunities.

A 1990 study found that professional development was one of 11 significant factors that influence teaching effectiveness (Harper, Weiser, & Armstrong, 1990). Current professional development opportunities for teachers are also not highly regarded as most are geared to fulfill requirements rather than address needs. Often entire school districts will be required to attend a day long lecture based training that addresses a single reform issue such as implementation of a state curriculum or integrating technology into the classroom (Lewis, Basmat, Carey, Bartfai, Farris, & Smerdon, 1999). Inservice activities focused on single issues only meet the needs of a few teachers. This is especially true when the audience is a mix of traditionally certified teachers, with strong pedagogical knowledge, and provisionally certified teachers, with more technical expertise. "It is likely that these two groups of teachers do not have the same inservice needs (Roberts & Dyer, 2004)" A 1989 study by Smylie asked teachers to rank 14 learning opportunities. Responses indicated that teachers found district inservice activities to be at the bottom of the list in value to the teacher. More valuable learning occurs when teachers pursue individual learning opportunities such as pursuing a higher degree or joining a professional organization in their field (Wilson & Berne, 1999). To better address the need for content knowledge, schools should allow and even encourage teachers to seek professional development opportunities that are designed for their content area and allow teachers to learn by doing; by investigating and building an understanding of content rather than listening to lectures (Loucks-Horsley, Styles, & Hewson, 1996).

Current professional development opportunities prove their success by evaluating whether teachers can perform the actions taught. This evaluation does not, however, assess the integration of workshop content into the classroom or its impact on student achievement (Loucks-Horsley & Matsumoto, 1999). The connection between teacher content knowledge, teacher professional development, and student achievement is still not well researched or understood, however some new approaches to professional development, such as partnerships, are producing positive results. When teachers were asked to rank learning opportunities in order of value, opportunities they could take advantage of in their classroom were rated number one (Smylie, 1989). In order to take advantage of this finding and meet the requirements of the No Child Left Behind Act, numerous programs have been developed which partner professionals with teachers and allow in-classroom interaction which could result in increased content knowledge for participating teachers.

Building Partnerships

While the No Child Left behind Act clearly states a requirement for schools to provide quality teachers for students, this Act goes a step further and suggests that K-12 math and science education will be strengthened through math and science partnerships as states work with institutions of higher learning to improve instruction and curriculum (2000). The idea of partnerships has long been encouraged in the field of agricultural education with the idea that partnerships expand resources for all parties and add relevance to the content being taught (Williams, 1991). The expansion of partnerships into science and mathematics education could bring the same benefits.

Several schools have acted on the suggestion and formed partnerships between teachers and local university faculty. The overall reporting on these partnerships claims positive results for teachers, faculty, and GK-12 students (Battle & Hawkins, 1996; Richmond, 1996; Howe & Stubbs, 1996). In some instances, teachers were able to learn specific content, interact with the scientists and, in some cases, other teachers, to more clearly understand concepts and synthesize ideas that would be usable in the classroom. In the instance studied by Howe and Stubbs, teachers were part of a learning community and had a content specialist readily available (1996). This program resulted in greater confidence in teachers, increased content knowledge, and experience in taking in-depth content and creating lessons tailored for specific students (Howe & Stubbs, 1996).

In another instance, collaboration between scientists and science teachers resulted in a new, technologically rich, curriculum ready-made for the classroom (Battle & Hawkins, 1996). Richmond (1996) states that while in a collaborative setting both the scientist and the teacher have knowledge the other does not and communication of that knowledge is key for successful interaction. When that communication is successful it provides opportunities for significant reforms on both sides.

Results of Recent GK-12 Programs

Aware of the opportunities for impact in public school and also in the professional fields of science and mathematics, the National Science Foundation has offered financial support in the form of grants designed to support programs improving science, technology, engineering, and mathematics in public schools (NSF, 2006) Some programs include single session classroom visits and small prolonged contact programs as part of larger recruitment efforts such as the Engineering Outreach Program at North Carolina State University (Bottomley & Parry, 2002). Others are more centered on increasing teacher competency such as the Michigan Tech program, which aims to aid middle school math and science teachers in transforming their current curriculum into cutting edge classes that better prepare students to meet state and national standards (Sorby & Baartmans, 2001).

Many NSF funded programs include components to develop students interest in STEM careers and improve graduate students communication skills while improving content knowledge of public school teachers (Hamisch, Comstock, Bruce, & Buell, 2005; Lundmark, 2004, Lyons, Banich, Brader, & Ebert, 2002). An assessment of a NSF

GK-12 program at Cornell provided evidence that graduate student participants were positively impacted by their participation. Graduate students reported they had improved their teaching skills and were interested in continuing outreach activities throughout their careers (Trautmann & Krasny, 2006). However, there is little available research that describes how teachers are impacted by involvement in NSF GK-12 programs. These programs are relatively new and their impacts have yet to be fully documented. It is important to research GK-12 programs and assess their impact on improving teacher content knowledge and student achievement.

CHAPTER III

METHODOLOGY

Purpose of the Study

This study is part of a National Science Foundation Grant project that was approved by the Institutional Review Board at Texas A&M University. The intent of this study was to describe impacts of having graduate students serve as content specialists in middle school classrooms on graduate students and teachers. A secondary purpose was to determine if graduate student characteristics can serve as predictors of success for similar future programs and graduate student/teacher partnerships. This chapter will include a description of the population, instruments, and procedures utilized in this study.

Objectives

This study was guided by the following objectives:

1. Describe demographic characteristics of teachers and graduate student fellows participating in the NSF GK-12 program entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.
2. Describe the knowledge, experience, and comfort levels of graduate students and teachers and the competency levels of graduate students in education related areas.
3. Determine changes in knowledge, experience, comfort, and competency levels of graduate student fellows and middle school teachers in education related areas that occur over time while

participating in the NSF GK-12 project entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.

4. Determine if graduate student fellow characteristics can be used to predict success of future programs developed for science/math professionals and public education teachers.

Population

The population for this study was middle school math and science teachers in Texas and graduate students at Texas A&M University pursuing degrees in science, technology, engineering and/or mathematics areas. The sample for this study was a convenience, non-probability sample (Gall, Gall, & Borg, 2003) of middle school math and science teachers and graduate student fellows participating in the NSF GK-12 project entitled: *Fellows Integrate Science/Math in Rural Middle Schools* during the 2004-2005 and 2005-2006 school years. Selection of this sample allowed for collection of data from middle school math and science teachers interested in improving student achievement by finding new and innovative resources for their classrooms and also from graduate students pursuing professional careers in science, technology, engineering and/or mathematics but interested in providing resources for public education.

A total of 33 graduate students and 33 middle school teachers participated in the program during the two years studied. Graduate students remaining with the program into the second year were placed with different middle school teachers than they worked with during the 2004-2005 school year. This resulted in new and different interactions for every continuing participant in the program. For this reason, responses from continuing participants are considered to be independent of the responses from the previous school year.

Instrumentation

Data collection for this study will involve the use of four survey instruments. The first instrument, entitled, Knowledge, Experience, and Comfort Levels (KEC), was modified from the *Louisiana Tech 2003 GK Teaching Fellow Intake Survey*. This instrument contained 21 statements that measure self perceived knowledge levels, experience levels, and comfort levels in education related areas. These 21 statements were categorized into three measurement scales for analysis; (1) education stakeholders, (2) teaching issues and strategies, and (3) productivity skills.

Knowledge, Experience and Comfort Level Questionnaire

Education Stakeholder Items

Survey instrument items that assessed participants' knowledge, of, experience with, and comfort level with education stakeholders were as follows:

1. K-12 teachers
2. Elementary school students
3. Middle school students
4. High school students
5. K-12 administrators
6. University faculty engaged in K-12

Teaching Issues and Strategies Items

Survey instrument items that assessed participants' knowledge, of, experience with, and comfort level with teaching issues and strategies were as follows:

7. Science education reform
8. Current issues in K-12 education
9. Teaching college students
10. Planning a learning experience for K-12
11. Theories of learning (e.g. Constructivism)
12. Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)
13. Assessing student learning
14. Evaluating educational activities (e.g. classes, workshops)

15 Technology in instruction

16. Interdisciplinary approaches to inquiry and problem-solving

Productivity Skills Items

Survey instrument items that assessed participants' knowledge, of, experience with, and comfort level with productivity skills were as follows:

17. Planning a project
18. Following through on project tasks
19. Keeping a project on schedule
20. Communicating effectively with other group members.

21. Being a team or project leader

Responses were based on a Likert-type scale ranging from 1-very low to 5-very high. A higher numeric value for any scale indicated higher levels of knowledge, experience, and comfort. Reliability coefficients for the instrument used at Louisiana Tech University were unavailable. Validity and reliability of the revised instrument used for this study were established by conducting a pilot test. Reliability of the data collected during this study was tested using the Statistical Package for the Social Sciences (SPSS) 14.0. The questionnaire used in this study produced reliability coefficients for the scales ranging from .72 to .87, as shown in Table 1.

This instrument was administered to both teachers and graduate students. Teachers completed this questionnaire during each summer training session and at the end of each school year. Graduate students also completed the questionnaire during each summer training session and at the end of each school year.

Table 1
Knowledge, Experience, and Comfort Level Questionnaire Internal Scales and Reliability Coefficients

Scale	Group or Issue	n	Alpha[a]
Education Stakeholders		39	.72
	Middle school students		
	K-12 teachers		
	University faculty engaged in K-12		
	K-12 administrators		
	High school students		
	Elementary school students		
Teaching Issues and Strategies		38	.86
	Planning a learning experience for K-12 students		
	Technology in instruction		
	Teaching college students		
	Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)		
	Current issues in K-12 education		
	Assessing student learning		
	Interdisciplinary approaches to inquiry and problem-solving		
	Science education reform		
	Evaluating educational activities (e.g. classes, workshops)		
	Theories of learning (e.g. Constructivism)		

Table 1 continued

Scale	**Group or Issue**	**n**	**Alpha**[a]
Productivity Issues		39	.87
	Planning a project		
	Communicating effectively with other group members		
	Following through on project tasks		
	Keeping a project on schedule		
	Being a team or project leader		

[a] Cronbach's alpha used.

Two additional questionnaires were adapted from instruments used to evaluate student teachers in the Department of Agricultural Leadership, Education, and Communications (ALEC) at Texas A&M University. The Fellow Impact Evaluation questionnaire, adapted from the *Lesson Evaluation Form* used in the ALEC department, allowed teachers to measure the performance of the graduate student in their classroom. This questionnaire consisted of 23 items. This instrument was completed by teachers at the mid-point and end of each school year.

The third questionnaire used in this study was the Program Impact Questionnaire. This instrument was adapted from the *Student Teacher Evaluation Form* utilized in the Department of ALEC and two adaptations were used; one tailored to teachers and the other for graduate students. This instrument measured the overall impact of having the graduate student as a classroom resource on both the graduate student and the teacher. This questionnaire designed for graduate students consisted of 31 items, of which 25 were relevant to this study. The teacher questionnaire included 18 items, of which 17 were relevant to this study. Both questionnaires included items grouped into four categories; 1) Integration, 2) Team Contact, 3) Interaction Results, and 4) Program Organization. The items used in this study are categorized below.

Program Impact Questionnaires

Integration Items

Items on the graduate student questionnaire related to integration were as follows:

1. I was perceived as a role model by students and faculty in my school
2. Students viewed me as a teacher more than a scientist or mathematician
3. I served as a school-wide resource
4. Many activities included math and science principles regardless of the class in which they were presented
5. Inquiry learning was increased in my classroom due to my activities
7. I increased and improved the use of technology in my classroom

Items on the teacher questionnaire related to integration were as follows:

1. My RM/RS provided an appropriate activity for each unit covered.
2. Students did not view the RM/RS as a student teacher
3. The RM/RS served as a school-wide resource
4. Many activities included math and science principles regardless of the class in which they were presented
5. The RM/RS increased and improved the use of technology in my classroom

Team Contact Items

Items on the graduate student questionnaire related to team contact were as follows:

8. I provided a useful link between my lead teacher and university faculty
9. University faculty conducted a presentation in my classroom
11. My students benefited from my contact with university faculty
13. I involved other RM/RS's in my classroom activities
14. My students were influenced by TAMU employees other than me

Items on the teacher questionnaire related to team contact were as follows:

6. My RM/RS provided a useful link between me and university faculty
7. University faculty conducted a presentation in my classroom
8. My students benefited from my contact with university faculty
10. My students were influenced by TAMU employees other than the RM/RS

Interaction Results Items

Items on the graduate student questionnaire related to interaction results were as follows:

15. I improved my lead teacher's content knowledge
16. I have a better understanding of education principles because of working with my lead teacher
17. My activities improved students' learning of state standards

18. I used my entire budget for classroom supplies
19. I provided supplies that my lead teacher will be able to use next year

Items on the teacher questionnaire related to interaction results were as follows:

11. My content knowledge had been improved by the RM/RS
12. I have a better understanding of math and science principles because of working with the RM/RS
13. I am more satisfied with my job because I have an RM/RS in my classroom
14. I am more proficient with technology because of my GK-12 program involvement
15. My use of inquiry learning has increased due to my work with this program

Program Organization Items

Items on the graduate student questionnaire related to program organization were as follows:

20. I spent at least eight hours working directly with students each week.
21. At least one hour was spent planning for upcoming events with the lead teacher each week
24. It is important for professionals in my field to contribute to K-12 math and science education
26. The GK-12 program has influenced how I will contribute to public education in the future

27. I have learned about the needs and difficulties of publication through my involvement in this program
28. I am more organized due to my involvement in this program
30. I have gained communication skills through the GK-12 program
31. The work required of me for participating in this program was worth while for the amount of improvement I made in the classroom

Items on the teacher questionnaire related to program organization were as follows:

16. My RM/RS spent at least eight hours a week working directly with students
17. At least one hour was spent planning for upcoming events with the RM/RS weekly
18. The work required of me for participating in this program was acceptable for the amount of improvement made in my classroom.

