THE INFLUENCE OF A TRAIN-THE-TRAINER PROFESSIONAL DEVELOPMENT ON TEACHER PERCEPTIONS OF SCIENCE INTEGRATION AND INQUIRY-BASED INSTRUCTION

By

JESSICA MARIE BLYTHE

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2014

To all the agriscience teachers who mentor, encourage, and care for their students and
to my students at Baker Country High School, Florida

ACKNOWLEDGMENTS

First and foremost, I would like to thank my loving parents, JoAnn and Keith. Their unwavering support has been instrumental in allowing me to grow into the person I have become, both professionally and personally. I would also like to thank my Nana and Duke for all of the love and encouragement a granddaughter could ever need. Over the years I have asked my family to support me as I moved farther and farther away from home. They have instilled in me a sense of curiosity and love for life-long learning. Their caring, compassionate, and understanding natures have allowed me to strive for my professional goals while knowing I have a strong foundation in my family. I am blessed to have you as my family and I love you all.

I would also like to thank those friends who have become my sisters over the years as they enabled me to put school first Tera, Meggers, Ida, and Lauren. They provided support and balance in my life. Your encouragement, support and ideas have been greatly cherished. I would also like to thank my little sister, Julie. Your mastery of the English language and skill in academic writing are amazing! I am sure that I will learn from you for years to come. I can’t wait to see what the future brings for us all.

I would like to acknowledge the work of my advisor and mentor, Dr. Brian Myers, and thank him for all he has done to help me succeed in graduate school. Over the course of my graduate program he has worked hard to provide me with a variety of experiences to help me become a qualified faculty member and pursue a career about which I am passionate. I know that he will continue to be a trusted advisor and mentor as I enter the profession; I only hope that I can live up to his expectations as young faculty member.

The members of my committee, Dr. Ed Osborne, Dr. Alyson Adams, and Dr. Andrew Thoron, have shown true dedication to the improvement of this work and my development as a future faculty member. They provided sound structure and questioned my ideas throughout the process to ensure a high quality research study and also to help me learn how to defend my decisions. They have put in numerous hours reading this dissertation, and I know that it was at times very tedious.

I would also like to express my gratitude for my amazing Ag Ed family. To my high school agriscience teachers, Ms. Wilard, Mrs. LaFlamme and Mr.Griffin, who instilled a love for Ag Ed through modeling dedication to the profession and their students. To Ms. Farrah Johnson, my trusted mentor, you showed me how determination and hard work can help make a difference and not just an impression. Your dedication to your students and service to the profession is inspirational. I hope that I can live up to the example you set. To Greg Johnson, my trusted co-teacher and partner in teaching for four years, thank you for all that you have taught me over the years. As I have moved on into higher education you have always kept me grounded in the practical applications of the work I have done and still need to do. I have always valued your opinion and trusted your advice. To the Ag Ed teachers in Florida and across the nation, you have become more than just my peers but also my friends. Thank you for your dedication to your students, it is always inspirational.

Finally, I would like to thank the undergraduate and graduate students I have worked with in AEC over the past 3 years. To the countless lunch buddies, study partners, office mates, mentors and mentees: You have made work feel like a second home I am grateful for all of you.

TABLE OF CONTENTS

APPENDIX

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

FFA	The National FFA Organization
IBI	Inquiry-based Instruction
ISS	Integrative Science Survey
ITT	Inquiry-based Teaching Techniques
NAAE	National Association of Agricultural Educators
NATAA	National Agriscience Teacher Ambassador Academy
NCTAF	National Council on Teaching and America's Future
NRC	National Research Council
NWP	National Writing Project
SCS	School Culture Survey Questionnaire
TAP	Teacher Attitudes towards Professional Development Questionnaire
TtT	Train the Trainer

Abstract of Dissertation Presented to the Graduate School
of the University of Florida in Partial Fulfillment of the
Requirements for the Degree of Doctor of Philosophy

THE INFLUENCE OF A TRAIN-THE-TRAINER PROFESSIONAL DEVELOPMENT ON TEACHER PERCEPTIONS OF SCIENCE INTEGRATION AND INQUIRY-BASED INSTRUCTION

By

Jessica Marie Blythe

May 2014

Chair: Brian E. Myers
Major: Agricultural Education and Communication

The purpose of this study was to describe the influence of the train-the-trainer professional development form of professional development on participants' perceptions of agriscience integration and inquiry-based instruction (IBI). The independent variables considered were elements of high-quality professional development, such as duration, active participation, coherence, and school culture; teacher attitudes towards professional development; and teacher demographics. The dependent variables assessed were teachers' perceptions of agriscience integration and IBI.

This study utilized a quasi-experimental design to assess the impacts of a teacher professional development program and experimental follow-up support on secondary teachers' perceptions of science integration and IBI. This study was a census of all teachers who attended a 2012 professional development workshop facilitated by a National Agriscience Teacher Ambassador at the FFA and/or NAAE National Convention. Participants completed four surveys over the subsequent year to assess their perceptions of agriscience integration and IBI. Descriptive methods were used to analyze teachers' perceptions of agriscience integration and IBI. Correlations

and follow-up regression analysis were conducted to determine the relationships between the teachers’ perceptions and the elements of high-quality teacher professional development.

Results of the study revealed that respondents had favorable perceptions of science integration into agriculture programs and planned to increase the levels of science integration in their programs. Additionally, a majority of respondents reported utilizing IBI more than once a week. Because participants of the study did not utilize the experimental follow-up support system for the workshop, clear effects could not be determined. There was a positive correlation between science integration and IBI. A variation of positive and negative correlations was found between the dependent and independent variables. Five models were found to be significant predictors of respondents’ perceptions of science integration three models were found to be significant predictors of IBI.

These findings indicate that teachers perceive science integration and IBI as positive influences in secondary agriculture education which supports the integration of science and science teaching techniques in secondary agriculture education programs. Though relationships exist between science integration and IBI, and various elements of school culture and professional development, further investigation is needed to better understand these relationships and their predictive variability.

CHAPTER 1
INTRODUCTION

Building and developing a better teacher workforce has been a focus across the United States (National Council on Teacher Quality, 2012; National Commission on Teaching and America's Future [NCTAF], 2010). Approximately 36% of teachers have not graduated from a university or college teacher preparation program (NCTAF, 2010), while almost one quarter of teachers have emergency or substandard teaching licenses (NCTAF, 2010). Additionally, teaching has been such a challenging profession that as many as one-third of all teachers have left the profession within three years, and 50% have left within five years (Ingersoll, 2003). The accumulations of these factors and other factors have demanded that continuous professional development opportunities for teachers be of high quality and rigor and serve to develop teachers' knowledge, skills and understandings of teacher practice.

Preparing Effective Teachers

Today's society has been constantly evolving, which has deeply impacted schools and students. Teaching is not just a technical activity but one that requires theoretical and practical understanding and abilities related to teaching and learning (National Research Council, 1996). The gap between teaching practices and educational reform outcomes has not been without reason: the teaching profession has changed over the past century, continuously altering the knowledge and skills that teachers need in order to positively impact student learning (Darling- Hammond & Bransford, 2005). In order to close the gap between teacher preparedness and the knowledge and skills demanded by the changes in society, continuous teacher professional development has become a standard of educational reforms and an expectation of teachers.

Before formal teacher education programs existed in the United States, the assumption was that anyone who had completed a given level of education could teach effectively up to that grade level (Labaree, 2008). However, the common school movement of the early nineteenth century induced not just a need for more teachers, but also demanded higher teacher qualifications. This increased the necessity for systematic and professional training in the teaching profession (Labaree, 2008). In the nineteenth century teacher education occurred in a variety of organizational settings until state Normal Schools emerged in the last quarter of the century (Labaree, 2008). More recently, preservice teacher education degrees have been offered through a variety of institutions. This has allowed teachers to enter the classroom with a variety of backgrounds in teaching and learning and participate in professional development from an assortment of sources.

When hoping to increase student learning outcomes and success, one must begin with recognition of the impact teachers have on student outcomes. New student performance expectations have implied that new ways of teaching are needed. Schools cannot be improved without improving the skills and abilities of the teachers who work in them (Darling-Hammond et al, 2009), because teachers are the direct connection to the students. Teaching quality has been found to be one of the most important factors in raising student achievement (Mitzell, 2010).

In the past 100 years, a shift has occurred from teachers as the professional in charge of making decisions about curriculum, teaching, learning and assessment for their classrooms to a culture where states have made the decisions about what students learn, what they must achieve as the outcome, and what standards apply (Days & Sachs, 2004). Though both mindsets have recognized the need for teacher learning, adaptation, and change in order to successfully create a culture of student learning, teachers' ability to control their classroom has diminished, due to constraints by educational policies and administrators.

Reform efforts in education have required a substantive change in how classes are taught (NRC, 1996; 2009). School reform and current legislative actions have demanded instructional changes designed to address the need for higher student achievement in the United States today (Ashdown & Hummel-Rossi, 2005). "Concerned with the need to raise standards of achievement and improve their positions in the world economic tables, governments over the last 20 years have intervened more actively to improve the system of schooling" (Days & Sachs, 2004, p.13). Any change within a school system must start with change in teacher practices, thus creating a strong need for continuous and effective teacher preparation and professional development (Darling-Hammond & Bransford, 2005).

Teaching is a diverse and complicated practice, and no individual can be expected to know everything about the profession simply by earning a degree in education (Darling-Hammond & Bransford, 2005). The credit requirements of undergraduate teacher preparation programs have limited the time available to prepare preservice teachers for the many responsibilities of being a teacher (Myers, Dyer, & Washburn, 2004). Professional development has been defined as the "deepening of teachers' understanding about the teaching/learning process and the students they teach, which must begin with pre-service education and continue throughout a teacher's career" (Darling-Hammond & McLaughlin, 1995, p. 203). Professional development is a complex process, which mirrors the complexity of the purposes and practices of teaching and learning. The professional development of teachers must be a continuous, life-long learning process (Desimone, 2009; NRC, 1996) in which teachers engage to help create a culture of life-long learning for their students and school (Mitzell, 2010). An educator's development must be ongoing and situated in an authentic context where new meanings are co-constructed and internalized through interactions with others (Darling Hammond & McLaughlin, 2005; Guskey, 2000; Pollnow, 2012).

Though most professional development has focused on the needs of beginning teachers, a majority of experienced teachers have also confronted challenges each year (Roberts & Dyer, 2004). Experienced teachers have faced changes in subject matter, new instructional methods, new technology, changed laws or standards, and different student learning needs (Mitzell, 2010). Professional development has allowed teachers to strengthen teaching practice throughout their careers to help provide the best educational practices for their students.

Professional Development

Teacher learning, particularly professional development, has "traditionally been a patchwork of opportunities stitched together into a fragmented and incoherent 'curriculum'" (Wilson & Barne, 1999). Views of professional development for teachers have varied widely. Some have perceived professional development as everything a learning experience should not be - an imposed, brief, deficit-oriented, underfunded process lacking rigor and coherence, treated as an additional responsibility for teachers instead of part of a natural process (Days & Sachs, 2004). Others have perceived professional development as an inspiring, engaging learning opportunity that can impact teachers' daily practice and focus on professional renewal and growth, while stemming from an individual commitment to learning (Days & Sachs, 2004).

The philosophy behind professional development has evolved from a focus on training teachers to adopt particular teaching practices in their classrooms to a focus on helping teachers adopt a critically reflective approach to teaching and learning that allows them to examine when effective teaching is occurring in their classrooms (Smith, Hofer, Fillespie, Solomon, & Rowe, 2003). Prior to the mid-1990s, teacher professional development was a matter of voluntary commitment or something for those with career ambitions (Craft, 2000).