Responses were based on a Likert-type scale ranging from 1, strongly disagree, to 5, strongly agree. A higher numeric value for any item indicated a higher level of agreement with the item. The Program Impact questionnaire was completed by both teachers and graduate students at the end of each school year. Validity for these survey instruments was previously established through review by a panel of experts consisting of university faculty engaged in K-12 education and K-12 teachers.

Procedures

The KEC instrument distribution followed a pre-post format and was administered to participants at the beginning and end of each school year. The additional instruments were administered at the end of each school year for a summative evaluation of the performance of the graduate student and the impact of the program on all participants. The beginning-of-the-year questionnaires were distributed during the summer training sessions which were required for all participants. Additional teachers and graduate students were incorporated into the program throughout the school year that had to be administered the questionnaires separately. The end-of-the-year questionnaires were distributed by email. Follow-up procedures outlined by Dillman, (2000) were followed. Follow up procedures included sending out reminders, in this case, by email, after the first wave of responses ended. Reminder contacts were made three times by email and a fourth contact was made by phone to any participants who had not responded after the email contacts.

Protocols and procedures recommended by Lindner, Murphy, and Briers (2001) were used to control for nonresponse error as a threat to external validity of this study. Late respondents are operationally defined as those who respond in the last wave of respondents in successive follow-ups to a questionnaire (Lindner et al., 2001). A minimum number of 30 late respondents is recommended for the number of late respondents to be meaningful practically and statistically, however in cases where the minimum number is not reached, nonresponse error can be controlled for by comparing early to late responses using the first 50% of responses as early and the later 50% as late

(Lindner et al., 2001). In order to address non-response, this study compared early to late respondents by comparing the first 50% of responses with the later 50%. Comparison of responses yielded no differences; therefore nonresponse error is not considered a threat to the external validity of this study and no limitations are placed on the generalizability of the results based upon the responses of late respondents.

Data Analysis

Data were analyzed using Statistical Package for the Social Sciences (SPSS) version 14.0. Demographics were described using descriptive statistics. Means and standard deviations were reported. Compare Means Analysis was used to determine if statistical difference in mean knowledge, experience, and comfort with each of the educational components exists over time. Responses to the performance and impact questionnaires were analyzed by calculating means and standard deviations to determine average performance.

In addition, multiple regression analysis was used to determine if correlations existed between characteristics of graduate student fellows and classroom impact in order to predict success in future programs. The Fellow Impact Questionnaire was used to determine the classroom impact of graduate students. Teachers assessed the graduate students and completed the questionnaire. Responses were them summed to create an overall impact score for each graduate student. The summed scores were used in the multiple regression analysis.

Graduate student gender, race, and age demographics were chosen for analysis. The latest report from the National Center for Education Statistics shows that over 75%

of public school teachers are female and almost half of them are less than 40 years old (NCES, 2006). Analysis of similar characteristics in graduate students was done to determine if classroom success is related to gender or age. There is ongoing concern over the lack of minority teachers (Torres, Santos, Peck, & Cortes, 2004) so this study sought to analyze race of graduate student participants with an interest in utilizing similar programs to increase student contact with minority group professionals.

CHAPTER IV

FINDINGS AND DISCUSSION

Purpose of the Study

The purpose of this study was to describe the impact of an intervention on public education teachers and future academic and business professionals. By tracking teachers self-perceived knowledge, experience, and comfort levels over time, changes attributed to the presence of a content specialist (graduate student fellow) in their classroom were exposed. Impacts were also noted in the graduate student fellows due to their exposure to the public education in the capacity of a content specialist. This study was guided by the following objectives:

1. Describe demographic characteristics of teachers and graduate student fellows participating in the NSF GK-12 program entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.
2. Describe the knowledge, experience, and comfort levels of graduate students and teachers and the competency levels of graduate students in education related areas.
3. Determine changes in knowledge, experience, comfort, and competency levels of graduate student fellows and middle school teachers in education related areas that occur over time while participating in the NSF GK-12 project entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.

4. Determine if fellow characteristics can be used to predict success of future programs developed for science/math professionals and public education teachers.

Objective One

Objective one was to describe the demographic characteristics of graduate student and middle school teacher participants in the *Fellows Integrate Math/Science in Rural Middle Schools* program. A total of 33 graduate students participated in the program during the 2004-2005 and 2005-2006 school years. Nineteen graduate students indicated their gender as female (58%) and 14 indicated male (42%). When asked to specify race, responses were 79% white (n=26), 12% Asian (n=4) and 9% Hispanic/Latino (n= 3). Graduate students ranged in age from 23 to 38 with 20 graduate students younger than 25 (61%), nine graduate students between the ages of 25 and 34 (27%), and four graduate students 35 or older (12%). Eighteen graduate students were in the process of earning Masters degrees (56%) and 15 were working toward Doctoral degrees (45%). Ten graduate students were pursing degrees in mathematics related areas (30%), 21 were in science related majors (64%), and two were in technology related majors (6%). Figures 1-5 depict fellows responses to demographic related questions.

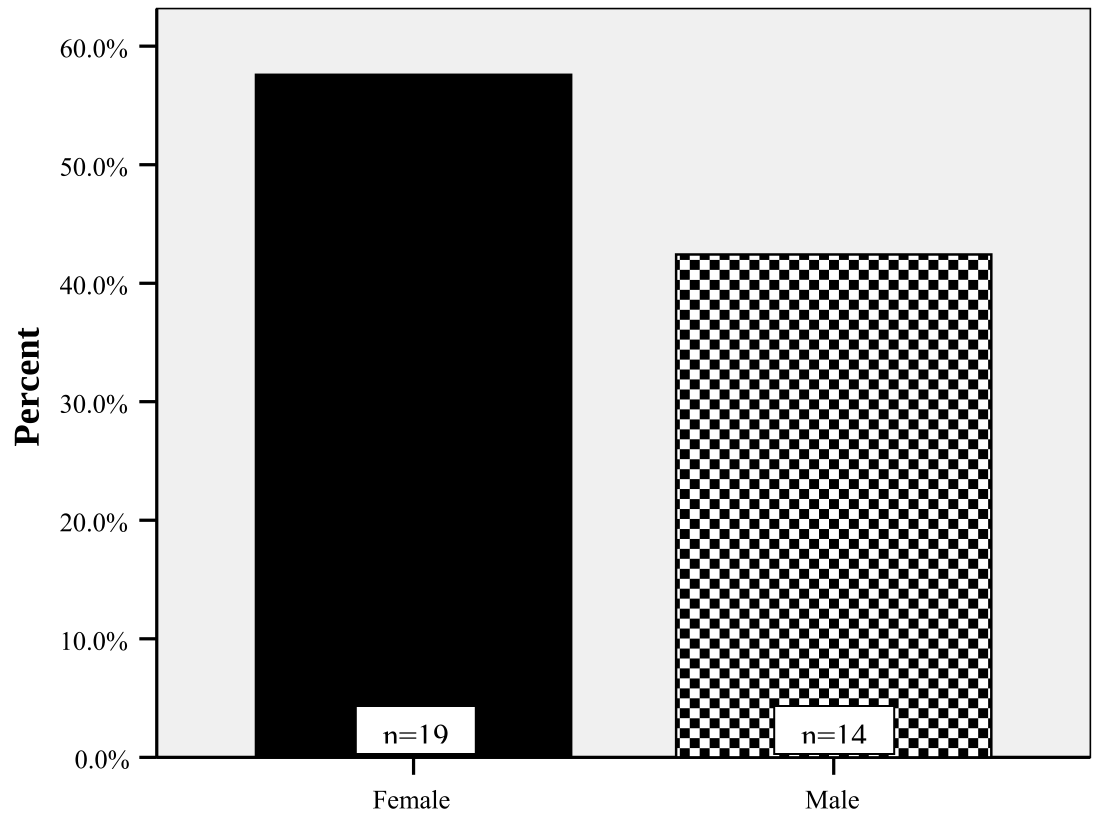

Figure 1. Gender of Participating Fellows (N=33).

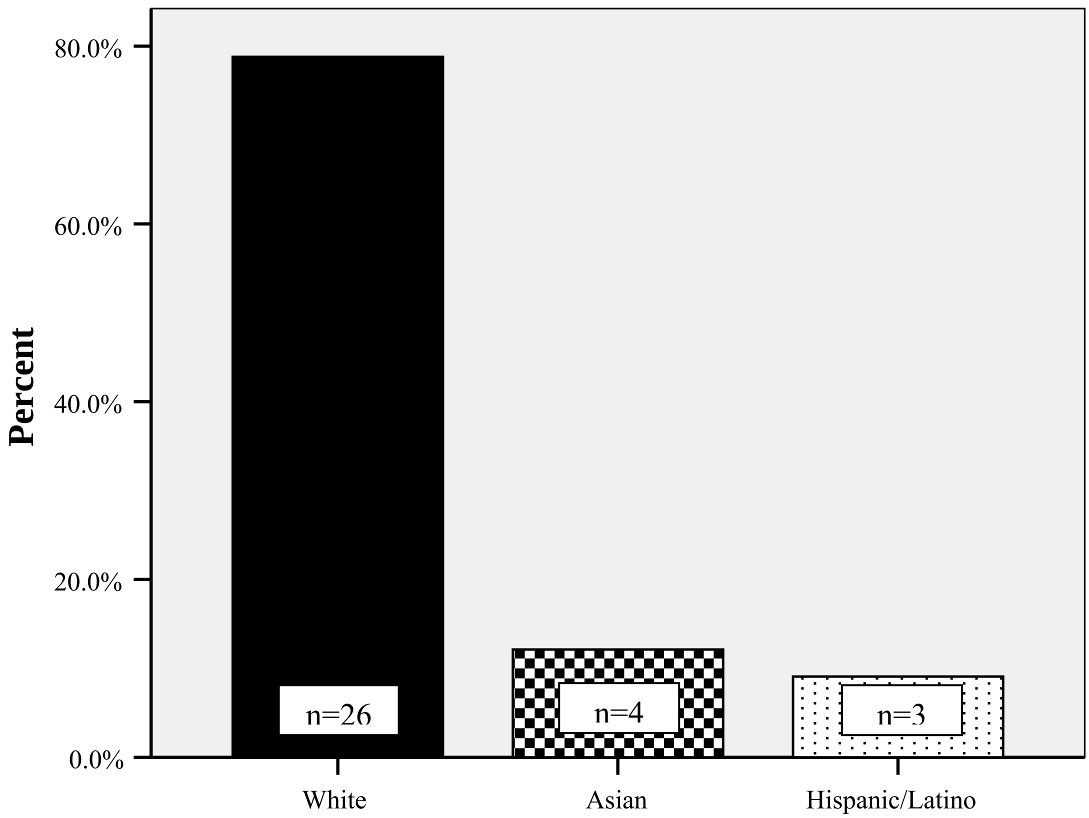

Figure 2. Race of Participating Fellows (N=33).

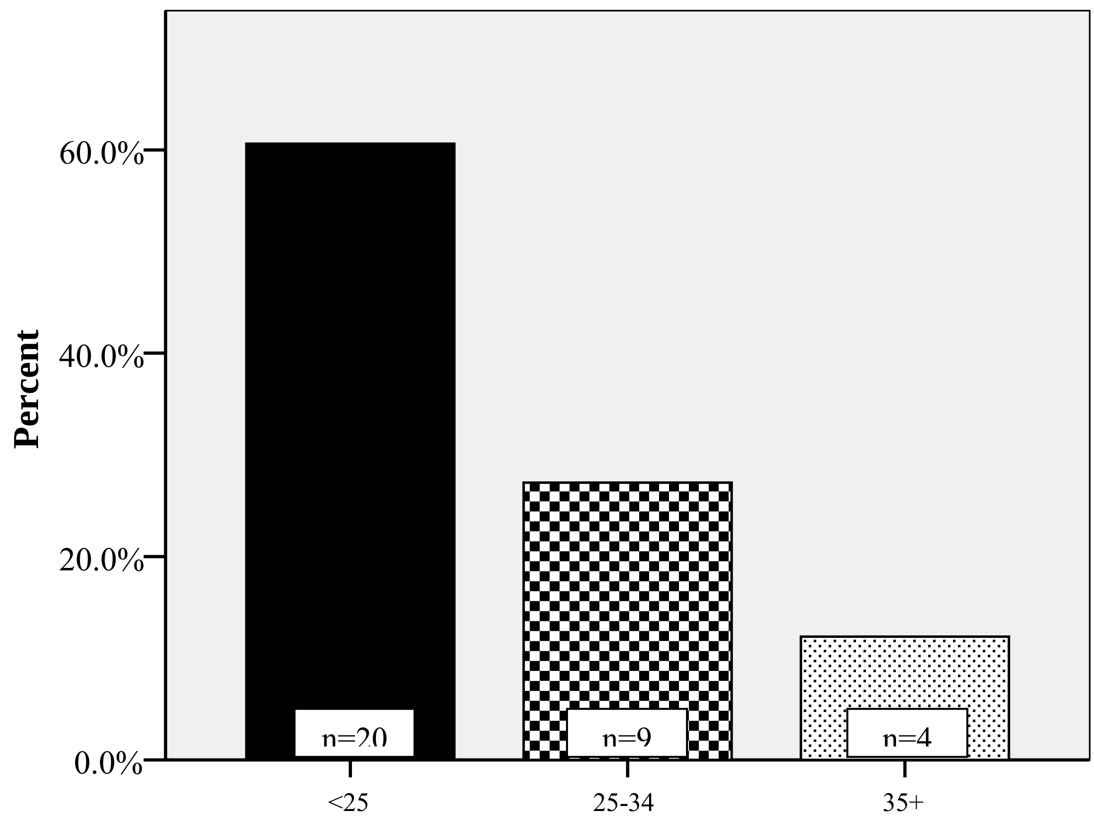

Figure 3. Age Groups of Participating Fellows (N=33).

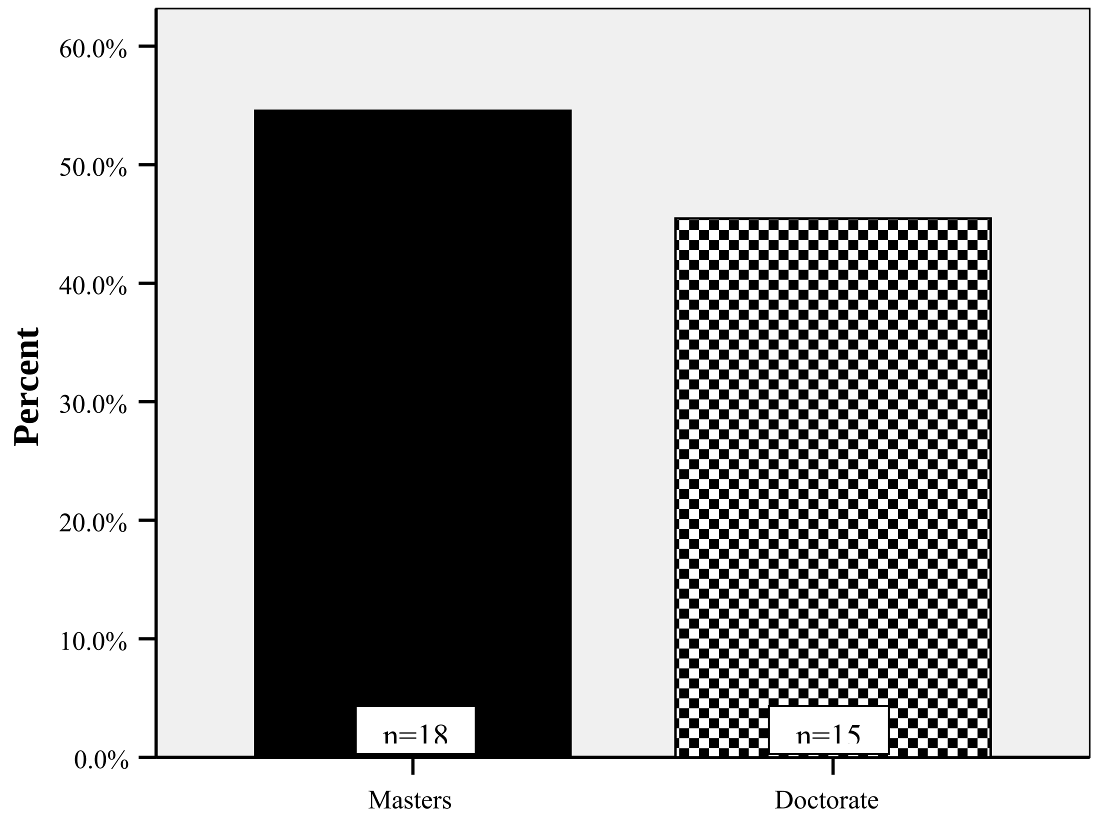

Figure 4. Degrees Being Pursued by Participating Fellows (N=33).

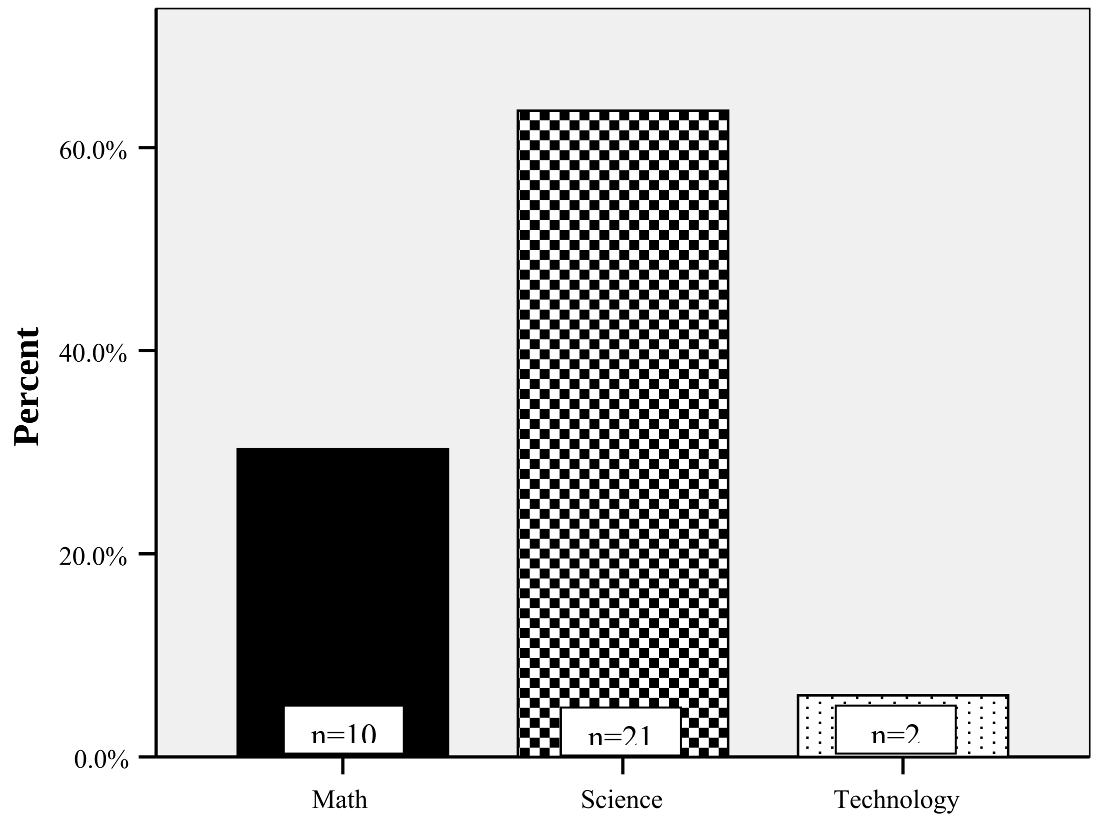

Figure 5. Fellows' Major Fields of Study (N=33).

A total of 33 teachers participated in the program during the 2004-2005 and 2005-2006 school years. Twenty-four teachers indicated their gender as female (73%) and four indicated their gender as male (12%). Five teachers chose not to indicate their gender on the questionnaire. When asked to specify race, 25 teachers chose White (73%), two chose Black (12%) and six teachers chose not to respond to the question (18%). Teachers ranged in age from 24 to 62 with 1 younger than 25 (3%), four teachers between the ages of 25 and 29 (12%), six between the ages of 30 and 39 (18%), seven between the ages of 40 and 44 (21%), four between the ages of 50 and 54 (12%), and two teachers 60 or over (6%). Nine teachers chose not to indicate their age on the questionnaire (27%). Nine teachers have completed Masters degrees (27%) while 16 teachers have Bachelors degrees (49%). Eight teachers chose not to indicate their education level on the questionnaire (24%). Three of the participating teachers had been teaching for less than five years (9%). Nine teachers had taught between five and nine years (27%), seven teachers had taught from 10-14 years (21%), five teachers had taught between 15 and 19 years (15%) and one teacher had taught for more than 19 years (3%). Eight teachers chose not to indicate how many years of teaching experience they had (24%). Eight of the participating teachers taught math (24%) while 17 teachers taught science (52%). Eight teachers chose to not indicate which subject they taught (24%) Figures 6-11 depict teachers’ responses to demographic related questions.

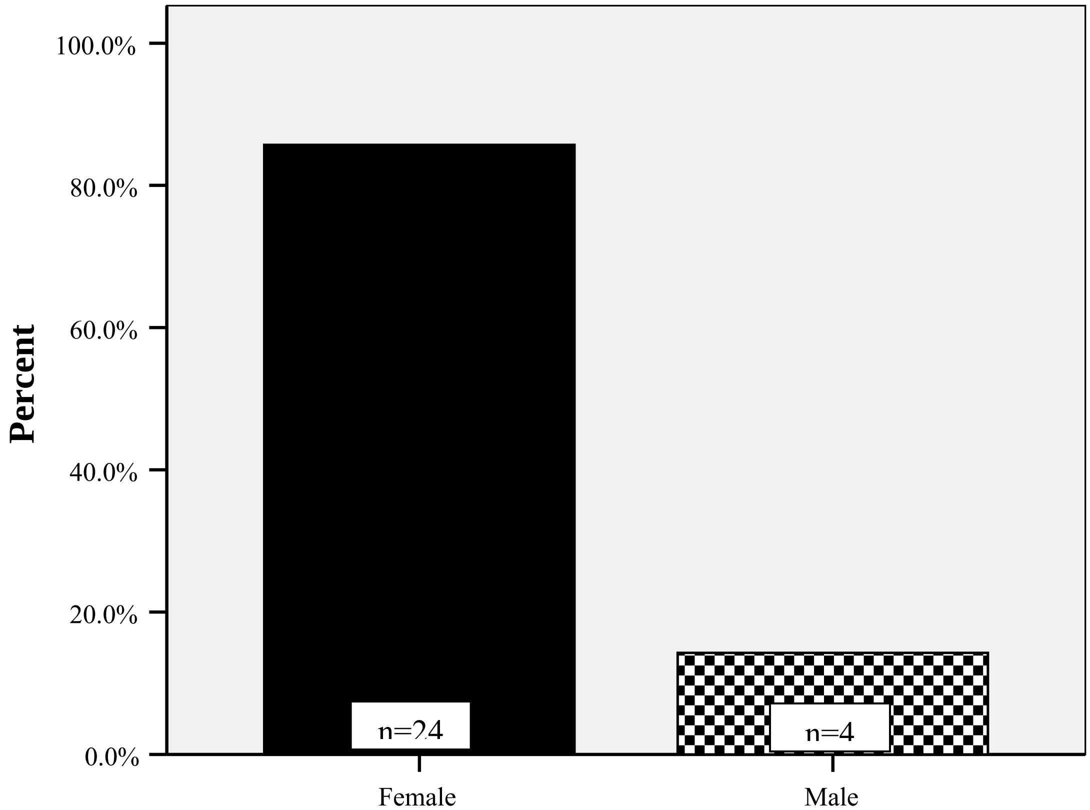

Figure 6. Gender of Participating Teachers (N=28).

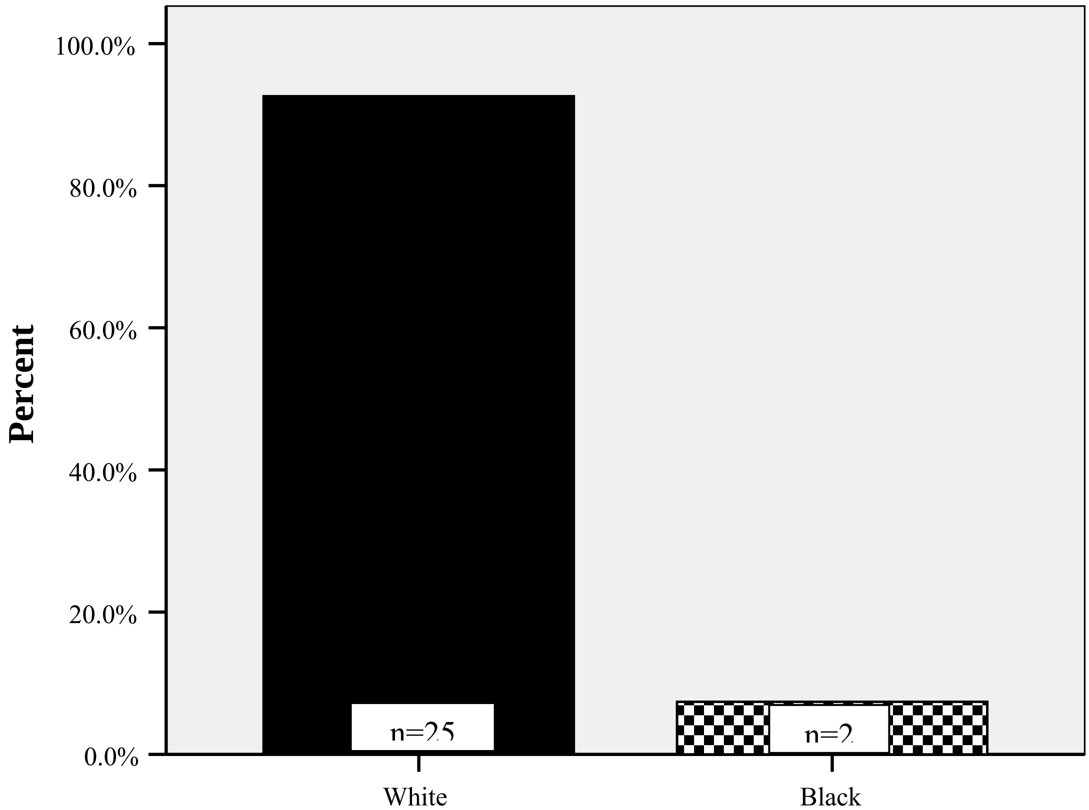

Figure 7. Race of Participating Teachers (N=27).