Teachers have pursued individual professional development opportunities, from enrolling in master's degree courses to signing up for summer or weekend workshops (Guskey, 2000). Additional professional development has occurred in social settings through conversations with other teachers, joining professional associations, and classroom observations (Wilson & Barne, 1999). Teachers have experienced a wide range of activities and interactions that can influence their knowledge and skills; improve their teaching practice; and contribute to their personal, social and emotional growth (Cohen, McLaughlin, & Talbert, 1993; Desimone, 2009).

Though professional development has been an expected part of the teaching profession for decades, little evidence existed that described what professional development programs have looked like over time (Webster-Wright, 2009). What teachers learn during professional development and what aspects of professional development promote teacher change have remained difficult to determine, because of the lack of clear, systematic information concerning professional development (Desimone, 2009).

Though the literature has identified a common set of characteristics that need to be considered to make professional development effective, little direct evidence has shown these characteristics are related to improved teaching practices and increased student achievement (Garet et al., 2001; Loucks-Horsley et al., 2011; U.S. Department of Education, 1999). Some studies have suggested professional development that shares all or most of the identified characteristics can have a substantial, positive influence on teachers' classroom practice (Birman, Desimone, Garet, & Porter, 2000; Garet et al., 2001). If teachers critically and reflectively engage in professional development activities designed to develop learning, meet student needs or manage change to the classroom environment then professional development can lead to teacher change (Gu, 2007).

Research has criticized professional development opportunities as ineffective because they have not "provide[d] teachers with sufficient time, activities, and content necessary for increasing teacher knowledge and fostering meaningful changes in their classrooms" (Loucks-Horsley, Hewson, Love, & Stiles, 1998, p.258). Duration and follow-up support of a professional development program was found to be related to the degree of teacher change (Shields, Marsh, & Adelman, 1998; Weiss, Montgomery, Ridgeway, & Bond, 1998). The lack of evaluative information on the professional development opportunities from which teachers and school districts can choose (Hill, 2009) has shown that little was known about what teachers actually learn while attending professional development programs (Wilson & Berne, 1999).

Professional Development in Agricultural Education

Professional development programs have historically assisted agriculture teachers in developing the knowledge and skills necessary to perform their teaching roles (Barrick, Ladewig, & Hedges, 1983; Birkenholz & Harbstreit, 1987). Like agricultural professionals in other fields, agriculture teachers must be continually updated on advances within the agriculture industry, in addition to continually refining their education professional skills (Guskey, 2000; Schunk, 2008). As any other teacher, agriculture teachers have been expected to take part in professional development (Greiman, 2010), yet little is known about the professional development experiences of secondary agriculture teachers. Due to the diversity between and within states, professional development opportunities for agriculture teachers must include breadth and depth of content, in addition to being diverse in format (Harris, 2008). Secondary agriculture teachers must take advantage of a diverse array of professional development opportunities to keep current with the changes that take place in education and the agriculture industry (Harris, 2008).

National Agriscience Teacher Ambassador Academy

One of the longest running national professional development opportunities for secondary agriculture teachers has been the National Agriscience Teacher Ambassador Academy (NATAA). Over 170 teachers from 48 states have participated in NATAA over the past 10 years (NAAE.org, 2013). NATAA focused on the incorporation of inquiry-based instruction (IBI) into secondary agriculture classrooms to help develop students' scientific knowledge (NAAE.org, 2013). The Academy has three guiding objectives (NAAE.org, 2013):

- Provide teachers with educational resources, training and information on ways to implement science-based activities in classroom for environmental science, food science, sustainability and biological sciences;
- Share lesson plans, laboratory exercises and teaching strategies in order to improve the resources available to teaching agriscience;
- Train and influence the next generation and future employees who will advance agricultural sciences to the next level.

NATAA has utilized a train-the-trainer (TtT) professional development model. The premise of this model has been that a select group of teachers from across the United States participates in an intensive, weeklong professional development program that immerses them in inquiry-based instruction (Myers & Parker, 2011). Upon completion the teachers become trainers, with the expectation that they will then conduct additional workshops to help additional teachers (participants) learn how to utilize IBI in their classrooms. NATAA has also offered follow-up opportunities for the trainers. However, no follow-up has been offered to the participants of the trainers' workshops. Research has shown that NATAA creates change in the trainers' teaching practices (Myers, Thoron, & Thompson, 2009; Shoulders & Myers, 2011; Thoron, Myers, & Abram 2011). However, the impact of trainer-led workshops on the participants' teaching practices had not been determined.

Statement of the Problem

Professional development programs have been an essential component of the educational system by which teachers' knowledge and skills are continually updated to meet the demands of today's schooling (Darling-Hammond & Bransford, 2005). The ever-evolving educational practices and standards that have dominated today's schools have demanded that teachers' knowledge and skills be continuously developed to meet the needs of their learners (Webster-Wright, 2000).

While professional development has been a mandated part of teacher practice, the opportunities for professional development have not always resulted in changes in teacher practice (Garet et al, 2001). The NRC (2009 & 1996) and the National Research Agenda (Doerfert, 2011) have called for an examination of teacher professional development practices as a way to develop highly-qualified, expert teachers who can impact student learning. A common recommendation has been that professional development be recognized as part of the continuous life-long learning process for individual and professional growth, enabling teachers to become robust experts in learning processes.

While research has focused mainly on teacher satisfaction, commitment to innovation (Desimone, 2009), and detailing key characteristics and design elements of professional development (Good, 2007), little research has examined interactions between the elements of professional development and teacher change in practice. Analysis of professional development characteristics has not shown any single formula for teacher professional development that creates change in teacher practice. There has been a perceived weak correlation between teacher professional development and effective sustained improvement in teacher practice. This study addressed this problem by beginning to address this problem by exploring the various elements of high quality teacher professional development and teachers' perceptions about the professional development content over the course of a year.

Purpose of the Study

The primary purpose of this study was to describe the influence of the train-the-trainer professional development model on NATAA workshop participants' perceptions of science integration in agriculture and inquiry-based instruction.

Statement of Objectives

In order to meet the above purpose several objectives were developed:

- Objective 1: To describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture following a trainer-led professional development workshop.

- Objective 2: To describe the NATAA workshop participants' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a trainer-led professional development workshop.

- Objective 3: To determine the NATAA workshop participants' utilization of NATAA follow-up support after a trainer-led professional development workshop.

- Objective 4: To determine the effects of online follow-up on NATAA workshop participant's perceptions of science integration in agriculture and IBI.

- Objective 5: To determine the relationship between NATAA workshop participants' perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model (teacher variables, professional development program variables, school culture and other professional development).

- Objective 6: To predict teacher perceptions of science integration in agriculture and IBI based on the elements of the high-quality teacher professional development model.

Significance of the Study

This study was significant for agricultural teacher educators seeking to create positive change in teachers' practices through effective professional development models. The train-the-trainer professional development model has been a well-received model for teacher professional development, but the effects of the professional development on the second generation of teachers trained by this model have not been empirically supported (Pollnow, 2012). The results of this study may inform professional development planning, as well as introduce how train-the-trainer models of professional development may inform teacher practice. Overall, this study can provide implications for teacher educators by modernizing their outreach programs to practicing teachers.

The National Agriscience Teacher Ambassador Academy may also find value in this study. The findings of this study can be utilized to provide insight into the factors of the professional development program which may be influencing the teacher participants' implementation of IBI in their own classrooms. This study may also influence the NATAA professional development program for the trainers.

The cost of teacher professional development has also been a matter of interest. The results of this research may be utilized to provide insight into the influence of online follow-up support with respect to teacher change, allowing more follow-up support to occur for teachers who participate in professional development. Additionally, funding agents of professional development have typically required empirical support for the models of professional development that receive funding.

This study also held significance for agricultural education. The National Research Agenda (Doefert, 2011; Osborne, n. d.) and the National Research Council (1998; 2009) called for agricultural education to prepare successful secondary agriculture teachers. The results of this study may help to quantify how agricultural education may influence teacher change through professional development and provide a system of effective teacher professional development that promotes teacher change that impacts student learning.

Finally, this study held significance for practicing teachers. Teachers have often been required to participate in professional development and follow-up activities related to the professional development. The results of this study may indicate the importance of follow-up activities, as well as quantify how professional development may contribute to teacher practices.

Definition of Terms

The following terms were operationally defined for use in this study:

- AGRICULTURAL EDUCATION. The profession of teaching students in the diverse aspects of the agriculture industry (Thoron, 2010).
- CORE FACETS OF TEACHER PROFESSIONAL DEVELOPMENT. A set of facets related to teacher professional development which provides a framework or examining the quality of diverse professional development experiences. The facets include: active participation, coherence, collaborative participation, content, duration (Desimone, 2009) and form (Guskey, 2000). Coherence, collaboration, duration and active participation are core facets which are treated as independent variables in this study.
- CORE FACET OF ACTIVE PARTICIPATION. The level of engagement of teachers in their own learning during the professional development experience (Garet et al., 2001). For the purposes of this study active participation and active learning are used interchangeably. The core facet of active participation is treated as an independent variable in this study.
- CORE FACET OF COHERENCE. How the professional development aligns with the teachers' individual knowledge, beliefs and practices, as well as school, district and state policies. Additionally, the alignment of the professional development with previous, concurrent and future professional development opportunities is included in the core facet of coherence (Desimone, 2009). The core facet of coherence is treated as an independent variable of this study.
- CORE FACET OF COLLECTIVE PARTICIPATION. Participation of teachers from the same, school, grade or department that allows teachers to interact and support each other as they implement the professional development innovation. (Desimone, 2009). The core facet of collaborative participation is treated as an independent variable of this study.
- CORE FACET OF CONTENT. The new skill, knowledge and understanding that are the central focus of the professional development (Guskey, 2000). Inquiry-based instruction and science integration in agriculture were the content focus of the professional development program examined in this study, and are the dependent variables.
- CORE FACET OF DURATION. Duration of a professional development experience includes the number of contact hours spent on the professional development activity, as well as the time span over which professional development activities occur (Desimone, 2009). The core facet of duration is treated as an independent variable in this study.

- CORE FACET OF FORM. There are many forms of professional development available and they vary in the way the other core facets of professional development are implemented. The form of the professional development examined in this study is the Train-the-Trainer form of professional development.

- EFFECTIVE PROFESSIONAL DEVELOPMENT. Professional development that successfully increases teacher learning and changes teaching practice, with the ultimate goal of improving student learning (Desimone, 2009).

- FACILITATOR. The individual or group of individuals who guides the trainers as they construct the new knowledge and practices throughout the professional development (Borko, 2004).

- HIGH-QUALITY PROFESSIONAL DEVELOPMENT. Professional development experiences that utilize the core facets of professional development to impact teacher knowledge and practices. The elements of high-quality professional development are the independent variables of this study.

- INQUIRY. A multidimensional activity that “involves making observations; posing questions; examining books and other sources of information to see what is already known; planning investigations; reviewing what is already known in light of experimental evidence; using tools to gather, analyze, and interpret data; proposing answers, explanations, and predictions; and communicating the results. Inquiry requires identification of assumptions, use of critical and logical thinking, and consideration of alternative explanations” (NRC, 1996, p. 23).

- INQUIRY-BASED INSTRUCTION. (IBI) Instructional methods that require students to acquire knowledge through the process of inquiry (NRC, 2000). The workshop content provided by the trainers to the participants in this study were lessons that utilized inquiry-based instruction. IBI represents one of the dependent variables in this study.

- INQUIRY-BASED INSTRUCTION METHODS. The particular methodological knowledge and skills needed to implement Inquiry-based instruction within a classroom. For this study the methodological knowledge and skills were assessed through the IBI-SR instrument and were measured by participants’ self-reported perceptions of specific benchmarks related to IBI.