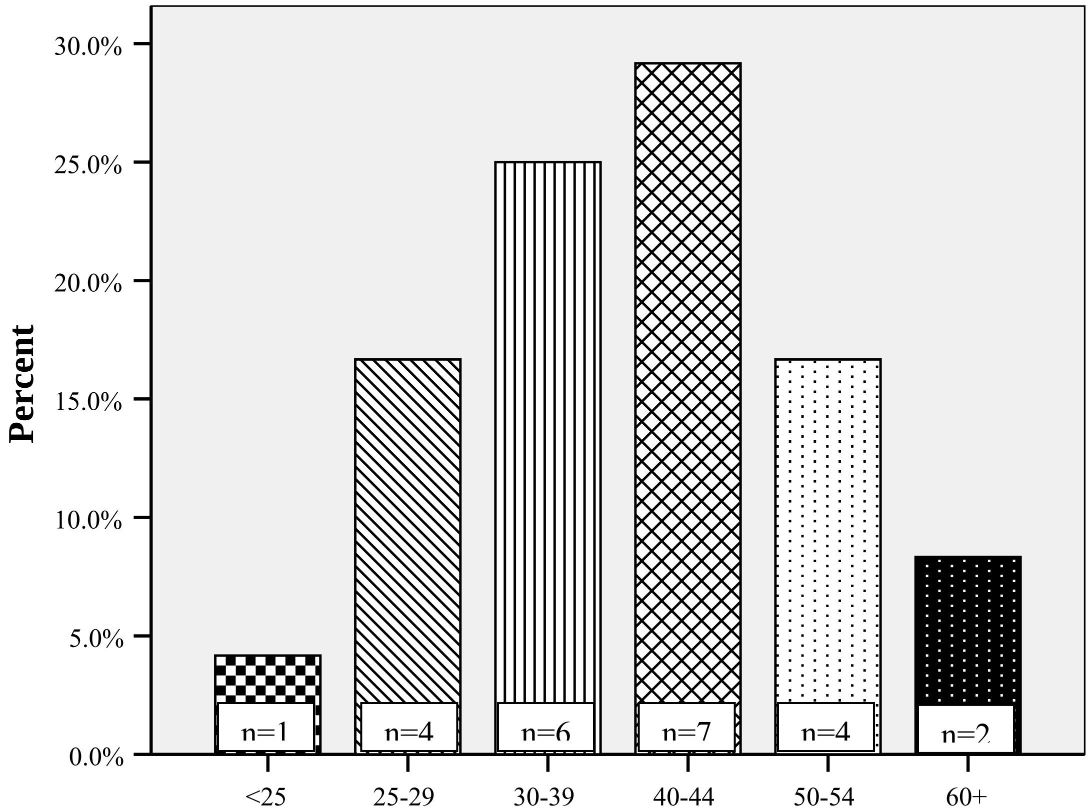

Figure 8. Ages of Participating Teachers (N=24).

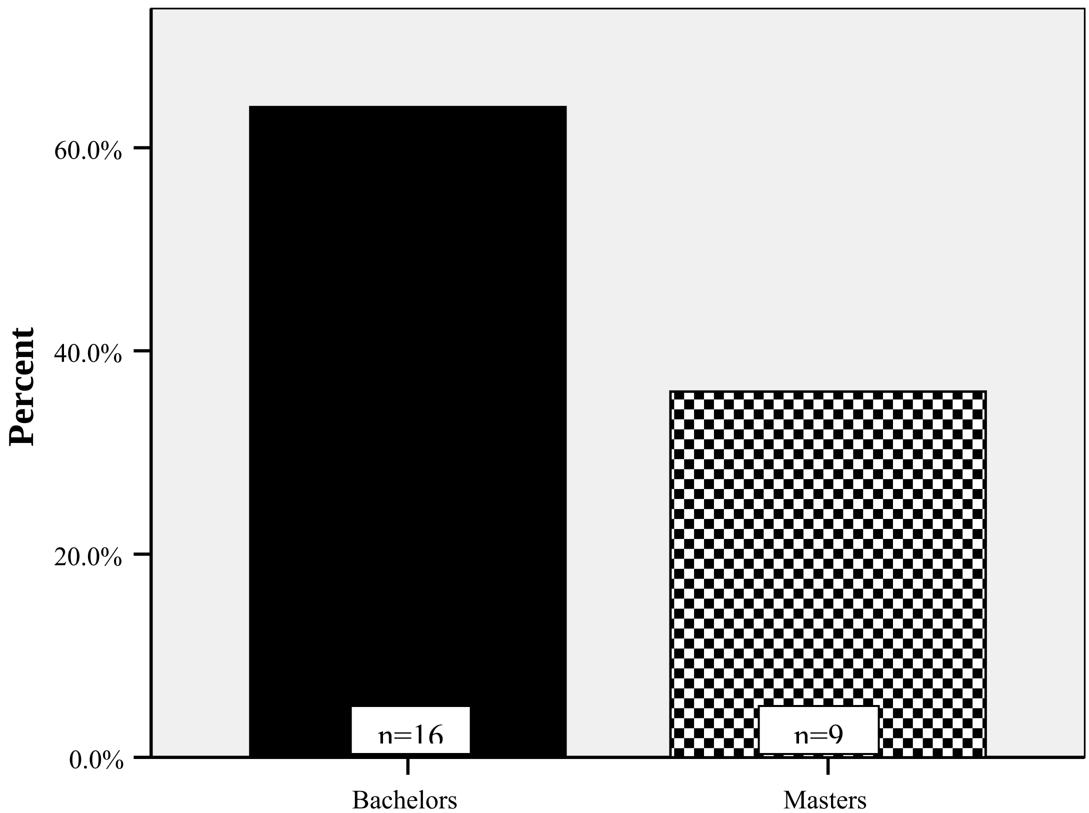

Figure 9. Education Levels of Participating Teachers (N=25).

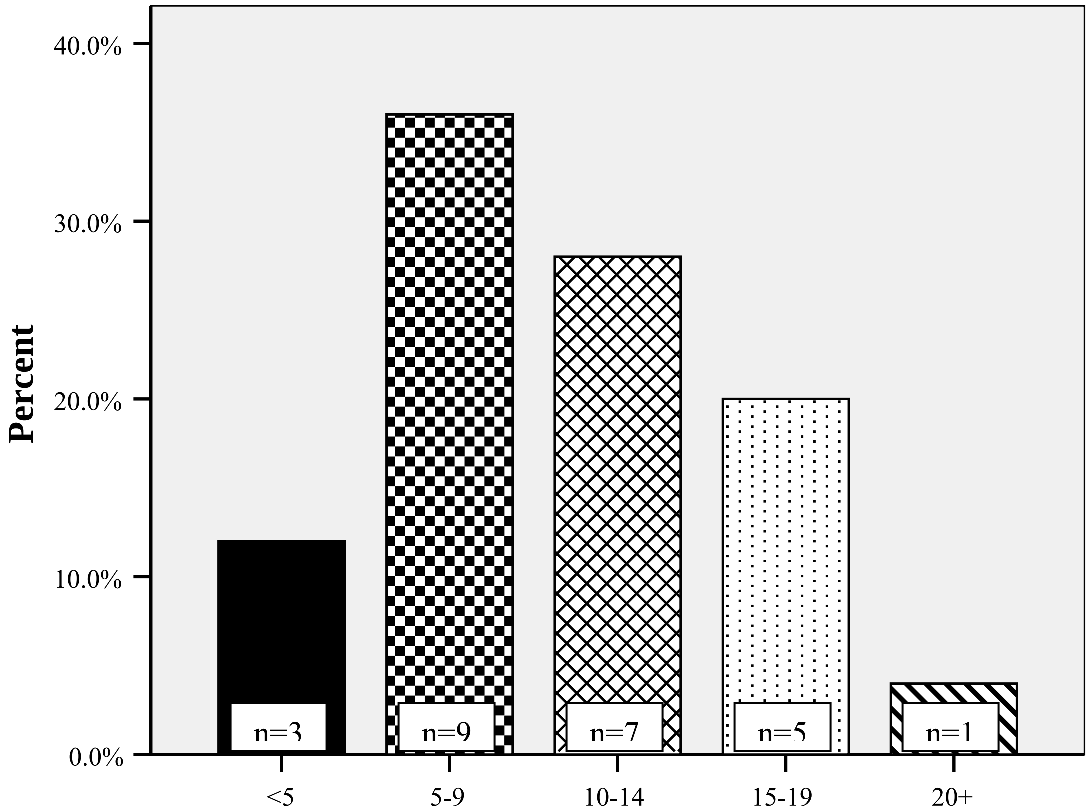

Figure 10. Participating Teachers’ Years of Teaching Experience (N=25).

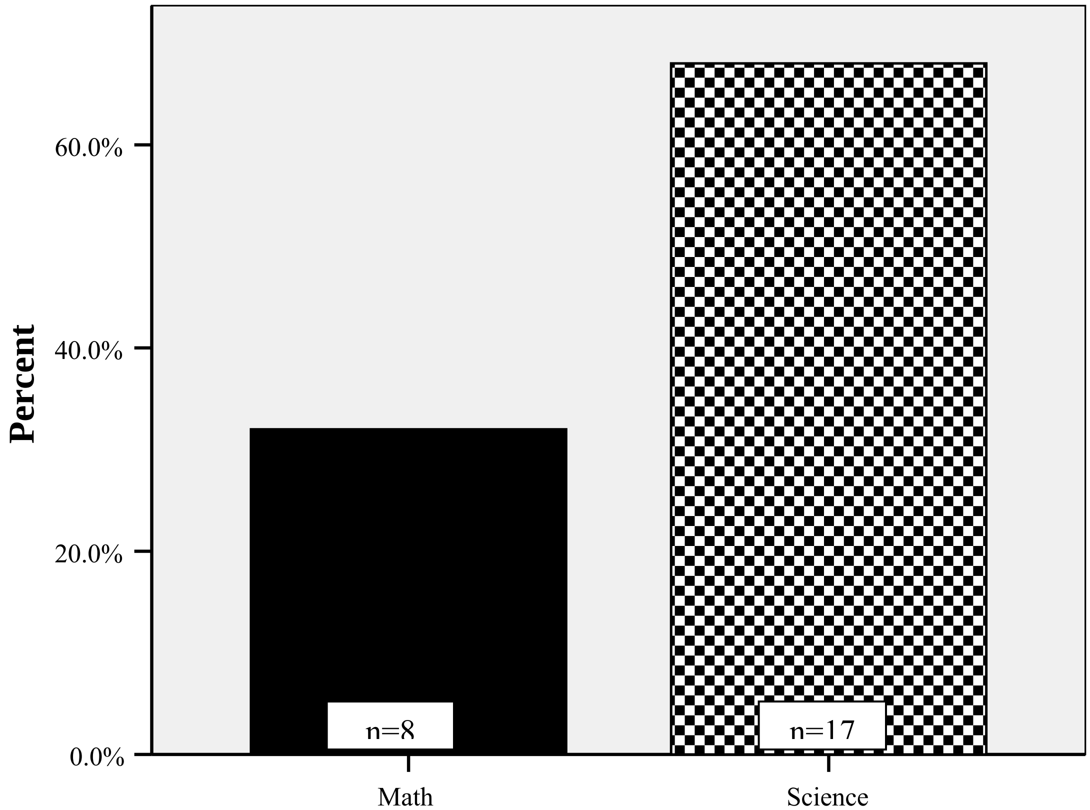

Figure 11. Subjects Taught by Participating Teachers (N=25).

Objective Two

Objective two was to describe the knowledge, experience, and comfort levels of graduate students and teachers and the competency levels of graduate students (fellows) in education related areas. Measurements were taken at the beginning and end of the school year for knowledge, experience, and comfort level. Measurements of graduate student competency were taken at mid-year and year end.

At the beginning of the school year, graduate students rated their knowledge levels of education related groups and issues. Of the 21 topics, graduate students rated their knowledge as high for 14 items and average for the remaining seven items. No items received very low, low, or very high mean responses. Mean ratings and standard deviations for all items can be found in Table 2.

Fellows were most knowledgeable about planning a project which earned a mean rating of 4.38 (*SD*= .59). This item was followed closely by three items with a mean knowledge level of 4.33: middle school students (*SD*= .58), planning a learning experience for K-12 students (*SD*= .56), and communicating effectively with group members (*SD*= .58). Fellows were least comfortable with elementary school students (*M*= 2.71, *SD*= 1.31) and high school students (*M*= 2.90, *SD*= 1.22).