- PROFESSIONAL DEVELOPMENT FOLLOW-UP. The activities, interaction and support provided by professional development providers after the initial training activities. Follow-up represents the support system offered as continued professional development as teachers implement and adapt what they learned to fit their own classrooms (Borko, 2004; Desimone, 2009). An email-support system was developed to provide the follow-up program for the NATAA professional development workshops in this study. This was an independent variable of the study.

- PROFESSIONAL DEVELOPMENT PROGRAM. All aspects of a professional development experience grouped together. This includes the initial interaction, the face-to-face components of the professional development, and additional follow-up elements provided by the professional development program (Borko, 2004).

- SCHOOL CULTURE. School culture is a complex pattern of norms, beliefs, values, and attitudes that are ingrained in an educational institution (Barth, 2002). A collaborative school culture includes factors such as, collaborative leadership, teacher collaboration, professional development, unity of purpose, collegial support and learning partnerships (Gruenert, 1998). School culture is an independent variable of the study.

- SCIENCE INTEGRATION IN AGRICULTURE. The accentuation of the natural sciences concepts and competencies when teaching secondary agricultural education curriculum. Science integration in agriculture is one of the dependent variables of this study.

- TEACHER ATTITUDES TOWARDS PROFESSIONAL DEVELOPMENT. This was treated as an independent variable of this study.

- TRAINER. The individual teacher who was guided through the intensive professional development by the facilitators, and then became the leader of additional professional development with the same content focus for an additional set of teacher participants. Trainers represented the first generation of teachers within the train-the-trainer professional development model.

- TRAIN-THE-TRAINER. A specific form of professional development in which facilitators lead highly skilled teacher trainers through an intensive professional development program. The trainers, in turn, conduct workshops with additional teacher participants, passing on the knowledge and skills developed in the original professional development to a second generation of teachers (Pollnow, 2012).

- TRAIN-THE-TRAINER PARTICIPANTS. The individual teachers who are guided through professional development by the trainers. They represented the second generation of teachers within the train-the-trainer professional development model.

- WORKSHOP. Discrete professional development events that are generally short and not repetitive in nature (Guskey, 2000).

Limitations of the Study

The conclusions and implications drawn from this study were subject to the study's limitations, including lack of generalizability of the results, the length of the study, fidelity of the workshop content, the environment of the workshop, the online nature of the follow-up support, as well as the motivation of teachers.

The data were limited to the purposively selected census of teachers participating in the National Agriscience Teacher Ambassadors workshops at the National FFA convention and the National Association of Agriculture Educators annual conference. Therefore, the results cannot be generalized beyond the population of this study. Additionally, non-response from the teacher participants also limited the generalizability.

The duration of the study subjected it to the threat of history, as teachers may have been exposed to additional professional development or information concerning inquiry-based instruction methods, therefore the length of the study is a limitation. When interpreting the study's results, these historical factors could have impacted teachers' perceptions concerning inquiry-based instruction. An additional threat due to the study's length was maturation, as teachers continued to develop their teaching practices between the beginning and end of the study.

The fidelity of workshop content is also a limitation of this study. The professional development workshops were not delivered by the researcher; multiple teacher trainers delivered the workshops. As a result, instruction of inquiry-based instruction during the workshop may have varied. This threat was reduced due to the training the teacher trainers received during their National Agriscience Teacher Ambassador Academy.

The initial professional development workshops occurred as part of part of larger convention. Teacher participants attended the workshops while at the National FFA Convention or the National Convention of the National Association of Agricultural

Educators. While at the National FFA Convention teachers were most likely chaperoning students throughout the convention. Therefore, the environment surrounding the workshop may not have been conducive to teachers having complete focus on the professional development.

An additional limitation was the online nature of follow-up support utilized in this study. The structure of follow-up delivery was online, which may have influenced teachers' perceived trustworthiness of the source (Owston, 1998). This limitation was addressed through the posting of a description of the follow-up on the NATAA website and announcement of the follow-up support during each of the workshops.

Finally, the motivation of the participants is also a limitation of this study. The self-motivation of teachers for participating in the professional development was not explored in depth in this study. The role of teacher motivation in professional development may have influenced the teachers' participation, or lack thereof, in the follow-up support.

Assumptions of the Study

The following assumptions were made in order to conduct this study:

- Teachers participating in this study answered the questions on the instrument to the best of their ability.
- Teacher trainers participating in the study delivered the professional development content concerning inquiry-based instruction according to what they learned at NATAA.
- Measured variables, such as methodology, impact of student outcomes, and utilization of inquiry-based instruction, were accurately identified.
- Teachers participated in the follow-up support services provided.

Summary

Professional development has been a requirement of the teaching profession, for which teachers have been held accountable by agencies, policy makers, and society. However, there has been a chasm between current professional development practices and the understanding of the effects of professional development on teacher practice. If professional development is to positively impact teachers, who in turn impact student learning, the components of professional development events must be examined. This study addressed the National Research Agenda's (Doerfert, 2011) call for teacher engagement in professional development practices as a continuation of preparing and developing teachers, which can result in meaningful learning for students. Chapter 1 outlined the importance of professional development within the teaching profession and how essential it has been in assisting teachers to be adaptive in the ever changing environment of public schools today. Though there have been many challenges to conducting effective professional development, the manner in which different components of professional development experiences impact teacher change must be understood.

This study addressed the need for teacher education, specifically agriculture teacher education, to examine current professional development practices and opportunities to support teacher change following a professional development workshop. The purpose of this study was to describe workshop participants' perceptions of inquiry-based instruction and the effects of online follow-up support after a professional development workshop delivered by trainers prepared by a train-the-trainer professional development model. The significance of this study stemmed from the examination of how aspects of the train-the-trainer professional development model on change in teachers’ perceptions of science integration in agriculture and inquiry-based instruction. The results of this study held meaning for teacher educators, teacher professional development practitioners, NATAA and practicing teachers.

CHAPTER 2
REVIEW OF LITERATURE

Chapter 1 described the justification for examining models of professional development within agricultural education. The principal focus of this study was to determine the effects of a train-the-trainer professional development model on teachers' perceptions of inquiry-based instruction.

This Chapter describes the theoretical and conceptual framework that guided the study. Also included in Chapter 2 is a review of the relevant research. The review of literature focused on empirical research in the following areas: the core facets of professional development, the train-the-trainer professional development model, teachers as professional development participants, professional development programming, and teacher perceptions.

Theoretical Model Guiding the Study

A conceptual model, depicted in Figure 2-1, was used to guide this study and explain high-quality teacher professional development utilizing the train-the-trainer (TtT) form of professional development. High-quality teacher professional development directly impacts teacher knowledge and practice, which in turn influences student learning outcomes. Teacher participants' knowledge and practice related to the adaptation of professional development content are also influenced by school culture and the educational policies imposed within their school systems. School culture and educational policies also influence teacher professional development and student learning outcomes.

The embedded model represents the interactions taking place specifically during a TtT professional development program (Figure 2-2). The TtT form includes two generations of professional development programing and participants, which occur in two distinctly different contexts. The main program components of each generation are composed of similar elements, but differences arise within each element. The contexts account for the environment in which the professional development occurs. Within the context there is interaction between the leaders of the professional development, the professional development programming and the teachers' learning from the professional development within each context.

The emphasis of this study focused on the second generation of the TtT form of professional development. The goal of this study was to describe the relationship between the teacher participants' perceptions and the TtT professional development form. This was accomplished by examining the interactions between the professional development program and the teacher participant, as well as the relationship between the teacher trainer and teacher participant,

Constructivism

The philosophy grounding this study was constructivism, which states that all learning is the construction of knowledge through experience (Fosnot, 2005). Based on work in philosophy, psychology, science and biology, constructivism describes knowledge not as "truths to be transmitted or discovered, but as emergent, developmental, nonobjective, viable constructed explanation by humans engaged in meaning-making in cultural and social communities of discourse" (Fosnot, 2005, p. ix). Constructivist theories can be germane to a variety of educational contexts (Gurney, 1989), and educators have accepted the constructivist approaches to teacher learning (Borko, 2004; Darling-Hammond & McLaughlin, 2011; Le Ferve & Richardson 2002; Patton, Parker, & Neutzling, 2013; Sigel, 1978).

Rather than view learning as a linear process, similar to behaviorism and maturationism, constructivism views learning as a complex and fundamentally nonlinear process (Fosnot & Perry, 2005). Doolittle and Camp (1999) identified constructivism as a philosophy that is based on a continuum containing three broad categories of constructivism: cognitive constructivism, social constructivism, and radical constructivism. Cognitive constructivism anchors one end of the continuum focusing on the cognitive processes of the individual learner and states that individuals can accurately perceive and know the external knowledge (Doolittle & Camp, 1999). The alternate end of the continuum is anchored by radical constructivism. Radical constructivism implies that knowledge constructed by an individual is simply a representation of external knowledge, but the external knowledge cannot be known by the individual (Doolittle & Camp, 1999). Social constructivism lies between the two extremes and focuses on knowledge being constructed and shared socially rather than individually. This knowledge is bound by the setting and place in which it is constructed (Doolittle & Camp, 1999).

The cognitive constructivist framework suggests that an educator's task is to provide learners with opportunities to build knowledge rather than dispense knowledge (Fosnot, 2005). Learning from the constructivist perspective is construed as "an interpretive, recursive, nonlinear building process by which active learners interacting with their surroundings – the physical and social world" (Fosnot & Perry, 2005, p. 34), which closely aligns with the views of teacher learning in professional development.

A constructivist perspective provides a framework for examining teacher professional development by emphasizing the importance of teachers actively constructing knowledge through a well-developed and supported professional development program. Based on the general principles of learning derived from constructivist theory, Fosnot and Perry (2005) suggested several instructional practices, which have been supported by additional professional development literature, which may be helpful in planning effective professional development.

Learning is not a result of development; learning is development (Fosnot & Perry, 2005). When designing professional development for teachers, facilitators must address how learners understand, interpret and think about the content, as well as how the teachers' learning notions may affect their interpretation of the learning process (Patton, Parker, & Neutzling, 2013). For professional development to develop teachers' understanding of learning and understanding, teachers must be engaged in the tasks of teaching, assessment, observation and reflection (Darling-Hammond & McLaughlin, 2011).

Additionally, constructivism asserts that uncertainty facilitates learning, and learner error represents "a self-regulatory process of struggling with the conflict between existing personal models of the world and discrepant new insights" (Fosnot, 2005, p. ix). Professional development facilitators must be cognizant of what teachers bring to the professional development experiences and challenge them with investigations in realistic and meaningful contexts (Patton, Parker, & Neutzling, 2013). Professional development for teachers must be grounded in experimentation and reflection through a process of inquiry (Darling-Hammond & McLaughlin, 2011).

Fosnot and Perry (2005) also stated that reflective abstraction drives learning as individuals attempt to generalize across previous experiences. Teachers must be provided with the opportunity to actively explore knowledge, solve problems, and then reflect and think critically on the process (Brooks & Brooks, 1993) during professional development. Effective professional development must be connected to teachers' work with students and provide sustained, intensive support through modeling and collective solving of problems related to the professional development content and implementation in individual classrooms (Darling-Hammond & McLaughlin, 2011).

To complete the constructivist instruction practices for teacher professional development suggested by Fosnot and Perry (2005), a dialog must occur between teachers and members of their learning community. Within a professional development program facilitators must encourage teachers to actively discover new knowledge, try new practices, and discuss personal activities and reflection with others (Patton, Parker, & Neutzling, 2013). Darling-Hammond and McLaughlin (2011) stated that effective professional development must be collaborative through the sharing of knowledge and a focus on a community of practice.

Teachers do not apply theories, rather they construct theories from their practice through active participation with the experiences provided by professional development and teaching practice (Keiny, 1994). Constructivism in the context of teacher professional development demands that teachers think, create, and be engaged in the learning process with support throughout the process provided by the professional development programming.

Model for High-Quality Teacher Professional Development

High-quality teacher professional development has been a necessity for teachers to continually update their knowledge and practices related to the profession. The effectiveness of professional development for teachers must be considered throughout the process, beginning with the planning process and following through to the improvement of student learning outcomes (Guskey & Sparks, 1996). Teacher professional development is a multidimensional process that involves complicated relationships between professional development, teacher change and improvements in student learning (Guskey & Sparks, 1996). Many models have theorized relationships between elements of teacher professional development that have a positive impact on teacher knowledge and skill as well as student learning outcomes (Guskey & Sparks, 1996; Loucks-Horsley & Matasuma, 2000; Borko, 2004).

High-quality teacher professional development experiences

The central focus of the theoretical model guiding this study (Figure 2-3) is high-quality teacher professional development. Although it has no direct impact on student learning outcomes, professional development is an important and necessary part of improvements in student learning (Guskey & Sparks, 1996). Though little is known empirically about high-quality professional development, a core set of facets that comprise effective high-quality professional development has gained consensus (Desimone, 2009; Garet et al., 2001). These facets provide a theoretical framework for examining the quality a diverse array of professional development opportunities provided for teachers. The educational literature has suggested that these features are critical to improving teacher knowledge and skills which, in turn, create change in teaching practices, leading to positive student learning outcomes (Grieman, 2010). Content, duration, coherence, active learning, collective participation and format are explicit facets that represent a guide for the considerations which must be made in order to develop and plan a high-quality professional development program.

Content. Literature has theorized that content may be the most important factor in teacher professional development. Content is the knowledge and skills that have been selected for teachers to learn to enhance their professional practices (Guskey & Sparks, 1996; Loucks-Horsley & Matasumo, 2000). Greiman (2010) emphasized the need to complement content knowledge by also presenting pedagogical knowledge within professional development programing.

Teachers must comprehend the central facts and concepts of the content they teach and understand how content concepts are connected in order to enhance student understanding of the content (Borko, 2004). According to Loucks-Horsley and Matsumoto (1999), teachers must be able to make decisions about “what students know, what they need to know, and how they can be helped to gain that knowledge – and the knowledge to help their students do so” (p. 261).

Darling-Hammond and Bransford (2005) described three areas of knowledge required for effective teaching: subject matter knowledge, pedagogical knowledge, and pedagogical content knowledge. Each of these three areas works together to assist the teacher in planning and implementing lesson plans that allow for student learning. Subject area knowledge is the specific content in a discipline, pedagogical knowledge provides knowledge of universal teaching and learning principles, and pedagogical content knowledge is the discipline-specific teaching and learning principles within that specific content area (Roberts & Kitchel, 2010). For teachers to be effective throughout their careers they must continually develop and update their knowledge and skills in all three of these areas.

Duration. Literature concerning the duration of professional development has indicated that two aspects of time should be considered for professional development. The first is the number of contact hours spent on the professional development activity, emphasizing the time spent at a professional development event (Desimone, 2009; Garet et al., 2001). The second is the time span over which the professional development activities occur (Desimone, 2009; Garet et al., 2001). Both elements of duration contribute to the effectiveness of professional development, because as time increases, a deeper discussion of content and pedagogical strategies may occur. Additionally, teachers have more time to apply what they have learned in their own classroom with their own students (Garet et al., 2001).

Coherence. Three elements are of importance when describing the coherence of professional development experiences. The professional development opportunities must align with the individual teacher knowledge, beliefs and practices, as well as the school, district, state and federal expectations and trends. Additionally, professional development opportunities should also be coherent with previous, concurrent, and future professional development opportunities they have participated in (Desimone, 2009; Garet et al., 2001). Professional development must build and expand on previous professional development experiences by helping teachers make connections to what they have previously learned.

Active participation. Teachers must be actively engaged in their own learning, just as they engage their students in the learning process (Garet et al., 2001). Garet et al. (2001) described active learning as learning that involves teachers in "meaningful discussion, planning and practice" (p. 925). Active participation, also referred to as active learning, should occur both during the professional development and as part of the follow-up procedures that are incorporated as teachers apply the professional development content to their classrooms (Guskey & Yoon, 2009). Some examples of active learning within professional development are classroom observations, curriculum planning, and review of student work and progress. Additionally, the experiences that occur during the professional development program are themselves, situations in which active learning occurs (Desimone, 2009).

Collective participation. Collective participation allows for teachers who participate in professional development to interact and support each other as they implement the professional development innovation in their own classrooms. Desimone (2009) articulated that collective participation can occur through “participation of teachers from the same school, grade, or department” (p. 184).

Implementation of this facet within a professional development program provides support for building an active learning community after the professional development program concludes. It engages teachers in ongoing discussion, reflective teaching, observation and interactive support that allow the professional development to continue over the school year (Greiman, 2010). Collective participation can utilize technology to bridge distances between teacher participants but may also occur in person (Greimen, 2010), as long as the opportunity for interaction of all the professional development participants is provided.

Format. There have been many forms of professional development available, and research has not indicated one specific form or structure better than another. Each professional development has been unique, and the way in which the other facets of professional development (content, active learning, duration, coherence, and collective participation) have been utilized make a professional development effective or not. Graduate coursework, summer conferences, one-shot workshops, mentoring, communities of practice are all forms of professional development (Greiman, 2010).

Train-the-trainer form of teacher professional development

The basic premise of the TtT form of professional development is a multi-generational process of training a select number of participants (trainers) who in turn provide training for a broader array of participants (see Figure 2-2). The TtT form has been used extensively in the business world, the military, and government, in addition to applications in educational institutions (Joyce, 2007). The TtT form utilizes the advantages of small group formatting and avoids lecture hall atmospheres, which encourages active participation and collaboration (Dooley, Metcalf, & Martinez, 1999; Joyce, 2007). The TtT form has traditionally utilized localized experts who share skills and provide support for their colleagues (Technology, 2001). Careful attention should be paid to the selection of trainers in order to provide for differences in location and teaching experiences (Joyce, 2007; Pollnow, 2012), because they provide additional, localized professional development and support to the second generation of teacher participants. The trainers can develop and adapt the second generation of professional development programming to meet the needs a specific group of teacher participants, allowing for variations in contexts, time frames, and programing aspects (Joyce, 2007). Borko, Elliott, and Uchiyama (2002) identified the TtT form of professional development to be a cost effective way of delivering professional development to teachers in diverse locations and rural states.

The quality of professional development can be charted using the relationships between four elements for professional development explained in Borko's (2004) model of elements of a professional development system. The professional development program, facilitators, teachers and context provide for the relationships which occur during professional development that lead to improvements in teacher practice and student learning outcomes. Borko (2004) recognized the complex links between the form of professional development and teachers' learning during professional development activities that lead to changes in classroom practice. Borkos' (2004) model of the elements of a professional development system aligns with the embedded train-the-trainer form of teacher professional development and provides the framework of the relationships that exist with the professional development.

Multi-generational professional development. The TtT form of professional development has two generations of professional development to be considered. The relationships between the context, facilitator, teacher participant and professional development programming need to be examined within both generations. The trainer professional development represents the first generation of professional development in the TtT form of teacher professional development. This generation of TtT professional development focuses on the development of teacher trainers, which is executed by the facilitator and has its own distinctive professional development programming experiences within a unique context. The second generation of the TtT form of professional development allows for the transformation the teacher trainer into the role of facilitator, during professional development programs with teacher participants.

Context. Guskey and Sparks (1996) recommended the context of professional development to be twofold. Context must provide for both the culture in which the professional development takes place, as well as where new knowledge from professional development will be implemented. Context characteristics are the "organization, system or culture in which staff development takes place and where new understandings will be implemented" (Guskey & Sparks, 1996, p. 35). Borko (2004) recognized that both the individual teacher and the social systems in which he/she participate in learning activities are essential when examining professional development, as they influence the effectiveness of the professional development. Facilitator, teacher participant and professional development program focus are also determined by the social systems in which a professional development occurs (Borko, 2004). Mewborn (2003) suggested the professional development should occur in the context of teachers' daily practices to assist in validating the knowledge and skills in classrooms.

In the framework of the TtT form of teacher professional development, context provided an examination of the environment in which the professional development took place. Context includes the location, as well as the organizations providing for the professional development and teachers reasons for attending (Guskey & Sparks, 1996).

Facilitator. The role of the facilitator is often described as "a sub-stantively neutral person who manages the group process" to help achieve identified goals (Thomas, 2010, p. 239). However, new approaches to facilitation have described a different version, putting teachers at the center of professional development with a focus developing personal and professional relationships and providing support in addition to content expertise (Patton, Parker, & Neutzling, 2013). Facilitation should focus on what the teacher knew, believed, and brought to the learning situation and how learners understood, interpreted, thought and felt about the content presented (Rovegno & Dolly, 2006). Facilitators may have a variety of traditional roles: administrators, mentors, instructional coaches, subject area specialists or teachers (Croft et al., 2010).

Teacher trainer. The teacher trainer is the centerpoint of the TtT form of teacher professional development, as trainers' transition from the role of teacher learner to facilitator within the professional development program. When examining the trainers' role in professional development, Dunkin and Biddle's (1974) presage variables outlined considerations for teacher learning and development that lead to specific knowledge and practice that may impact student learning outcomes. Formative experiences, development experiences and teacher characteristics can all influence both the trainers' ability to learn from the professional development, as well as effectively teach additional professional development participants. Dunkin and Biddle (1974) provided that teacher experience and properties include a wide array of elements, including instructors' own education experiences, the attitudes of instructors, as well and any in-service teaching and teaching practice. Any activity or experiences teachers have that can shape their behavior in the classroom is a presage variable and contributes to teaching style and expectations for learning (Dunkin & Biddle, 1974).

Teacher formative experiences represent all experiences teachers encounter prior to teacher training (Dunkin & Biddle, 1974). Teacher formative experiences may include socio-economic status, age, gender, race, or any additional experiences which may influence teacher characteristics and personality (Dunkin & Biddle, 1974). Teacher development experiences represent any training teaches may have received to enhance their knowledge of teaching and learning. These experiences include college or university attendance, courses taken, attitudes of teachers' instructors, experiences during practice teaching, and professional development or post-graduate education (Dunkin & Biddle, 1974). Dunkin and Biddle (1974) described teacher properties as "measurable personality characteristics the teacher takes with her into the teaching situation" (p. 40). Through these properties, teachers' formative and developmental experiences are applied into classroom practices.

Teacher participant. The teacher participant component of the TtT form of teacher professional development is composed of variables similar to those of the teacher trainer. The teacher participants' formative and developmental experiences, properties and perceptions all influence the teachers' relationships with the professional development program, teacher trainer and the classroom practices.

Professional development program. In Guskey and Sparks's (1996) model for staff development and improvement in student learning, the quality of teacher professional development is based on three major factors: content variables, process variables, and context characteristics. If only one factor is the focus of planning professional development, then the effectiveness of the professional development is weakened, with a diminished chance of improving student learning (Guskey & Sparks, 1996).

Content variable characteristics are primarily concerned with the "new knowledge, skills, and understandings that are the foundation of any professional development" (Guskey & Sparks, 1996, p. 34). The content of professional development must help teachers keep pace with the changing knowledge base concerning both educational practices and subject matter information and be used to help teachers develop their teaching practices (Guskey & Sparks, 1996). Professional development content must focus on scope, credibility, and the practicality of teacher change required to implement the new knowledge, in addition to building the teacher's knowledge base (Guskey & Sparks, 1996).

Content variables align with the content core facet of high-quality professional development previously discussed. The content variables of the NATAA professional development program focused on science integration and the use of inquiry-based instruction (IBI) in secondary agricultural education programs.