Table 2
Fellow's Knowledge Levels of Education Related Groups and Issues at the Beginning of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.33	.58
K-12 teachers	3.90	.94
University faculty engaged in K-12	3.67	.91
K-12 administrators	3.29	1.06
High school students	2.90	1.22
Elementary school students	2.71	1.31
Teaching Issues and Strategies		
Planning a learning experience for K-12 students	4.33	.56
Technology in instruction	4.00	.55
Teaching college students	3.86	1.28
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.86	.79
Current issues in K-12 education	3.67	.91
Assessing student learning	3.67	1.07
Interdisciplinary approaches to inquiry and problem-solving	3.48	.87
Science education reform	3.30	1.03
Evaluating educational activities (e.g. classes, workshops)	3.10	1.04
Theories of learning (e.g. Constructivism)	2.95	1.12

Table 2 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Planning a project	4.38	.59
Communicating effectively with other group members	4.33	.58
Following through on project tasks	4.29	.78
Keeping a project on schedule	4.24	.77
Being a team or project leader	4.19	.68

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

When the fellows were asked to indicate their previous level of experience with the 21 education related groups or issues, the fellows rated their experience level as high for 12 items and average for the remaining nine items. The complete list of education related groups and issues as well as the mean level of previous experience and standard deviation for each may be found in Table 3.

Fellows perceived their previous experience to be highest with middle school students (*M*= 4.43, *SD*= .60) and teaching college students (*M*= 4.38, *SD*= .50). Fellows perceived their previous experience levels to be lowest with elementary students (*M*= 2.62, *SD*= 1.32) and high school students (*M*= 2.62, *SD*= 1.20).

Table 3
Fellow's Experience Levels with Education Related Groups and Issues at the Beginning of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.43	.60
K-12 teachers	4.00	.78
University faculty engaged in K-12	3.67	1.11
K-12 administrators	3.00	1.14
High school students	2.62	1.20
Elementary school students	2.62	1.32
Teaching Issues and Strategies		
Planning a learning experience for K-12 students	4.38	.50
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.86	.66
Technology in instruction	3.81	.87
Current issues in K-12 education	3.52	.93
Teaching college students	3.48	1.29
Assessing student learning	3.43	1.03
Interdisciplinary approaches to inquiry and problem-solving	3.33	.91
Science education reform	3.30	1.03
Theories of learning (e.g. Constructivism)	2.81	1.21
Evaluating educational activities (e.g. classes, workshops)	2.81	1.12

Table 3 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Planning a project	4.33	.66
Following through on project tasks	4.33	.73
Communicating effectively with other group members	4.24	.77
Keeping a project on schedule	4.19	.81
Being a team or project leader	3.90	.89

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Fellows were asked to indicate their comfort level with each of the questionnaire items. Fifteen items elicited a mean rating in the high range. The remaining six items were items of average comfort level for the fellows. Table 4 includes all 21 items and their corresponding means and standard deviations from the beginning of the year data collection.

Fellows indicated that they were most comfortable with middle school students (*M*= 4.48, *SD*= .60), K-12 teachers (*M*= 4.43, *SD*= .60), and communicating effectively with other group members (*M*= 4.43, *SD*= .68). Fellow's responses indicated their comfort levels were lowest with theories of learning (*M*= 2.86, *SD*= 1.11) and evaluating educational activities (*M*= 3.00, *SD*= 1.10).

Table 4
Fellow's Comfort Levels with Education Related Groups and Issues at the Beginning of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.48	.60
K-12 teachers	4.43	.60
University faculty engaged in K-12	4.00	.95
Elementary school students	3.81	1.12
K-12 administrators	3.48	1.08
High school students	3.43	1.17
Teaching Issues and Strategies		
Planning a learning experience for K-12 students	4.29	.78
Technology in instruction	4.00	.71
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.86	.66
Teaching college students	3.67	1.16
Assessing student learning	3.67	1.11
Current issues in K-12 education	3.57	1.03
Science education reform	3.29	.96
Interdisciplinary approaches to inquiry and problem-solving	3.29	.90
Evaluating educational activities (e.g. classes, workshops)	3.00	1.10
Theories of learning (e.g. Constructivism)	2.86	1.11

Table 4 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Communicating effectively with other group members	4.43	.68
Following through on project tasks	4.33	.80
Planning a project	4.29	.78
Keeping a project on schedule	4.19	.87
Being a team or project leader	4.10	1.00

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

After serving in a middle school classroom for an entire school year, participating fellows were once again asked to indicate their knowledge experience, and comfort levels with the 21 education related items. When responding to the knowledge portion of the questionnaire, fellows perceived their knowledge as high for nine items. An average knowledge level was held for the remaining 12 items. A complete list of mean knowledge levels and standard deviations for each item may be found in Table 5.

Fellows perceived themselves to be most knowledgeable about communicating effectively with group members (*M*= 4.08, *SD*= .58) and following through on project tasks (*M*= 3.96, *SD*= .91). Responses indicated that the fellows were least knowledgeable about theories of learning (*M*= 2.54, *SD*= 1.02), science education reform (*M*= 2.83 *SD*= .94), and K-12 administrators (*M*= 2.83, *SD*= 1.24).

Table 5
Fellow's Knowledge Levels of Education Related Groups and Issues at the End of the School Year (N=24)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	3.65	.94
K-12 teachers	3.33	.96
High school students	3.30	1.06
University faculty engaged in K-12	3.13	1.10
Elementary school students	2.91	1.13
K-12 administrators	2.83	1.24
Teaching Issues and Strategies		
Technology in instruction	3.71	.81
Teaching college students	3.67	1.20
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.54	.83
Planning a learning experience for K-12 students	3.46	.93
Assessing student learning	3.17	.96
Current issues in K-12 education	3.09	.87
Interdisciplinary approaches to inquiry and problem-solving	2.92	.78
Evaluating educational activities (e.g. classes, workshops)	2.91	.85
Science education reform	2.83	.94
Theories of learning (e.g. Constructivism)	2.54	1.02

Table 5 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Communicating effectively with other group members	4.08	.58
Following through on project tasks	3.96	.91
Planning a project	3.83	.76
Being a team or project leader	3.79	.72
Keeping a project on schedule	3.71	1.08

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

At the end of the school year, fellows were once again asked to rate their experience level with the 21 education related items. Of the 21 items, 11 earned ratings indicating high experience levels. Ten items were found to have average experience levels. No items were rated as very low, low, or very high experience areas. Table 6 includes a complete listing of the 21 groups and issues and also the mean rating and standard deviation associated with each one.

The area with the highest rated experience level for participating fellows was communicating effectively with group members. This was followed by planning a project (*M*= 3.96, *SD*= .91), following through on project tasks (*M*= 3.96, *SD*= .94), and middle school students (*M*= 3.96, *SD*= 1.12). K-12 administrators (*M*= 2.50, *SD*= 1.14) and theories of learning (*M*= 2.50, *SD*= .89) were the areas of lowest experience level for fellows at the end of the school year.

Table 6
Fellow's Experience Levels with Education Related Groups and Issues at the End of the School Year (N=24)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	3.96	1.12
K-12 teachers	3.42	1.18
High school students	3.21	1.25
Elementary school students	3.04	1.37
University faculty engaged in K-12	2.91	1.16
K-12 administrators	2.50	1.14
Teaching Issues and Strategies		
Technology in instruction	3.54	.98
Teaching college students	3.54	1.38
Planning a learning experience for K-12 students	3.50	.98
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.42	.78
Interdisciplinary approaches to inquiry and problem-solving	2.92	.78
Assessing student learning	2.88	.95
Evaluating educational activities (e.g. classes, workshops)	2.83	.89
Current issues in K-12 education	2.82	.91
Science education reform	2.57	1.08
Theories of learning (e.g. Constructivism)	2.50	.89

Table 6 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Communicating effectively with other group members	4.17	.64
Planning a project	3.96	.91
Following through on project tasks	3.96	.96
Keeping a project on schedule	3.83	1.09
Being a team or project leader	3.79	.78

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

When asked to indicate their comfort levels with 21 education related groups or issues, the participating fellows indicated high comfort with 12 items. An average comfort level was expressed for nine items. None of the items included in the questionnaire elicited responses of very low, low, or very high comfort from the fellows. Mean responses and standard deviations for all items may be found in Table 7.

Items fellows were most comfortable with included communicating effectively with other group members (M= 4.25, SD= .68), middle school students (M= 4.10, SD= .99), and following through on project tasks (M= 4.00, SD= .93). Items with lowest mean comfort levels included theories of learning (M= 2.67, SD= .82), K-12 administrators (M= 2.83, SD= 1.01), and science education reform (M= 2.83, SD= .89).

Table 7
Fellow's Comfort Levels with Education Related Groups and Issues at the End of the School Year (N=24)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.12	.99
K-12 teachers	3.92	1.02
High school students	3.50	1.22
Elementary school students	3.33	1.37
University faculty engaged in K-12	3.22	1.09
K-12 administrators	2.83	1.01
Teaching Issues and Strategies		
Teaching college students	3.67	1.40
Planning a learning experience for K-12 students	3.67	.92
Technology in instruction	3.63	.88
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.50	.83
Interdisciplinary approaches to inquiry and problem-solving	3.08	.78
Assessing student learning	3.04	.75
Evaluating educational activities (e.g. classes, workshops)	2.96	.83
Current issues in K-12 education	2.95	.84
Science education reform	2.83	.89
Theories of learning (e.g. Constructivism)	2.67	.82

Table 7 continued

Group or Issue	***M***	***SD***
Productivity Issues		
Communicating effectively with other group members	4.25	.68
Following through on project tasks	4.00	.93
Planning a project	3.96	.81
Being a team or project leader	3.92	.83
Keeping a project on schedule	3.75	1.11

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Teachers were also asked at the beginning and end of the year to indicate their knowledge, experience, and comfort levels with educational stakeholders, classroom issues and strategies, and also productivity issues. At the beginning of the year, teachers indicated a very high knowledge of two items, high knowledge of 15 items, and an average knowledge of the remaining four items. Items eliciting a rating of very high knowledge include middle school students (M= 4.72, SD= .58) and assessing student learning (M= 4.50, SD= .62). Means and standard deviations for knowledge of all 21 items are shown in Table 8.

Table 8
Teachers' Knowledge Levels of Education Related Groups and Issues at the Beginning of the School Year (N=18)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.72	.58
K-12 teachers	4.44	.71
K-12 administrators	4.22	.81
High school students	3.78	1.31
Elementary school students	3.61	1.34
University faculty engaged in K-12	3.39	.92
Teaching Issues and Strategies		
Assessing student learning	4.50	.62
Planning a learning experience for K-12 students	4.28	.90
Evaluating educational activities (e.g. classes, workshops)	4.28	.90
Technology in instruction	4.22	.94
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	4.11	.96
Current issues in K-12 education	3.67	.84
Interdisciplinary approaches to inquiry and problem-solving	3.67	.84
Theories of learning (e.g. Constructivism)	3.28	.90
Science education reform	3.06	1.26
Teaching college students	2.83	1.47

Table 8 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Following through on project tasks	4.39	.85
Keeping a project on schedule	4.39	.92
Planning a project	4.33	.84
Communicating effectively with other group members	4.33	.77
Being a team or project leader	4.33	.69

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Teachers rated their experience levels for the 21 questionnaire items at the beginning of the year. Experience with middle school students (*M*= 4.72, *SD*= .58) and assessing student learning (*M*= 4.50, *SD*= .71) were both rated as very high. Six items were rated with average experience levels and the remaining 13 items were items of high experience for the teachers. The lowest averages were for science education reform (*M*= 2.94, *SD*= 1.31) and teaching college students (*M*= 2.72, *SD*= 1.49). Mean responses and standard deviations for all items may be found in Table 9.

Table 9
Teachers' Experience Levels with Education Related Groups and Issues at the Beginning of the School Year (N=18)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.72	.58
K-12 teachers	4.39	.78
K-12 administrators	4.28	.75
High school students	3.44	1.34
University faculty engaged in K-12	3.44	.92
Elementary school students	3.22	1.35
Teaching Issues and Strategies		
Assessing student learning	4.50	.71
Planning a learning experience for K-12 students	4.39	.92
Evaluating educational activities (e.g. classes, workshops)	4.17	.86
Technology in instruction	4.17	.92
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	4.00	.91
Current issues in K-12 education	3.67	.97
Interdisciplinary approaches to inquiry and problem-solving	3.56	.86
Theories of learning (e.g. Constructivism)	3.22	.94
Science education reform	2.94	1.31
Teaching college students	2.72	1.49

Table 9 continued

Group or Issue	***M***	***SD***
Productivity Issues		
Keeping a project on schedule	4.33	.77
Planning a project	4.28	.83
Following through on project tasks	4.28	.83
Communicating effectively with other group members	4.28	.75
Being a team or project leader	4.22	.73

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Teachers' responses, when asked about the comfort levels with 21 education related items indicated they have very high comfort levels with K-12 teachers (*M*= 4.50, *SD*= .71) and middle school students (*M*= 4.78, *SD*= .43). Fifteen items received mean ratings in the high range and the remaining four items were rated with high comfort levels. A complete list of items, mean ratings, and standard deviations may be found in Table 10.

Table 10
Teachers' Comfort Levels with Education Related Groups and Issues at the Beginning of the School Year (N=18)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.78	.43
K-12 teachers	4.50	.71
K-12 administrators	4.22	.65
High school students	3.72	1.49
Elementary school students	3.61	1.38
University faculty engaged in K-12	3.56	.92
Teaching Issues and Strategies		
Assessing student learning	4.39	.61
Planning a learning experience for K-12 students	4.28	.90
Technology in instruction	4.28	.96
Evaluating educational activities (e.g. classes, workshops)	4.11	.83
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	3.82	.95
Current issues in K-12 education	3.56	.92
Interdisciplinary approaches to inquiry and problem-solving	3.39	.85
Teaching college students	3.22	1.44
Theories of learning (e.g. Constructivism)	3.22	.94
Science education reform	2.89	1.28

Table 10 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Following through on project tasks	4.39	.70
Keeping a project on schedule	4.28	.90
Planning a project	4.22	.81
Communicating effectively with other group members	4.22	.88
Being a team or project leader	4.11	.76

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

At the end of the school year, teachers were again asked to indicate their knowledge levels of the 21 education related items. Teachers indicated very high knowledge of three items, high knowledge of 15 items and average knowledge of three items. Items of very high knowledge were: 1) K-12 teachers (*M*= 4.72, *SD*= .58), 2) middle school students (*M*= 4.50, *SD*= .62), and 3) communicating effectively with other group members (*M*= 4.72, *SD*= .58). The lowest ranked items were: 1) University faculty engaged in K-12 (*M*= 3.24, *SD*= .70), 2) science education reform (*M*= 3.19, *SD*= 1.25), and 3) teaching college students (*M*= 3.00, *SD*= 1.34). Average ratings and standard deviations for all items may be found in Table 11.

Table 11
Teachers' Knowledge Levels of Education Related Groups and Issues at the End of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.76	.44
K-12 teachers	4.62	.50
K-12 administrators	4.43	.68
High school students	4.24	.94
Elementary school students	4.19	.98
University faculty engaged in K-12	3.24	.70
Teaching Issues and Strategies		
Planning a learning experience for K-12 students	4.48	.68
Assessing student learning	4.48	.60
Evaluating educational activities (e.g. classes, workshops)	4.29	.64
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	4.14	.66
Technology in instruction	4.10	.63
Current issues in K-12 education	3.90	.63
Theories of learning (e.g. Constructivism)	3.86	.79
Interdisciplinary approaches to inquiry and problem-solving	3.81	.75
Science education reform	3.19	1.25
Teaching college students	3.00	1.34

Table 11 continued

Group or Issue	*M*	*SD*
Productivity Issues		
Communicating effectively with other group members	4.52	.51
Following through on project tasks	4.48	.60
Being a team or project leader	4.38	.60
Planning a project	4.33	.66
Keeping a project on schedule	4.33	.58

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

When asked to indicate their experience levels with the items at the end of the year, teachers indicated their experience was very high with four items, high for 15 items, and average for two items. The items of very high experience were: 1) K-12 teachers (*M*= 4.62, *SD*= .50), 2) middle school students (*M*= 4.71, *SD*= .46), 3) assessing student learning (*M*= 4.52, *SD*= .60), and 4) communicating effectively with other group members (*M*= 4.52, *SD*= .51). Teacher responses indicated areas of lowest experience were science education reform (*M*= 2.95, *SD*= 1.40) and teaching college students (*M*= 2.71, *SD*= 1.35). A complete list of mean responses and standard deviations for all 21 items may be found in Table 12.

Table 12
Teachers' Experience Levels with Education Related Groups and Issues at the End of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
Middle school students	4.71	.46
K-12 teachers	4.62	.50
K-12 administrators	4.48	.68
High school students	3.95	1.16
Elementary school students	3.81	1.25
University faculty engaged in K-12	3.50	.69
Teaching Issues and Strategies		
Assessing student learning	4.52	.60
Planning a learning experience for K-12 students	4.48	.68
Evaluating educational activities (e.g. classes, workshops)	4.29	.64
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	4.25	.64
Technology in instruction	3.90	.89
Current issues in K-12 education	3.86	.73
Theories of learning (e.g. Constructivism)	3.71	.72
Interdisciplinary approaches to inquiry and problem-solving	3.71	.90
Science education reform	2.95	1.40
Teaching college students	2.71	1.35

Table 12 continued

Group or Issue	***M***	***SD***
Productivity Issues		
Communicating effectively with other group members	4.52	.51
Following through on project tasks	4.48	.60
Keeping a project on schedule	4.33	.58
Planning a project	4.29	.72
Being a team or project leader	4.19	.68

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Teacher responses to the end-of-the-year questionnaire revealed very high comfort levels with two items, high comfort levels with 17 items, and average comfort levels with two items. Items with very high comfort level responses were K-12 teachers (*M*= 4.76, *SD*= .44), and middle school students (*M*= 4.76, *SD*= .44). Responses indicated average comfort levels for science education reform (*M*= 3.00, *SD*= 1.30) and teaching college students (*M*= 2.90, *SD*= 1.48). A complete list of mean responses and standard deviations for all items may be found in Table 13.

Table 13
Teachers' Comfort Levels with Education Related Groups and Issues at the End of the School Year (N=21)

Group or Issue	*M*	*SD*
Education Stakeholders		
K-12 teachers	4.76	.44
Middle school students	4.76	.44
K-12 administrators	4.33	.91
High school students	4.14	1.01
Elementary school students	4.05	1.07
University faculty engaged in K-12	3.60	.82
Teaching Issues and Strategies		
Planning a learning experience for K-12 students	4.43	.81
Assessing student learning	4.43	.68
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	4.20	.70
Evaluating educational activities (e.g. classes, workshops)	4.14	.73
Current issues in K-12 education	3.86	.79
Technology in instruction	3.86	.91
Interdisciplinary approaches to inquiry and problem-solving	3.62	.92
Theories of learning (e.g. Constructivism)	3.55	.95
Science education reform	3.00	1.30
Teaching college students	2.90	1.48

Table 13 continued

Group or Issue	***M***	***SD***
Productivity Issues		
Following through on project tasks	4.38	.67
Planning a project	4.24	.77
Communicating effectively with other group members	4.24	.77
Keeping a project on schedule	4.00	.78
Being a team or project leader	4.00	.78

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

Teachers were asked to assess the competency of their resident scientist or mathematician with a fellow evaluation questionnaire administered at the mid-point of the school year and again at the end of the school year and a program impact questionnaire administered at the end of the school year. This competency assessment measured the fellows' overall performance in the classroom. The fellows were also asked to assess their own performance with an end-of-the-year program impact questionnaire.

Teacher responses to the fellow evaluation questionnaire at the mid point of the school year indicated five areas of very high competency and 18 areas of high competency. The areas of very high competency were: 1) quality of preparation for activities (M= 4.55, SD= .80), 2) organization of equipment and activity materials for effective use with the different classes the RM/RS works with (M= 4.68, SD= .72), 3) effectiveness in developing good rapport with students M= 4.68, SD= .57), 4) ability as a good "housekeeper," maintaining classroom cleanliness during and after activities *M*= 4.50, *SD*= .74), and 5) effectiveness of developing and presenting activities that reinforce concepts taught by the lead teacher (*M*= 4.64, *SD*= .90). Mean ratings and standard deviations for all items on the questionnaire may be found in Table 14.

Table 14
Teachers' Perceptions of Fellow's Classroom Competency at Mid-Year (*N*= 22)

Classroom Competency Item	*M*	*SD*
Quality of preparation for activities	4.55	.80
Adequacy of written activity plan	4.10	.77
Clarity of activity objectives	4.41	.780
Appropriateness of activity objectives	4.41	1.01
Organization of equipment and activity materials for effective use with the different classes the RM/RS works with	4.68	.72
Ability to create in students awareness of the need to study topics undertaken	4.23	.97
Ability to develop interest of students	4.45	1.01
Ability to maintain interest of students	4.48	.81
Effectiveness in using a variety of appropriate delivery methods	4.27	1.08
Effectiveness in coping with unexpected situations that arise in the classroom	4.32	.78
Effectiveness in pacing activities from one part to the next according to students' achievement	4.23	1.07
Effectiveness in providing continuity of learning among the activities taught	4.23	.87

Table 14 continued

Classroom Competency Item	*M*	*SD*
Effectiveness in involving all students in class activities	4.32	1.09
Ability to take individual differences of students into account for activities	4.23	1.07
Balance between “RS/RM talk” and “student talk” in classroom	4.45	.74
Effectiveness in having students develop problem-solving abilities	4.09	1.07
Effectiveness in having students draw worthwhile conclusions about what has been studied in and out of class	4.23	1.11
Effectiveness and appropriateness if school and community relationships with other teachers and parents	4.14	1.04
Overall management of classroom	4.09	.87
Effectiveness in developing good rapport with students	4.68	.57
Effectiveness in maintaining discipline	4.05	1.00
Ability as a good “housekeeper,” maintaining classroom cleanliness during and after activities	4.50	.74
Effectiveness of developing and presenting activities that reinforce concepts taught by the lead teacher	4.64	.90

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

When asked to re-assess fellows’ competency levels at the end of the year, teachers again provided positive responses. Twelve items were rated as areas of very high competency. The highest rated item was quality of preparation for activities (*M*= 4.76, *SD*= .56) which was followed by six items receiving a mean response of 4.71.

These included 1) organization of equipment and activity materials for effective use with the different classes the RM/RS works with (*SD*= .59), 2) ability to develop interest of students with (*SD*= .59), 3) effectiveness in involving all students in class activities with (*SD*= .47), 4) effectiveness in developing good rapport with students with (*SD*= .71), 5) ability as a good "housekeeper," maintaining classroom cleanliness during and after activities with (*SD*= .59), and 6) effectiveness of developing and presenting activities that reinforce concepts taught by the lead teacher with (*SD*= .47). The remaining 11 items were perceived as areas of high competency. Teachers did not perceive fellows' competency levels to be average, low, or very low for any of the items. A complete list of mean responses and standard deviations for each item are available in Table 15.

Table 15
Teachers' Perceptions of Fellows' Classroom Competency at the End of the School Year (N=17)

Classroom Competency Item	***M***	***SD***
Quality of preparation for activities	4.76	.56
Adequacy of written activity plan	4.38	.81
Clarity of activity objectives	4.65	.61
Appropriateness of activity objectives	4.53	.72
Organization of equipment and activity materials for effective use with the different classes the RM/RS works with	4.71	.59
Ability to create in students awareness of the need to study topics undertaken	4.41	.71
Ability to develop interest of students	4.71	.59
Ability to maintain interest of students	4.65	.61
Effectiveness in using a variety of appropriate delivery methods	4.29	.77
Effectiveness in coping with unexpected situations that arise in the classroom	4.35	.79
Effectiveness in pacing activities from one part to the next according to students' achievement	4.24	.75
Effectiveness in providing continuity of learning among the activities taught	4.35	.70
Effectiveness in involving all students in class activities	4.71	.47
Ability to take individual differences of students into account for activities	4.29	.92
Balance between "RS/RM talk" and "student talk" in classroom	4.53	.80

Table 15 continued

Classroom Competency Item	***M***	***SD***
Effectiveness in having students develop problem-solving abilities	4.24	.75
Effectiveness in having students draw worthwhile conclusions about what has been studied in and out of class	4.29	.77
Effectiveness and appropriateness if school and community relationships with other teachers and parents	4.59	.71
Overall management of classroom	4.29	.85
Effectiveness in developing good rapport with students	4.71	.47
Effectiveness in maintaining discipline	4.12	.93
Ability as a good "housekeeper," maintaining classroom cleanliness during and after activities	4.71	.59
Effectiveness of developing and presenting activities that reinforce concepts taught by the lead teacher	4.71	.47

Note. Scale: 1= Very Low, 2= Low, 3= Average, 4= High, 5= Very High

The final assessment was conducted with a program impact questionnaire. This questionnaire was administered in two versions. One was tailored specifically for participating teachers and the other for graduate student fellows. The assessment was designed to measure the impact the graduate student had in the classroom. Both questionnaires contained 14 equivalent items. The graduate student fellow questionnaire contained 10 items specific to the fellows. The teacher questionnaire contained two items specific to teachers. Each questionnaire contained items grouped into four categories: 1) Integration, 2) Team Contact, 3) Interaction Results, and 4) Program Organization.

The graduate student questionnaire contained 24 items. Fellows strongly agreed with three statements, agreed with 13 questionnaire statements, neither agreed nor disagreed with seven items, and disagreed with one item. All of the items receiving responses of strongly agree were specific to the graduate student questionnaire. These statements were: 1) It is important for professionals in my field to contribute to K-12 math and science education (M= 4.58, SD= .61), 2) The GK-12 program has influenced how I will contribute to public education in the future (M= 4.53, SD= .61), and 3) I have learned about needs and difficulties of public education through my involvement in this program (M= 4.53, SD= 1.02). Graduate students disagreed with the statement saying university faculty conducted a presentation in my classroom (M= 1.95, SD= 1.43). A complete list of all statements, mean responses and standard deviation may be found in Table 16.