Process variables of a professional development program are concerned with the types and forms of professional development, as well as how the professional development is planned, implemented and followed-up (Guskey & Sparks, 1996). Process variables are concerned with the forms of professional development and the way those activities are "planned, organized, carried out and followed-up" (Guskey & Sparks, 1996, p. 35). Process variables align with the duration, active learning, collaboration and form facets of high-quality professional development. Three major process variables were identified in the second generation of NATAA professional development: workshops, follow-up and online components of professional development.

Teacher knowledge and practice

Professional development has a direct effect on teacher knowledge and practices, which directly influences student learning outcomes. Teacher knowledge and practices are the most significant outcome of any professional development effort

(Guskey & Sparks, 1996; Loucks-Horsley & Masumoto, 1999). If professional development does not change teacher professional knowledge or classroom practices, then improvements in student learning should not be expected (Guskey & Sparks, 1996). Loucks-Horsley and Matsumoto (1999) recognized that teacher learning, in both knowledge and practice, is the connection between teacher professional development and student learning.

Guskey (2000) presented a comprehensive hierarchal evaluation model for examining teacher learning in relation to professional development programs. The lowest level of evaluation, which must be conducted before exploring higher levels, is evaluation of participant reactions. This represents the assessment of questions about content, process, and context that are often obtained through participant questionnaires at the end of professional development sessions (Guskey, 2000). Guskey (2000) considered the initial satisfaction measures to be of importance, as higher-level outcomes are based on positive reactions from teacher participants. The second-level outcomes are related to participant learning. Guskey divided learning into three goals: (a) cognitive, which are the knowledge and understandings; (b) psychomotor goals, which are skills and behaviors; and (c) affective goals, which are attitudes and beliefs. Third-level outcomes of professional development evaluation are those that relate to organizational change and support, which determine the effectiveness of the teacher professional development within a specific context. Fourth-level outcomes are the participants' use of new knowledge and skills within classroom practice. By selecting appropriate indicators of teachers' practice, evaluation of teachers' use of the professional development content can occur "after participants have had sufficient time to reflect on what they learned and to adapt the new ideas to their particular setting" (Guskey, 2000, p. 178). The final-level outcomes in Guskey's evaluation of teacher professional development are the evaluation of student learning outcomes.

Harland and Kinder (2006) also theorized a typology of professional development outcomes, which provided three orders of outcomes. Third-order outcomes are: (a) provisionary outcomes, which are the physical resources which result from professional development participation; (b) informational outcomes, which occur when teachers are cognizant of the basic knowledge and facts pertaining to the professional development content; and (3) new awareness, which is a shift in teacher perceptions from previous assumptions about the content of the professional development. Second-order outcomes are: (a) affective outcomes, which relate to the emotional experiences of teachers in the learning situation; (b) motivational outcomes, which relate to teachers motivations to implement the content learned at the professional development program; and (c) institutional outcomes, which are influenced by collaboration, school culture and the collective impact of a group of teachers. First-order outcomes are: (a) value-congruent outcomes, which occur when teachers personalize the professional development content to inform their personal teaching practices and (b) knowledge and skills, which exemplify the development of deeper levels of understanding related to the professional development content. Harland and Kinder (2006) hypothesized that when all order outcomes have been achieved the ultimate goal of professional development can be reached, which is the impact on practice.

Educational policies

The model for high-quality teacher professional development recognizes the impact educational policies makes on teacher knowledge and practice, as well as the professional development experience and student learning outcomes. New course mandates, curriculum frameworks, testing and policies cannot produce increases in student learning without an investment in the professional development of teachers, as the need for changes in teaching practices have often been founded on changes in educational policy (Darling-Hammond & McLaughlin, 2011). Darling-Hammond and McLaughlin (2011) identified the need for educational policies and legislation to examine and emphasize job-embedded professional development to assist in development of teacher knowledge and practice. Successful educational reforms have relied on continuous teacher learning, and effective teacher learning has relied on new approaches to teacher professional development (Scribner, 1999).

All major education policy areas, including those that relate to curriculum, assessment, teacher and administrator licensing and evaluation, and accountability have shaped the preferred teaching practices and expected learner outcomes within all schools (Darling-Hammond & McLaughlin, 2011). Professional development programs and teachers implementing new ideas must filter through previous policies that send contradictory signals and impede enactment of new practices (Darling-Hammond & McLaughlin, 2011). Mandatory standardized testing, assigned textbooks, rigid curriculum guides, and teacher evaluation systems are familiar examples and have created incentives to maintain status quo teaching practices (Darling-Hammond & McLaughlin, 2011).

Policies that govern the evaluation of teachers must support teaching for understanding and continuous teacher learning, based in ongoing improvement and critical inquiry. Many evaluation processes have been founded on a notion of teaching as a set of routines that can be observed and checked off during a brief inspection (Darling-Hammond & McLaughlin, 2011). These limit teachers' abilities to practice new techniques and maintain a positive evaluation. Evaluations can also be detrimental to the mindset of teachers concerning continuous professional development, as *needs improvement* has often the lowest score on teacher evaluations; yet all teachers should strive to improve professional practices (Darling-Hammond & McLaughlin, 2010).

School culture

School culture represents the elements of a teacher's specific school system, including but not limited to administration, peer teachers, parents and students that may contribute to the school environment. The importance of a supportive school culture to professional development became "…clear in the 1960s and 1970s when teachers who attended exciting National Science Foundation-funded institutes found it difficult to apply their learning once they returned to their own schools" (p. 265), as they lacked the administrative, collegial, material, and parental support to use new practices learned through the professional development (Loucks-Horsley & Matsumoto, 1999).

If administrators are part of the professional development program, administrator knowledge and practices may be directly influenced by the professional development (Guskey & Sparks, 1996). Administrators' interaction with teachers, through activities such as clinical supervision, coaching, and evaluation may influence teachers' knowledge and practice. Additionally, administrators set the "…tone for school culture by modeling high standards of professional behavior and by ensuring the school is a true learning community that supports experimentation and values efforts to improve" (Guskey & Sparks, 1996, p. 36). Administrators also influence the development of educational policies regarding "…school organization, the curriculum, assessment, textbooks, discipline, attendance, and grading", which have a powerful impact on how students learn and what they learn (Guskey & Sparks, 1996, p. 36). The model of the relationship between professional development and improvement in student learning recognizes teachers' influence educational policies, but that influence depends on the degree to which teacher input is accepted (Guskey & Sparks, 1996).

Student learning outcomes

Student learning outcomes have been the paramount purpose of education, as all elements of schooling demand that student learn. Desired student learning outcomes influence the educational policies and the school culture, as well as the knowledge and skills needed by teachers. Goals for student learning outcomes influence high-quality teacher professional development, as they have demanded that teacher knowledge and practice are current and effective. Designing professional development programs with clear student learning outcomes in mind requires those designing professional development to cultivate an ideal mix of effective practices that lead to the desired results (Guskey, 2000).

Student learning outcomes represent the broad range of student learning goals found in formal education settings. Outcomes may be assessment results, portfolio evaluations, or scores from standardized tests; or they could be measures of student attitudes, study habits, classroom behavior or work completion rates (Guskey & Sparks, 1996).

Evaluating professional development in terms of student learning provides new perspectives on teacher professional development and provides rigorous standards for effective professional development (Guskey, 2000). Clear goals based on student learning help to provide purpose for professional development and guidelines for evaluation of professional development (Guskey, 2000). Additionally, by focusing on student learning outcomes of professional development, the relationships surrounding effective professional development can be broadened allowing for a more systematic approach to professional development and evaluation (Guskey, 2000).

Guskey (2000) suggested that student learning outcomes examined in relation to high-quality teacher professional development will depend on the goals of professional development. Measures of student learning typically included as indicators of student performance and achievement, such as assessment results and assignment grades, can be used to examine the impact of professional development. Additionally measures of student attitudes, skills, and behaviors should also be considered, with multiple methods of assessment being used (Guskey, 2000).

Dunkin and Biddle's (1974) model of teaching and learning identified the outcomes of effective teaching as product variables, which are concerned with changes that develop in a student as a result of being involved in classroom activities with a teacher. The changes can be seen and evaluated in both immediate student growth and long-term student growth. Immediate student growth is often investigated through measures of subject-matter learning and student attitudes toward the subject (Dunkin & Biddle, 1974). Long-term growth is extremely difficult to measure, given the large number of factors that could impact student learning over an extended period of time. It has been difficult to attribute long-term student growth to a specific teacher or course (Dunkin & Biddle, 1974). Though difficult to measure, professional development should be designed with both immediate and long-term student learning in mind.

Review of Literature

Core Facets of High-quality Teacher Professional Development

The literature base included few studies that empirically explored what constitutes high-quality or effective professional development programs (Borko, 2004; Desimone, 2009; Webster-Wright, 2000). Instead, research has focused on teacher feedback and perceptions concerning professional development programming.

To date there have been few evaluations of professional development that incorporated multiple sources and included information concerning the implementation of professional development content and outcomes in student learning (Borko, Jacobs, & Koeliner, 2010). Quantifying the principles outlined for professional development in the theoretical literature has proven difficult for researchers (Borko, Jacobs, & Koeliner, 2010).

Garet et al. (2001) used data from a national evaluation of the National Eisenhower Professional Development Program, which supported professional development for math and science teachers. The program examined the relationship between features of professional development and teachers' self-reported change in knowledge, skills and classroom practices. The researchers categorized professional development activities into two groups. Reform professional development activities were considered to be activities such as study groups, committees, mentoring, internships, and resource centers. Workshops and conferences were considered traditional professional development activities. The reform professional development activities spanned longer periods and had a greater number of contact hours, in addition to having a modest direct effect on enhancing teacher knowledge and skills (Garet et al., 2001). Additionally, the authors found that the durational elements of a professional development program, time span, and contact hours had a substantial positive influence on opportunities for active learning and coherence. Duration was also found to have a moderate, positive influence on the emphasis of content knowledge. These findings indicated that high-quality professional development must be sustained over time and involve a substantial number of hours. The longer duration provided time for teachers to participate in active learning strategies, align the professional development with personal goals and teaching frameworks, as well as focus on the content (Garet et al., 2001). Content focus, active learning and coherence were found to have a substantial positive effect on enhanced knowledge and skill (Garet et al., 2001). Activities that emphasized content, were connected to teachers' professional development experiences and involved active learning strategies impacted teacher knowledge and skill.

In a similar study Desimone, Porter, Garet, Yoon and Birman (2002) examined features of professional development and their effect on changing teaching practice in mathematics and science from 1996 to 1999. The longitudinal study found that professional development is more effective in changing teacher practice when it has "collective participation from the same school, department, or grade; and active learning opportunities, such as reviewing student work or obtaining feedback on teaching; and coherence, for example: linking to other activities or building on teachers' previous knowledge. Reform type professional development also had a positive effect" (Desimone et al., 2002, p. 102). The study found no significant effects concerning the duration of the professional development.

Penual, Fishman, Yamaguchi, and Gallagher (2007) also studied the effects of different characteristics of professional development on teachers' knowledge and their ability to implement the professional development content in their teaching practice. Survey results from teachers who participated in professional development provided by 28 different providers were analyzed, and the findings were consistent with earlier studies (Desimone et al., 2002: Garet et al., 2000). The authors found that providing teachers with time to plan for implementation and technical support were significant for encouraging implementation of professional development content in the classroom.

Content

When planning for professional development, research findings have indicated content may be the most important consideration (Desimone, 2009). According to Darling-Hammond et al. (2009), one-fourth of teachers identified learning more about the content they teach as their priority for professional development. When considering the content choices of focus for professional development, one should consider content knowledge as well as teaching strategies, pedagogical content knowledge, pedagogical knowledge, and student outcomes (Garet et al., 2001). Desimone, Porter, Garet, Yoon and Birman (2002) reported that professional development focused on examining specific teaching practices can increase the use of those practices. Fennema et al. (1996) observed that the use of professional development related to student thinking of specific content was helpful to teacher curriculum development that enhanced student learning.