Table 16
Fellows' Evaluations of Their Impact on the Classroom (N=19)

Classroom Impact Statements	*M*	*SD*
Integration		
I was perceived as a role model by students and faculty in my school.[a]	4.21	.63
Inquiry learning was increased in my classroom due to my activities.	4.16	.77
I increased and improved the use of technology in my classroom.	3.89	1.15
Many activities included math and science principles regardless the class in which they were presented.	3.68	.95
I served as a school-wide resource.	3.32	1.11
Students viewed me as a scientist or mathematician more than a teacher.[b]	3.05	1.03
Team Contact		
I provided a useful link between my lead teacher and university faculty.	3.32	1.06
My students benefited from my contact with university faculty.	3.16	1.26
My students were influenced by TAMU employees other than me.	3.11	1.66
I involved other RM/RS's in my classroom activities.[a]	2.58	1.26
University faculty conducted a presentation in my classroom.	1.95	1.43
Interaction Results		
I provided supplies that my lead teacher will be able to use next year.[a]	4.47	.70

Table 16 continued

Classroom Impact Statements	***M***	***SD***
I have a better understanding of education principles because of working with my lead teacher.	4.05	1.22
My activities improved students learning of state standards.[a]	3.89	.68
I improved my lead teacher's content knowledge.	3.79	.79
I used my entire budget for classroom supplies.[a]	2.95	1.35
Program Organization		
It is important for professionals in my field to contribute to K-12 math and science education.[a]	4.58	.61
The GK-12 program has influenced how I will contribute to public education in the future.[a]	4.53	.61
I have learned about needs and difficulties of public education through my involvement in this program.[a]	4.53	1.02
The work required of me for participating in this program was acceptable for the amount of improvement I made in the classroom.	4.47	.70
I have gained communication skills through the GK-12 program.[a]	4.39	.61
At least 1 hour was spent planning for upcoming events with the lead teacher weekly.	4.26	1.05
I spent at least 8 hours working directly with students each week.	3.89	1.29
I am more organized due to my involvement in this program.[a]	3.58	1.17

Note. Scale: 1= strongly disagree; 2= disagree; 3= neither agree nor disagree; 4= agree; 5= strongly agree

[a]Items specific to graduate student questionnaire

[b]Presented to participants as negatively stated item, but positively stated and reverse-coded for data analysis.

The teacher version of the program impact questionnaire contained 17 statements. Teachers strongly agreed with six statements. Teachers agreed with eight statements and neither agreed nor disagreed with three statements. The statements teachers strongly agreed with were: 1) My RM/RS provided an appropriate activity for each unit covered (*M*= 4.65, *SD*= .61), 2) Students did not view the RM/RS as a student teacher (*M*= 4.63, *SD*= .62), 3) The RM/RS increased and improved the use of technology in my classroom (*M*= 4.53, *SD*= .87), 4) The work required of me for participating in this program was acceptable for the amount of improvement made in my classroom (*M*= 4.65, *SD*= .61), 5) RM/RS spent at least 8 hours working directly with students *M*= 4.59, *SD*= .71), and 6) At least 1 hour was spent planning for upcoming events with the RM/RS weekly (*M*= 4.53, *SD*= .87). Mean responses and standard deviations for all statements may be found in Table 17.

Table 17
Teachers' Evaluations of the Impact of the Fellow in the Classroom (N=23)

Classroom Impact Statement	***M***	***SD***
Integration		
My RM/RS provided an appropriate activity for each unit covered	4.65	.61
Students did not view the RM/RS as a student teacher.	4.63	.62
The RM/RS increased and improved the use of technology in my classroom.	4.53	.87
Many activities included math and science principles regardless the class in which they were presented.	4.35	.61
The RM/RS served as a school-wide resource.	4.06	.97
Team Contact		
My RM/RS provided a useful link between me and university faculty.	4.12	.99
My students benefited from my contact with university faculty.	3.44	1.67
My students were influenced by TAMU employees other than by the RM/RS.	3.12	1.58
University faculty conducted a presentation in my classroom.	2.53	1.77
Interaction Results		
I am more satisfied with my job because I have an RM/RS in my classroom.	4.29	.85
I am more proficient with technology because of my GK-12 program involvement.[a]	4.18	1.02
My content knowledge has been improved by the RM/RS.	4.12	.93
My use of inquiry learning has increased due to my work with this program.	3.88	.99

Table 17 continued

Classroom Impact Statement	***M***	***SD***
I have a better understanding of math and science principles because of working with the RM/RS.	3.82	.88
Program Organization		
The work required of me for participating in this program was acceptable for the amount of improvement made in my classroom.	4.65	.61
RM/RS spent at least 8 hours weekly working directly with students.	4.59	.71
At least 1 hour was spent planning for upcoming events with the RM/RS weekly.	4.53	.87

Note. Scale: 1= strongly disagree; 2= disagree; 3= neither agree nor disagree; 4= agree; 5= strongly agree

[a]Item specific to teacher questionnaire

Objective Three

Objective three was to determine differences in knowledge, experience, comfort, and competency levels that existed in graduate student fellows and middle school teachers due to participation in the NSF GK-12 program. Comparisons of beginning of the year responses to end of the year responses revealed little significant change.

Teachers' responses revealed no significant change in knowledge, experience, or comfort level with education related groups or issues. Graduate students' responses revealed significant decreases in knowledge of five areas, decreases in experience in five areas, and decreases in comfort levels in six areas. These changes are exhibited in Tables 18, 19, and 20. Teacher responses to the Fellow Impact Questionnaire indicate no significant changes in graduate students' competency in the classroom from mid-year to the end of the school year.

Table 18
Changes in Graduate Student Knowledge of Classroom Groups or Issues (n=24)

Group or Issue	Pre-test Mean	Post-test Mean	Mean Difference	Sig.
High school students	4.33	3.65	-.68	.006
Teaching college students	3.67	3.09	-.58	.040
Theories of learning (e.g. Constructivism)	4.33	3.46	-.88	.001
Planning a project	3.48	2.92	-.56	.028
Following through on project tasks	4.38	3.83	-.55	.011

Table 19
Changes in Graduate Student Experience With Classroom Groups or Issues (n=24)

Group or Issue	**Pre-test Mean**	**Post-test Mean**	**Mean Difference**	**Sig.**
Science education reform	3.67	2.91	-.75	.034
Current issues in K-12 education	3.30	2.57	-.73	.028
Teaching college students	3.52	2.82	-.71	.016
Theories of learning (e.g. Constructivism)	4.38	3.50	-.88	.001
Assessing student learning	3.86	3.42	-.44	.047

Table 20

Changes in Graduate Student Comfort Levels With Classroom Groups or Issues (n=24)

Group or Issue	**Pre-test Mean**	**Post-test Mean**	**Mean Difference**	**Sig.**
Elementary school students	4.43	3.92	-.51	.050
University faculty engaged in K-12	3.48	2.83	-.64	.045
Science education reform	4.00	3.22	-.78	.015
Teaching college students	3.57	2.95	-.62	.037
Theories of learning (e.g. Constructivism)	4.29	3.67	-.62	.020
Evaluating educational activities (e.g. classes, workshops)	3.67	3.04	-.63	.031

Objective Four

Objective four was to determine if fellow characteristics can be used to determine success of similar future programs developed for teachers and science/mathematics professionals. Demographic characteristics used for this objective included gender, and race and age. Findings indicate that there is no significant difference in the success of fellows based upon their gender, race or age. Beginning the program, graduate students exhibited similar knowledge, experience, comfort, and competency levels. As the fellows progressed through the school year, they exhibited similar changes and improvements. Gender, age, and race were not predictors of success for the participants in this study. Regression analysis results can be found in Table 21.

Table 21
Regression Analysis to Predict Successful Participation in GK-12 Programs

Variable	***B***	***SE***	***β***	***t***	***p***
Constant	91.52	12.01		7.62	.00
Gender	7.33	6.63	.30	1.11	.29
Race	1.94	4.08	.13	.48	.64
Age	-1.96	2.57	-.21	-.76	.46

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Purpose and Objectives of the Study

The purpose of this study was to describe the impact of an intervention on public education teachers and future academic and business professionals. In addition, this study sought to determine if demographic factors could serve as predictors for success of similar future intervention programs. This study was guided by the following objectives:

1. Describe demographic characteristics of teachers and graduate student fellows participating in the NSF GK-12 program entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.
2. Describe the knowledge, experience, and comfort levels of graduate students and teachers and the competency levels of graduate students (fellows) in education related areas..
3. Determine changes in knowledge, experience, comfort, and competency levels of graduate student fellows and middle school teachers in education related areas that occur over time while participating in the NSF GK-12 project entitled: *Fellows Integrate Science/Math in Rural Middle Schools*.
4. Determine if graduate student fellow characteristics can be used to predict success of future programs developed for science/math professionals and public education teachers.

Conclusions and Implications

Objective 1

Objective 1 was to describe demographic characteristics of teachers and graduate student fellows participating in the NSF GK-12 program entitled: *Fellows Integrate Science/Math in Rural Middle Schools*. The average graduate student participating in this study was a white female under the age of 25 in the process of earning a masters degree in a science related field. The average teacher participating in this study was a white female between the ages of 40 and 44 with a Bachelors degree and ten to fifteen years experience teaching science.

With the majority of teachers having Bachelor degrees and all participating graduate students working toward advanced degrees, the graduate students have greater exposure to more advanced technical content. Thus, the graduate students do have technical expertise to share with the teacher. This study does not take into account other professional development activities previously pursued by teachers, but the literature supports the fact that if teachers have been involved in traditional professional development programs they have not been exposed to advanced technical content (Lewis, et al., 1999; Wilson & Berbe, 1999; Loucks-Horsley, et al., 1996). The literature also supports in-classroom learning opportunities for teachers and indicates that teachers may be more receptive to learning content in situations such as those experienced through this program (Smylie, 1989).

Objective 2

Objective two was to describe the knowledge, experience, and comfort levels of graduate students and teachers and the competency levels of graduate students (fellows) in education related areas. At the beginning of the school year, graduate students perceived their knowledge to be average (seven items) or high (14 items) for all education related groups and issues included on the questionnaire. Items of highest perceived knowledge were 1) planning a project, 2) middle school students, and 3) communicating effectively with group members. At the end of the school year, graduate students perceived their knowledge to be average (12 items) or high (nine items) for all education related groups or issues included on the questionnaire. Items of highest perceived knowledge were 1) communicating effectively with group members and 2) following through on project tasks. The number of items of high knowledge decreased and the mean responses for most items decreased slightly. There were significant decreases in graduate student knowledge of five items. The decrease from beginning to end of the school year is likely due to fellows' overestimation of their actual knowledge of education related groups and issues at the beginning of the school year rather than an actual decrease in knowledge due to participation in the program..

Teacher responses indicated their knowledge levels were very high (2 items), high (15 items) or average (four items). The items of highest perceived knowledge were 1) middle school students and 2) assessing student learning. End of the year responses indicated teachers perceived their knowledge to be very high (three items), high (15 items), or average (3 items) for all education related groups or issues included on the questionnaire. The items of highest perceived knowledge were 1) K-12 teachers, 2) middle school students and 3) communicating effectively with other group members. There were no significant changes in knowledge of questionnaire items.

At the beginning of the school year, graduate students experience levels were high (12 items) or average (nine items) for all education related groups of issues included on the questionnaire. Items of highest experience levels were 1) middle school students and 2) teaching college students. At the end of the school year all items were once again rated as being areas of high (11 items) or average (10 items) experience. Items of highest levels of experience were 1) communicating effectively with other group members, 2) planning a project, 3) following through on project tasks, and 4) middle school students. Graduate students perceived experience with many questionnaire items decreased slightly and decreased significantly for five items. Again, this is likely due to overestimation of experience levels at the beginning of the school year rather than a negative impact of participation in the program.

Teachers' perceived experience levels at the beginning of the school year were very high (two items), high (six items) or average (13 items) for all items on the questionnaire. Highest rated items were 1) middle school students and 2) assessing student learning. End of the year responses indicated teachers perceived their experience levels to be very high (4 items) high (15 items) or average (two items) for all questionnaire items. Education related groups or issues of highest experience levels were 1) K-12 teachers, 2) middle school students, 3) assessing student learning, and 4) communicating effectively with other group members. No significant increase or decrease in experience levels were found from beginning to end of the school year for these participants.

When asked to indicate comfort level with education related groups and issues, graduate students indicated they felt high (15 items) or average (six items) comfort with each questionnaire item. Items of highest rating were 1) middle school students, 2) K-12 teachers, and 3) communicating effectively with other group members. Responses to the end of the year questionnaire indicated graduate students felt high (12 items) or average (nine items) comfort level with all items. Highest rated items were 1) communicating effectively with other group members, 2) middle school students, and 3) following through on project tasks. Significant decreases were indicated in the comfort levels of six items. This is likely due to overestimation of comfort levels at the beginning of the school year and not due to participation in the program.

Beginning of the year responses from teachers indicated their comfort levels were very high (two items), high (15 items) or average (four items) for all listed education related groups and issues. Items of highest comfort levels were 1) K-12 teachers and 2) middle school students. End of the year responses indicated very high (two items), high (17 items), or average (two items) comfort levels for all items on the questionnaire. Items of highest comfort level were again 1) K-12 teachers and 2) middle school students. No significant change was indicated from beginning to end of the school year.

Teachers' assessments of the competency of the graduate student fellows at the mid-point of the school year indicated the graduate students were very highly competent in five areas and highly competent in 18 areas. At the end of the school year, teachers indicated that graduate students were very highly competent in 12 areas and highly competent in 11 areas. While graduate student competency did improve over the course of the school year, the improvements were not statistically significant.