Duration

Penuel, Fishman, Yamaguchi and Gallagher (2007) indicated that often one of the most common criticisms of professional development opportunities is that they are too “short and offer limited follow-up to teachers once they begin to teach” (p.929). In regard to duration, research has shown no tipping point at which teacher professional development becomes effective. However, the research indicated that 20-30 hours should be spent on the professional development activity and spread over the course of a school semester (Desimone, 2009; Guskey, 2000; Garet et al., 2001; Yoon, Duncan, Lees, Scarloss, & Shapley, 2007).

Guskey and Yoon (2009) found that professional development programs lasting 30 or more hours showed positive effects on teacher practice and student learning outcomes. However, Kennedy (1998) reported that the effectiveness of the activities in which teachers participate throughout the duration of the professional development may be more important to improvements in student outcomes than duration alone.

Supovitz and Turner (2000) examined the relationship between high-quality teacher professional development, inquiry-based instruction and investigative classroom culture. Utilizing the Local Systematic Change (LSC) initiative of the National Science Foundation evaluation, Supovitz and Turner (2000) surveyed 4907 teachers in 787 different schools concerning their classroom practices, attitudes towards teaching, and their professional development experiences. Both models explored in the study found that increasing amounts of professional development were statistically associated with increases in IBI utilizations and investigative classroom culture. Findings indicated that teachers with less than 40 hours of professional development experiences used less inquiry oriented teaching practices than the average teacher. Additionally, teachers with more than 80 hours of professional development reported using IBI significantly more often than the average teacher. Similarly, teachers with 40-79 hours of professional development programming had significantly more investigative classroom cultures than those of the average teachers. Both of these indicated a strong positive relationship between the amount of teacher professional development and classroom practices.

Coherence

Garet et al. (2001) reported activities that were coherent appeared to support “change in teacher practice” (p.936). Teachers will not attend professional development unless they can directly see the benefits of their attendance, and those perceived benefits may be based on prior professional development experiences (Darling-Hammond, et al., 2009).

According to Loucks-Horsley and Matsumoto (1999), teachers’ beliefs and knowledge prior to a professional development experience affect what they learn. Darling-Hammond et al. (2009) reported that teachers indicated professional development must be connected to practice and address everyday challenges they face in the classroom. Professional development must also align with other initiatives at the school district, state, and national level in order for the teachers to want to participate in a professional development opportunity. Teachers applied new techniques and materials to fit their own teaching styles and classrooms, based on their own goals and experiences (Loucks-Horsley & Matsumoto, 1999).

Active participation

During the professional development program, teachers need the opportunity to experience the content as both the teacher and as students would in their classrooms. Classroom observation, both being observed and being the observer, is part of active learning; observations provide feedback and an opportunity to engage in discussion about the professional development innovation within the classroom context (Garet et al., 2001). Curriculum planning time engages teachers in analyzing and applying the professional development innovation to their own teaching context, such as their classroom and individual teaching styles. Reviewing student work, as well as making presentations or leading discussions concerning the professional development innovation, provides opportunities for teachers to interact, reflect on their teaching practices, and spend time focused on what and how the professional development has impacted their teaching experiences (Garet et al., 2001; Greiman, 2010).

Format

A workshop occurs outside of a teacher's classroom and involves a facilitators or leader with expertise (Loucks-Horsley, Stiles, Mundry, Love & Hewson, 2010). The current research on 'one-shot' workshops has conflicting findings and no substantive proof that provides for a clear decision as to the effectiveness of workshops. Professional development that utilizes this format appears to have limited impact on learning (Greiman, 2010).

Huffman, Thomas, and Lawrenz (2003) researched the relationships between the different types of professional development, teacher instructional practice, and student achievement. The authors divided professional development activities into five categories: immersion, curriculum implementation, curriculum development, examining practice, and collaborative work. Huffman, Thomas, and Lawrenz (2003) reported that curriculum development and examining practice were significant predictors of teachers' use of curriculum and instruction in science and mathematics, while immersion, curriculum implementation, and collaborative work were not found to be significant predictors. The authors reported that the model using curriculum development and examining practice provided for 35% of the variance in science teachers use of the standards-based curriculum and instruction.

Train-the-Trainer Form of Teacher Professional Development

Although the TtT form of professional development has been commonly used, a review of literature revealed little empirical evidence supporting its effectiveness. TtT professional development has not been rigorously studied in regards to actual impact on teacher knowledge and practice or student learning, leading some to report that the TtT form of professional development does not achieve the goals of impacting and providing meaningful professional development for an abundant numbers of teachers (Office of Education and Research, 1997) (see Figure 2-2). Guskey and Yoon's (2009) examination of research pertaining to teacher professional development found nine studies that met the standards of credible evidence set by the What Works Clearinghouse, none of which used a TtT approach. These researchers concluded that currently no strong, valid evidence demonstrates that TtT form of professional development is effective (Guskey & Yoon, 2009).

The longest standing implementation of a TtT model for teacher professional development has been the National Writing Project (NWP), which concentrated on improving the teaching of writing and the learning occuring within the nation's schools (Leiberman & Wood, 2003). Utilizing a TtT model, the NWP focused on situating teachers' learning in their classroom practices and personal writing. The content, context and activities involved with the NWP and the related workshops have not been clearly described (St. John, Hirabayashi, & Stokes, 2004). Case studies and interviews were utilized to gather self-reported data from teachers, which showed that NWP helped teachers develop a valuable professional network, changed personal teaching philosophies concerning writing, and increased the time spent on writing instruction and the diversity of teaching practices (Borko, 2004).

Joyce (2007) implemented and evaluated a modified TtT professional development program that was designed to teach spreadsheet skills to elementary teachers and students. To address limitations of TtT form of professional development, Joyce integrated action research, peer-coaching and mentoring into the TtT for the study. The results indicated that the content knowledge focus of the professional development was successfully transferred from the facilitator to the trainers, next to the participants, and finally to the participants' students (Joyce, 2007). Joyce (2007) also reported program elements that contributed to the transfer of knowledge between generations. Time was reported by both trainers and participants as an essential element of the professional development program, because it equated to a sense of value about what teachers were learning, as well as provided time to process the knowledge (Joyce, 2007). Participants appreciated that program sessions were delivered over an extended period of time that allowed teachers to master the skills needed to understand and teach the new concept and experiment and explore the content. The trainers within the study reported that support, defined as 'being there' provided by the facilitator and peer-trainers, was essential to the professional development at all points (Joyce, 2007).

Context

Borko, Jacobs and Koeliner (2010) found that context was not a factor traditionally considered when planning for professional development but has recently been recognized for the important role that it should play in shaping professional development. Many publications have emphasized the importance of describing and exploring context in relation to teacher learning through professional development; however, empirical literature which examined the relationship of context on the effectiveness of teacher professional development proved difficult to find.

Joyce's (2007) study of TtT professional development participants reported the importance of the program environment in transferring knowledge between facilitators, trainers, and participants. The trainers indicated that they felt safe trying new ideas and sharing experiences, while teacher participants indicated that the relationships with the trainer and the small learning community created a non-threatening learning environment (Joyce, 2007). Traditionally, professional development has taken place away from schools, classrooms, and students; while more contemporary professional development opportunities have occurred within the context of teachers' schools and classrooms (Borko, Jacobs, & Koeliner, 2010).

Trainer professional development

A number of studies have examined the trainer level of professional development within the National Agriscience Teacher Ambassador Academy (NATAA). Though the studies have not focused on the outcomes of the professional development, they have provided insight into professional development programming and trainer perceptions concerning science integration and inquiry-based instruction.

Myers, Thoron, and Thompson (2009) examined the trainers' attitudes, perceived barriers of integrating science, perceived competence of agricultural education teachers integrating science, and use of inquiry-based teaching methods during an initial professional development experience. These researchers reported that trainers value inquiry-based strategies and recognize the importance of integrating science into agriculture curriculum. The NATAA trainers indicated positive benefits for students when science is integrated into the agricultural curriculum, which is similar to results of previous research (Layfield, Minor, & Waldvogel, 2001; Myers & Washburn, 2008; Thompson & Balschweid, 1999; Thompson & Schumacher, 1998). The NATAA trainers' perceptions indicated that students were more motivated to learn, better prepared for science, and had more experiences in solving science problems when taught in the context of agriculture (Myers, Thoron, & Thompson, 2009). NATAA trainers reported that the biggest impediments to integrating science were insufficient time and planning support (Myers, Thoron, & Thompson, 2009). Additionally, trainers were concerned with the lack of materials and science content experience when integrating science and using inquiry-based instruction within agriculture courses (Myers, Thoron, & Thompson, 2009). Though trainers reported engaging students in inquiry-based instructional methods more than once a month, 90% of the trainers indicated they planned on increasing the amount of science that was integrated into their curriculum upon completion of the NATAA program (Myers, Thoron, & Thompson, 2009). NATAA trainers believed that administrators, peer teachers, guidance counselors, and community members support agriculture teachers and programs, including the teaching of science concepts and IBI in agriculture coursework (Myers, Thoron, & Thompson, 2009).

Myers and Thompson (2009) used a Delphi study of NATAA trainers to develop a list of actions to move agricultural education forward in regard to the integration of math, science, and reading. A consensus of the 2007 NATAA trainers indicated that curriculum development must include academically enhanced and integrated projects and activities, as well as expanded FFA career development events related to the core content integration area. Additionally, trainers reported that professional development related to academic integration and instruction in math, science, and reading was essential at the national, regional, state, and local levels. Myers and Thompson (2009) also reported that NATAA participants indicated the need for transformation within the profession to “help teachers, teacher educators, and department of education officials realize the role agriculture programs can play in increasing student achievement” (p. 83). NATAA trainers agreed on the need for agriculture teachers to collaborate with math, science and reading teachers for student benefits (Myers & Thompson, 2009).

Thoron, Myers, and Abrams (2011) used focus groups to determine the perceptions of NATAA trainers when implementing IBI into agricultural education programs. The authors found that the week-long NATAA professional development program changed teachers’ perceptions of inquiry by developing their understanding of the concepts and roles during IBI. Additionally, Thoron, Myers and Abrams (2011) reported that trainers transitioned to IBI methods differently. Though all trainers reported that the initial preparation for inquiry lessons took additional time and the rewards most often occurred during instructional time. The NATAA trainers’ perceptions of the role of inquiry in the school environment were also favorable and indicated that IBI led to positive connections between the agriculture teachers, their peers, and administrators. The authors found that trainer perceptions indicated that “positive attitudes for IBI promoted a change in behavior resulting in the agriculture teacher becoming a leader for the school in the newfound innovation that can be used in science education” (Thoron, Myers, & Abrams, 2011, p. 103). Thoron, Myers, and Abrams (2011) found that NATAA trainers were divided on student assessment in inquiry-based instruction;

some trainers reported they assessed learning the same as before the training, while others noted that changes were needed.

Shoulders and Myers (2011) examined NATAA trainers' stages of concern regarding IBI and how the NATAA professional development program influenced their comfort levels with IBI. The findings supported the effectiveness of the NATAA professional development cited in previous research. The participant responses indicated that NATAA professional development reduced low-level concerns for teachers who participated for two years, which indicated that the increase in professional development participation allowed for the teacher participants to focus on higher-level concerns related to the implementation of IBI. The research found that the amount of teaching experience did not directly affect the effectiveness of NATAA professional development; however, associated variables such as tenure, current economic climate, and job security may have influenced concerns of teachers with less than six years' experience.

Facilitator

Through a study of 12 experienced professional development facilitators Patton, Parker, and Neutzling (2013), identified that successful facilitators accentuated how teacher participants actively "constructed new meaning, based prior knowledge and experiences, acknowledged the influences of others in a social environment and emphasized the relevance of formal knowledge" (p. 530). Facilitators generally have accumulated a wealth of experiences, have viewed themselves as learners, willing to share accomplishments and defeats, are intrinsically motivated, and essential in creating professional development knowledge (Patton, Parker, & Neutzling, 2013).

Teacher trainer

Though little has been examined concerning teachers as professional development facilitators, publications indicated the effectiveness of peer teachers in helping develop teacher change (Garet et al., 2001; Guskey, 2000). Teacher participants indicated that they “appreciated being taught by ‘one of their own’” (Joyce, 2007, p. 95), and that teachers as facilitators created an environment that allowed them to focus on learning the skill.

Teachers selected to serve as trainers have been generally identified as exemplary teachers and leaders in teaching and learning within their school (Joyce, 2007; Pollnow, 2012). The NATAA trainers have previously been identified as leaders in the teaching profession (Myers, Thoron, & Thompson, 2009; Myers & Thompson, 2009), which has led previous researchers to suggest the benefits of involving NATAA trainers in developing curriculum providing workshops and leading further integration of science into agriculture curriculum.

Joyce (2004) identified stages of personal development for trainers. The first stage of personal development of trainers during the professional development process was buy in. Extrinsic buy-in was established prior to the professional development program, when trainers were asked to assist in developing the curriculum, which trainers indicated created a sense of personal value in the system (Joyce, 2007). Intrinsic buy-in occurred as trainers attended sessions and created personal spreadsheets and trainers reported “recognizing how [spreadsheets] could be used to facilitate activities in both their personal and professional lives” (Joyce, 2007, p. 91). The second stage of personal development identified by the trainers was ownership as they worked to create a curriculum that consisted of learning experiences that would be valuable for their students (Joyce, 2007). The trainers' reflection on the process of implementing the curriculum content in their classrooms provided them with additional opportunities to develop knowledge and understandings of the professional development content and utilize their students' inquiries to reinforce the professional development needs of the participants (Joyce, 2007).

Teacher participants

Supovitz and Turner (2000) also explored effects of teacher properties on the relationship between high-quality teacher professional development and IBI and investigative classroom culture. The authors reported that male teachers were more conservative in their inquiry practices and classroom culture than their female counterparts though the gender differences were only significant when examining the findings in relation to investigative classroom culture. Minority teachers reported more significant increases in IBI practices and investigative classroom culture than their white counterparts. Additionally, teaching experience was also found to have a significant negative association with investigative culture. Supovitz and Turner (2000) reported that teachers' content preparation and attitudes towards the professional development content were the most powerful individual influences on IBI practices and classroom culture. Teachers who reported more sympathetic attitudes toward the professional development content had significantly higher IBI practices and investigative classroom cultures.

Professional development program

Content variables. In 1988, the National Research Council recommended that academics be integrated into agricultural education, which has increased the amount of research pertaining to teachers' perceptions of science integration into agriculture curriculum.

Layfield, Minor, and Waldvofel (2001) conducted a study utilizing survey design to determine South Carolina agriculture teachers' perceptions regarding barriers of science integration. The authors found that teachers were prepared to teach integrated science concepts, yet barriers to integration included lack of funding, availability of equipment and scarcity of professional development opportunities focused on science integration into agriculture.

Using similar methods, Balschwield and Thompson (2002) determined Indiana agricultural science and business teachers' perceptions regarding science integration and reported similar positive attitudes to integration. Respondents indicated that the same three barriers to integration; however 36.6% of the teachers "indicated they had less time to prepare for classes and/or less personal time during their teaching day as a result of integrating or planning to integrate science" (Balschwield & Thompson, 2002, p. 7).

Research conducted in a different state identified similar perceptions and barriers (Warnick & Thompson, 2007). The respondents indicated that their own lack of science competence was an additional barrier to science integration. Warnick and Thompson (2007) reported that while a majority of respondents agreed to the benefits of collaboration between the school science department and agriculture department for student learning, fewer than half indicated they participate in such collaborations.

Myers and Washburn (2008) studied Florida agriculture teacher perceptions toward science integration. The respondents reported similar attitudes toward the importance of collaboration for student benefit and that students leaned more science and agriculture content through integration of the subjects. The authors reported half of the respondents felt science integration required additional preparation, and over two-thirds reported inadequate planning time as a barrier to science integration of agriculture course.

An 18-month study assessed the quality of math and science instruction in over 350 lessons (Weiss & Pasley, 2004; Weiss, Pasley, Smith, Banilower, & Heck, 2003). The researchers found that only 15% were of high-quality and less than 20% of the lessons were rigorous (Weiss & Pasley, 2003). Though the NRC has made numerous calls to utilize inquiry in science classrooms, the Weiss et al. (2004) findings indicated a lack of focus on IBI.

Process variables. Workshops have been criticized as the epitome of ineffective professional development practices. This claim has been amplified by programs which have occurred once and have provided no follow-up or sustained support. However, Guskey and Yoon (2009) found that all nine studies that met the standards of credible evidence set by the What Works Clearinghouse and also showed a positive relationship between professional development and improvements in student learning involved workshops or summer institutes. The workshops focused on “research-based instructional practices, involved active learning experiences for participants and provided teachers with opportunities to adapt the practice to their unique classroom situations” (Guskey & Yoon, 2009, p. 496).

Lydon and King (2009) investigated the impacts of a 90-minute workshop on teacher reactions, teacher learning, organizational support and change, new teacher knowledge and skill, and student learning outcomes. The researchers reported the 90-minute workshops resulted in long-term, positive change in teaching practices. Immediately following the workshop 86% of teacher participants indicated the professional development had increased their knowledge and understanding, while 80% reported an increase in their confidence levels. Eighty-eight percent of the teachers indicated that they intended to increase their use of content related to earth science practical work, and 64% intended to increase the amount of earth science investigational work. The teacher participants had incorporated the workshop content into their teaching on a long-term basis (Lydon & King, 2009).

Teachers have needed job-embedded assistance as they have adopted new strategies, curriculum and practices to their unique classroom contexts (Guskey & Yoon, 2009). All of the teacher professional studies identified by Guskey and Yoon (2009) showed significant positive effects on teacher practice and student learning including “significant amounts of structured and sustained follow-up after the main professional development activities” (p. 497).

Follow-up support has been found to be influential in the TtT model of professional development. Pollnow (2012) reported schools that had dedicated coaching programs to assist teachers in implementing the professional development content after the professional development program observed an increase in use of the content and the effectiveness of its use. When trainers can model professional development content strategies and provide coaching support for job-embedded professional development, participants report a greater influence on classroom instruction (Pollnow, 2012).

Advancements in technology have impacted teacher professional development models (Borko, Jacobs, & Koeliner, 2010). Professional development opportunities have been able to incorporate technology-centered components, such as digital libraries, virtual learning environments, electronic conferencing, and online community building (Borko, Jacobs, & Koeliner 2010). Technology has allowed for teachers to be involved in both synchronous and asynchronous conversations by employing different online tools (Borko, Jabobs, & Koeliner, 2010).

Dede (2006) reviewed a plethora of empirical studies focused on online and hybrid professional development programs and found that most reports evaluated elements of program design, delivery, participation levels, and discourse in online environments. Few participants of online professional development have reported changes in teacher knowledge and skill (Dede, 2006).

Ramsdell, Rose and Kadera (2006) used formative and summative evaluations to examine the PBS TeacherLine site, which offers online professional development courses to preK-12 teachers in a variety of fields. The professional development model utilized online discussions by trained facilitators with backgrounds in specific subject matter to tie classroom practice to local and national standards through streaming video and sharing of student work (Ramsdell, Rose, & Kadera, 2006). Findings showed participants' perceived ability to apply course content to their classroom practice was directly related to the quality of the facilitator and the satisfaction of the course (Ramsdell, Rose, & Kadera, 2006).

Teacher Knowledge and Practice

Garet et al. (2001) found enhanced knowledge and skills have a substantial positive influence on changes in teaching practice, demonstrating that teachers who reported enhanced knowledge and skills due to the professional development are more likely to report changing their teaching practices. In addition to the impact enhanced knowledge and skills have on changing teacher practice, coherence also has an important positive influence on change in teaching practice. This suggested teachers are more likely to change their practice when professional development experiences are connected to their other professional development experiences and are aligned with standards and assessments (Garet et al., 2001).

Crandall et al. (1982) examined efforts to implement 61 innovative practices in schools and classrooms in 146 districts across the United States and focused on stimulating teachers commitments to new practices. Crandall et al (1982) found when teachers were involved in the problem solving and decision making about the professional development prior to program implementation, the program lost effectiveness because of the alterations made by the teachers. The study showed that teacher commitment to the improvement efforts took place after teachers had implemented the practices in their own classrooms and had experience with the innovation (Crandall et all, 1982).

Loucks-Horsley and Matsumoto (1999) identified five themes related to how teachers learn and further develop their knowledge and skills. The first entails that meaning is made by building a structure organized around core concepts of a discipline. This indicated teachers need a foundation within the subject area they teach as well as an understanding of how students learn within the specific subject matter (Loucks-Horsley & Matsumoto, 1999). Another theme was that “experts use problem solving techniques unique to their disciplines to access relevant pieces of their stored information”(Loucks-Horsley & Matsumoto, 1999, p. 261), showing teachers must be capable of making decisions about what students know, what they need to know, how students can gain knowledge, and the best ways to help students do so. Learners must develop an understanding of how concepts can be generalized and applied in other situations, indicating teachers must know what knowledge to apply in different learning and teaching situations (Loucks-Horsley & Matsumoto, 1999). The fourth theme identified by Loucks-Horsley & Matsumoto (1999) was that learning is reinforced through the opportunity to self-assess, reflect and adapt the concepts. The final theme was that learning is influenced by a community and its sub-cultures; reinforcing the importance of teachers interactions with others as they implement the professional development content (Loucks-Horsley & Matsumoto, 1999).

Educational Policies

When educational policies highlight new teacher behaviors, teacher learning is provided with a common set of goals and challenges which supported teacher learning (Loucks-Horsley & Matsumoto, 1999). The educational policies surrounding effective teacher professional development have not been empirically linked to high-quality professional development for teachers or teacher knowledge and practice.

Garet et al. (2001) noted 79% of the teachers in the study reported participating in district-sponsored professional development. Pals and Crawford (1980) examined the roles and responsibilities of groups in providing professional development for secondary agriculture teachers in Iowa. The researchers found, according to agriculture instructors, that agricultural industry personnel, school district administrators, university college of agriculture department chairs, education professional development specialists, extension directors, extension specialists and community agriculture departments heads, local school districts, and state departments of education should shoulder the responsibility of funding professional development costs. The findings went on to state that university faculty and agriculture teachers should determine the goals and objectives for professional development.

School Culture

Professional development has been most successful when state, district, and local leaders have promoted a culture of continuous learning for teachers and created a school culture that has made professional development an intrinsic part of a teacher's work day (Croft et al., 2009). Teachers who have worked together to analyze the student achievement data and then base decisions for teacher professional development on those analyses have experienced high-quality teacher professional development programs (Loucks-Horsley & Matsumoto, 1999).

Distinct differences have been seen in schools in which teachers frequently interact and work closely on issues of teaching and learning and schools that do not (Rosenholtz, 1991). Additionally, Little (1982) found that teachers at schools characterized by collegiality, collaboration, and experimentation continuously engaged in professional learning (as cited by Loucks-Horsley & Matsumoto, 1999). However, not all research has found that a school culture that emphasizes teacher collaboration and experimentation fosters increased student achievement. Fullan and Hargreaves (1996) and McLaughlin (1993) reported that collaborative environments reinforce traditional teaching practices and stifle innovation.