Objective 3

Objective three was to determine differences in knowledge, experience, comfort, and competency levels that existed in graduate student fellows and middle school teachers due to participation in the NSF GK-12 program. Comparisons of beginning of the year responses to end of the year responses revealed little significant change. Teachers' responses revealed no significant change in knowledge, experience, or comfort level with education related groups or issues. This lack of change indicates that teachers were aware of education related groups and issues prior to participating in the program.

Graduate students' responses revealed significant decreases in knowledge of five areas, decreases in experience in five areas, and decreases in comfort levels in six areas. To explain this unexpected decrease in knowledge, experience, and comfort level, it might be helpful to conduct future assessment using a then-post design (Howard, Ralph, Gulanick, Maxwell, Nance & Gerber, 1979). Graduate students may have initially overestimated their knowledge, experience, and comfort levels with the questionnaire items and, after their experiences in the classroom, become more aware of their actual knowledge, experience, and comfort levels. This indicates that graduate students assumed they had an idea of what teaching was like but after first hand experience, realized what they thought they knew was wrong.

Teacher responses to the Fellow Impact Questionnaire indicate no significant changes in graduate students' competency in the classroom from mid-year to the end of the school year. To better assess change in competency, an additional assessment could be included at the beginning of the school year to better evaluate beginning competency of graduate students in the classroom. This would provide a more realistic beginning point of reference for development throughout the school year. When the assessment was conducted at the mid point of the year, graduate students had spent enough time in the classroom to learn classroom management skills from their lead teacher and develop strategies for working with students. Changes in graduate student competency from the beginning of the school year to the mid point of the year may be greater than the changes found in this study.

Objective 4

Objective four was to determine if graduate student demographic characteristics can be used to predict success of participants in future programs developed for science/math professionals and public education teachers. While the findings of this study support continuing NSF GK-12 programs with middle school teachers and graduate students in Texas, data analysis did not uncover any predictors for success of graduate students in the program based upon demographic characteristics. Although participating graduate students exhibited similar gender and age characteristics as participating teachers and public school teachers nationwide, these characteristics were not related to success in this program. In addition, the analysis of race indicated that there is no relationship between the race of the graduate student and their success in the classroom. Further study should be done to determine if including a greater number of minority professionals in similar programs may improve the attitudes of minority students toward pursuing science and math related careers.

While this study did not find specific predictors for success, mean responses indicate that graduate students and teachers feel the program is worthwhile. Teachers credit the program with improving their proficiency with technology, improving their content knowledge, and increasing their job satisfaction. Graduate students claim to have improved communication skills, are better organized, and have an ongoing interest in contributing to K-12 education throughout their careers.

Recommendations for Future Research

Teacher training and professional development are important issues that warrant continued study. Based on the findings of this study, future work should be continued to measure impact on participating graduate students as they become professionals in science and mathematics related careers. How does their experience in an NSF program influence them throughout their careers? Do they have continued interaction with public education institutions? Do graduate students who participated in programs similar to this one have improved job skills (e.g. communication, organization, time management, etc.) when compared to graduate students pursuing similar careers but not involved in public education?

To further explore the benefits experienced by teachers and graduates students, future studies should incorporate a qualitative component. A qualitative study should be conducted to gain insight into characteristics of teachers and graduate students, other than demographic characteristics, that lead to success. A case study approach would allow for in-depth study of teacher adoption of presentations and activities brought to their classroom by graduate students. Findings could be used to develop a model for success which could then be tested in future studies. Personality characteristics should be of particular interest for matching graduate students and lead teachers. Current research into personality characteristics and successful relationships of student teachers and cooperating teachers (Roberts, Mowen, Edgar, Harlin, & Briers, in press; Kasperbauer & Roberts, in press) indicate that personality characteristics are important considerations in working relationships.

Further investigation into personality characteristics and the development of a model will allow for better program design and more precise measurement of gains experienced by participants. Improved assessment will provide evidence for continued funding of such programs. In the case that funding can not be continued through the initial source, evidence of success can be presented to other parties to garner support. This could include asking individual colleges within a university system to sponsor a graduate student or inviting partners in industry to become involved.

To gain a clearer picture of the impact programs such as this have on the participants using quantitative methods, a post-then pre design should be employed to avoid participants' overestimation of their knowledge, experience, and comfort levels at the beginning of their experience. Additionally, student performance should also be explored as a measure of the success of the program. To fulfill the expectations of the No Child Left Behind Act, partnership programs must help improve student performance in science and math by increasing the content knowledge of participating teachers. To assess improvements in student performance, student scores on state required standardized tests should be examined. For this group of teachers and graduate students, the Texas Assessment of Knowledge and Skills (TAKS) test scores would provide evidence of students' knowledge of science and math. Scores of students impacted by the program could be compared to the state average to see if involved students have higher average scores.

Another avenue of study could include prior experiences of successful graduate students. Research into successful graduate students' perceptions of what experiences inspired them to continue their education may shed light on what opportunities should be available to youth today to inspire interest in math and science careers. Negative experiences could also be explored with an eye on what kinds of situations cause youth to lose interest in math and science.

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APPENDIX A

KNOWLEDGE EXPERIENCE AND COMFORT LEVEL QUESTIONNAIRE

Knowledge, Experience, and Comfort Level Questionnaire

Name: ____

Role: ☐Graduate Fellow ☐Local School Teacher ☐University Scientist
☐Other (describe)____

What is your current knowledge of, experience with, and comfort level with the following people or issues? Using the scale below, please indicate your response.

Knowledge of, Experience with, and Comfort level
1=Very Low
2=Low
3=Average
4=High
5=Very High

Group or Issue	Knowledge of	Experience with	Comfort level
K-12 teachers	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Elementary school students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Middle school students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
High school students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
K-12 administrators	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
University faculty engaged in K-12	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Science education reform	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Current issues in K-12 education	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Teaching college students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Planning a learning experience for K-12 students	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Theories of learning (e.g. Constructivism)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Various approaches to learning (e.g. active learning, lecturing, learning through inquiry)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Assessing student learning	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Evaluating educational activities (e.g. classes, workshops)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Technology in instruction	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Interdisciplinary approaches to inquiry and problem-solving	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Planning a project	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Following through on project tasks	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

Keeping a project on schedule	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Communicating effectively with other group members	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5
Being a team or project leader	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5

APPENDIX B

PROGRAM EVALUATION QUESTIONNAIRE:

TEACHER VERSION

GK-12 Fellows Program Evaluation

Name ____ Date _________

School______________________________ RS/RM______________________

Please evaluate your experience in the GK-12 Fellows Program by rating your agreement with each of the statements listed below according to the scale provided.

Agreement Levels
1= Strongly Disagree
2= Disagree
3= Neither Agree nor Disagree
4= Agree
5= Strongly Agree

Overall GK-12 Program Evaluation	Agreement				
Integration:					
My RM/RS provided an appropriate activity for each unit covered.	1	2	3	4	5
Students did not view the RM/RS as a student teacher.	1	2	3	4	5
The RM/RS served as a school-wide resource.	1	2	3	4	5
Many activities included math and science principles regardless the class in which they were presented.	1	2	3	4	5
The RM/RS increased and improved the use of technology in my classroom.	1	2	3	4	5
Team Contact:					
My RM/RS provided a useful link between me and university faculty.	1	2	3	4	5
University faculty conducted a presentation in my classroom.	1	2	3	4	5
My students benefited from my contact with university faculty.	1	2	3	4	5
PEER Web resources, such as virtual scientist visits and interviews, were presented in my classroom.	1	2	3	4	5
My students were influenced by TAMU employees other than by the RM/RS.	1	2	3	4	5
Interaction Results:					
My content knowledge has been improved by the RM/RS.	1	2	3	4	5

I have a better understanding of math and science principles because of working with the RM/RS.	1	2	3	4	5
I am more satisfied with my job because I have an RM/RS in my classroom.	1	2	3	4	5
I am more proficient with technology because of my GK-12 program involvement.	1	2	3	4	5
My use of inquiry learning has increased due to my work with this program.	1	2	3	4	5
Program Organization:					
RM/RS spent at least 8 hours weekly working directly with students.	1	2	3	4	5
At least 1 hour was spent planning for upcoming events with the RM/RS weekly.	1	2	3	4	5
The work required of me for participating in this program was acceptable for the amount of improvement made in my classroom.	1	2	3	4	5

APPENDIX C

PROGRAM EVALUATION QUESTIONNAIRE:

GRADUATE STUDENT VERSION

GK-12 Fellows Program Evaluation

Name ____ Date _____________

School__________________________ Lead Teacher _________________________

Please evaluate your experience in the GK-12 Fellows Program by rating your agreement with each of the statements listed below according to the scale provided.

Agreement Levels

1= Strongly Disagree
2= Disagree
3= Neither Agree nor Disagree
4= Agree
5= Strongly Agree

Overall GK-12 Program Evaluation	Agreement
Integration:	
I was perceived as a role model by students and faculty in my school.	1 2 3 4 5
Students viewed me as a teacher more than a scientist or mathematician.	1 2 3 4 5
I served as a school-wide resource.	1 2 3 4 5
Many activities included math and science principles regardless the class in which they were presented.	1 2 3 4 5
Inquiry learning was increased in my classroom due to my activities.	1 2 3 4 5
PEER modules were presented in my classroom.	1 2 3 4 5
I increased and improved the use of technology in my classroom.	1 2 3 4 5
Team Contact:	
I provided a useful link between my lead teacher and university faculty.	1 2 3 4 5
University faculty conducted a presentation in my classroom.	1 2 3 4 5
I involved my faculty mentor when questions arose regarding their area of expertise.	1 2 3 4 5
My students benefited from my contact with university faculty.	1 2 3 4 5
PEER Web resources, such as virtual scientist visits and interviews, were presented in my classroom.	1 2 3 4 5

I involved other RM/RS's in my classroom activities.	1	2	3	4	5
My students were influenced by TAMU employees other than me.	1	2	3	4	5
Interaction Results:					
I improved my lead teacher's content knowledge.	1	2	3	4	5
I have a better understanding of education principles because of working with my lead teacher.	1	2	3	4	5
My activities improved students learning of state standards.	1	2	3	4	5
I used my entire budget for classroom supplies.	1	2	3	4	5
I provided supplies that my lead teacher will be able to use next year.	1	2	3	4	5
Program Organization:					
I spent at least 8 hours working directly with students each week.	1	2	3	4	5
At least 1 hour was spent planning for upcoming events with the lead teacher weekly.	1	2	3	4	5
Distance Learning Community requests involved my area of expertise.	1	2	3	4	5
Time spent with Distance Learning Requests is reasonable and worthwhile.	1	2	3	4	5
It is important for professionals in my field to contribute to K-12 math and science education.	1	2	3	4	5
Spending 10 hours per week in a middle school classroom interfered with my other obligations as a graduate student.	1	2	3	4	5
The GK-12 program has influenced how I will contribute to public education in the future.	1	2	3	4	5
I have learned about needs and difficulties of public education through my involvement in this program.	1	2	3	4	5
I am more organized due to my involvement in this program.	1	2	3	4	5
I was able to participate in the GK-12 program and still perform scholarly duties expected of a graduate student.	1	2	3	4	5
I have gained communication skills through the GK-12 program.	1	2	3	4	5
The work required of me for participating in this program was acceptable for the amount of improvement I made in the classroom.	1	2	3	4	5

APPENDIX D

FELLOW IMPACT QUESTIONNAIRE

Fellow Impact Evaluation

Name ____ Date ________________

School_______________________ RS/RM_______________________________

Please evaluate the performance of your Resident Scientist or Mathematician for each of the statements listed below according to the scale provided.

Performance Rating of Resident Scientist/Mathematician

1= Poor
2= Fair
3= Acceptable
4= Good
5= Outstanding

Overall Evaluation of RM/RS	Rating				
Quality of preparation for activities	1	2	3	4	5
Adequacy of written activity plan	1	2	3	4	5
Clarity of activity objectives	1	2	3	4	5
Appropriateness of activity objectives	1	2	3	4	5
Organization of equipment and activity materials for effective use with the different classes the RM/RS works with	1	2	3	4	5
Ability to create in students awareness of the need to study topics undertaken	1	2	3	4	5
Ability to develop interest of students	1	2	3	4	5
Ability to maintain interest of students	1	2	3	4	5
Effectiveness in using a variety of appropriate delivery methods	1	2	3	4	5
Effectiveness in coping with unexpected situations that arise in the classroom	1	2	3	4	5
Effectiveness in pacing activities from one part to the next according to students' achievement	1	2	3	4	5
Effectiveness in providing continuity of learning among the activities taught	1	2	3	4	5
Effectiveness in involving all students in class activities	1	2	3	4	5
Ability to take individual differences of students into account for activities	1	2	3	4	5
Balance between "RS/RM talk" and "student talk" in classroom	1	2	3	4	5
Effectiveness in having students develop problem-solving abilities	1	2	3	4	5

Effectiveness in having students draw worthwhile conclusions about what has been studied in and out of class	1	2	3	4	5
Effectiveness and appropriateness if school and community relationships with other teachers and parents	1	2	3	4	5
Overall management of classroom	1	2	3	4	5
Effectiveness in developing good rapport with students	1	2	3	4	5
Effectiveness in maintaining discipline	1	2	3	4	5
Ability as a good "housekeeper," maintaining classroom cleanliness during and after activities	1	2	3	4	5
Effectiveness of developing and presenting activities that reinforce concepts taught by the lead teacher	1	2	3	4	5

Please use the remaining space to describe the impact your RM/RS has on your classroom.

VITA

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