Pollnow (2012) found the TtT model had a great influence on classroom instruction in schools where a culture of learning existed. "Leadership valued teachers' input and provided individual professional development at the request of the teachers and administrators. Teachers felt more comfortable in experimenting with new learning and were willing to try more behaviors" (Pollnow, 2012, p. 119).

Croft et al. (2009) suggested district leaders and school administrators develop a "school culture among teachers in which continued learning is considered an essential aspect of professional practice" (p. 11). Harkreader and Weathersby (1998) studied professional development differences between low and high performing schools and found that schools with principals, staff, and decision- makers who were advocates for professional development which was focused on student achievement, school goals, and teachers' needs generally performed higher.

Supovitz and Turner (2000) also explored the effects of elements of school culture on the relationship between high-quality teacher professional development and IBI and investigative classroom culture. Teachers who reported that they were supported in the use of IBI and investigative classroom cultures by administration showed a significantly greater use of the professional development content in their classrooms. Additionally, instructional materials, time for teachers to plan lessons, and availability of the related science supplies had a significant influence on teachers IBI practices. Teachers in schools with high numbers of students on free or reduced lunch programs had significantly lower levels of IBI and investigative classroom cultures, while the type of community the schools were situated in had little influence on teachers practices.

Utilizing a Delphi study, Myers and Thompson (2009) explored NATAA trainers' recommendations on how to move agricultural education into the areas of math, science, and reading integration. One of the key findings of this study was the need to focus on collaboration efforts between academic and agriculture teachers when integrating core subject areas into agriculture curricula. NATAA trainers indicated collaboration of teachers within a school system can help students better understand the academic and technical concepts and principles taught (Myers & Thompson, 2009).

Student Learning Outcomes

Loucks-Horsley and Matsumoto (1999) reported schools recognized for having exemplary professional development programs had aligned the professional development decisions with the student learning goals.

Huffman, Thomas, and Lawrenz's (2003) study of the relationship between professional development and student achievement found the professional development for science teachers was not significantly related to student achievement. However, the authors reported that curriculum development had a significant, negative relationship with student achievement in the cases of math teachers, which indicated mathematics teachers of student with lower achievement scores were found to engage in more long-term curriculum development. Regression models were used to examine the extent to which the five types of professional development were predictive of student achievement. The model for curriculum development accounted for 16% of the variance of student achievement.

Though research has highlighted the teaching methods and teacher knowledge and practices that impact student learning outcomes, empirical research has not linked teacher professional development directly to student learning. For example, Thoron (2010) sampled NATAA trainers for a study to ascertain the effects inquiry-based instruction on student argumentation skills, scientific reasoning, and content knowledge of secondary agriscience students. The trainers used in the study were provided additional materials and tutorials to enhance their inquiry-based teaching practices, thus modifying the professional development experiences. Though Thoron's (2010) sample was derived from a group of trainers who attended NATAA, no link was made to imply that the trainers' professional development was the cause or main influence on student learning.

Summary

The objective of Chapter 2 was to describe the theoretical and conceptual framework that guided this study. Furthermore, Chapter 2 presented the salient literature relevant to the study. The review of literature focused on empirical research in the areas of high-quality teacher professional development, TtT form of professional development, inquiry- based instruction, teacher learning and educational policies, school culture, and student learning outcomes in relation to teacher professional development.

Teacher professional development has played an important role in education. High-quality teacher professional development has been examined using a set of core facets and relationships between the professional development programing and individuals involved. Content, duration, coherence, active learning, collective participation, and form have been facets that must be considered when implementing high-quality professional development. Additionally, publications have indicated that a relationship exists between school culture, educational policies and teacher professional development, teacher knowledge and practice, and student learning outcomes.

The TtT form of professional development has been common practice for teacher professional development, yet little empirical research has shown that TtT models of professional development have an impact on both the first and second generations of teachers' knowledge and practice. Research indicated the model has an impact on the first generation of teachers, who become trainers and generally attend longer professional development programs that include all the core facets of professional development. To date, no research has shown an impact on the teacher participants of professional development programs conducted by trainers.

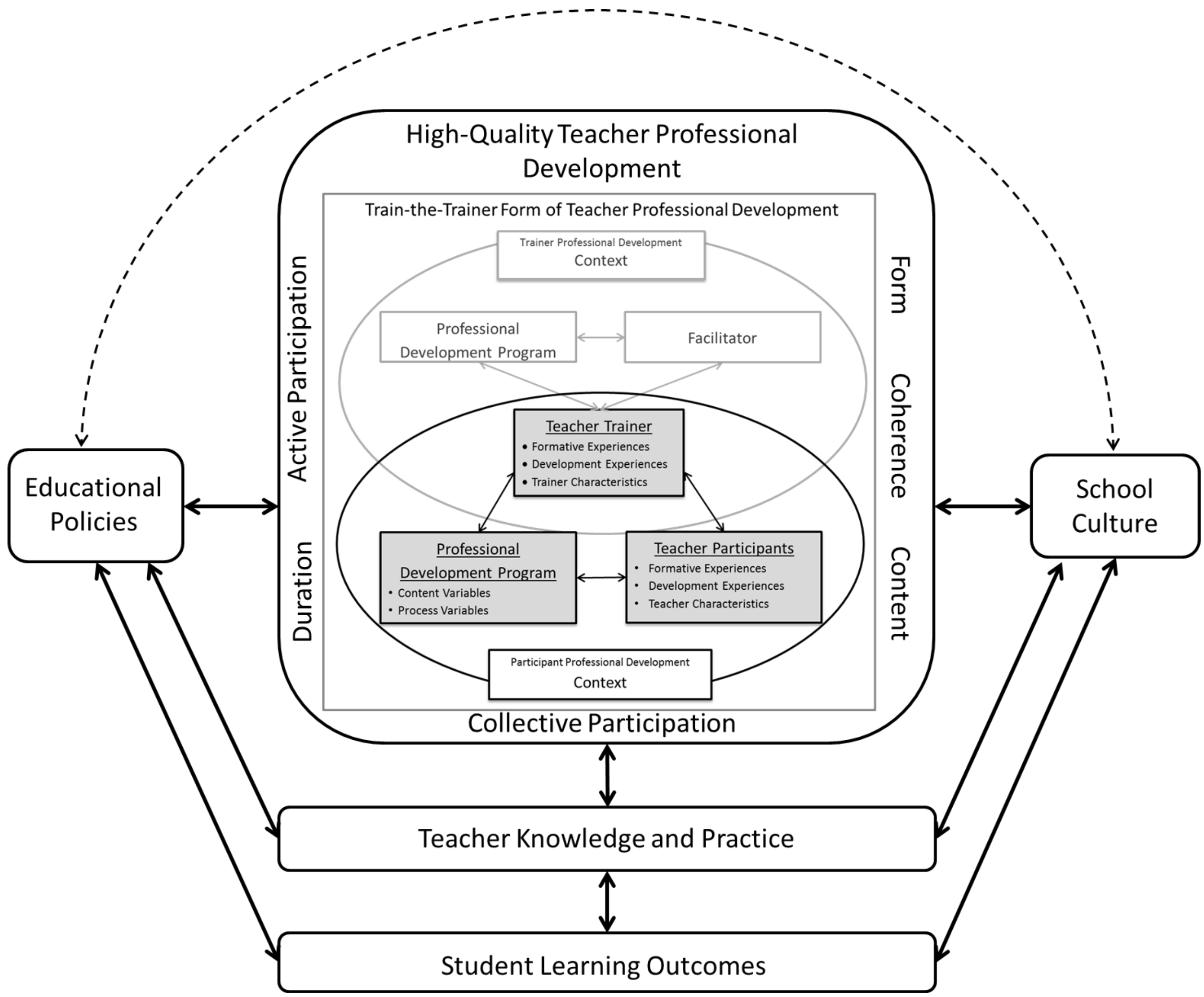

Figure 2-1. A model for the study of high-quality teacher professional development utilizing train-the-trainer model for professional development. (Adopted from Borko, 2004; Guskey & Sparks, 1996)

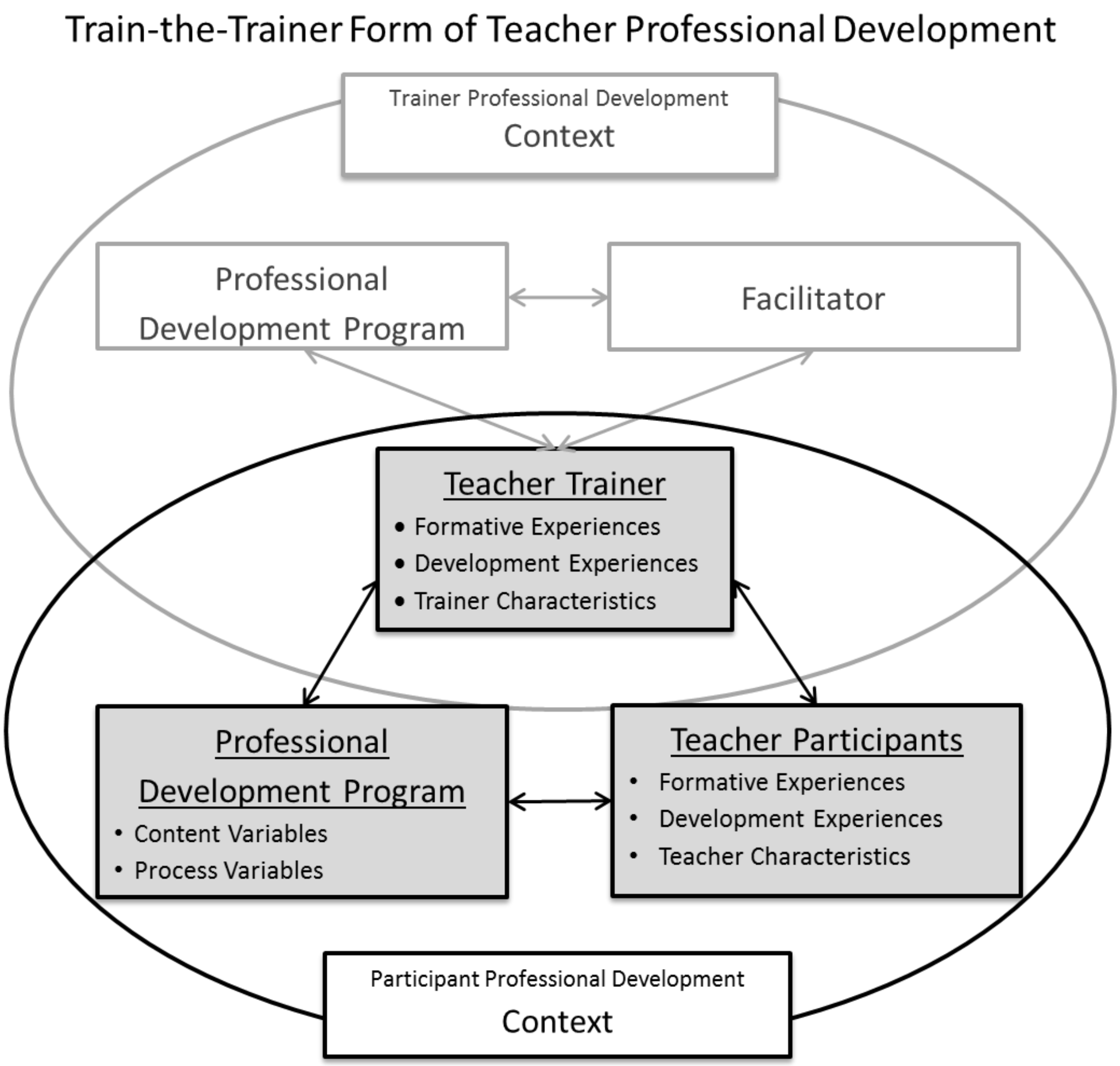

Figure 2-2. The Train-the-trainer form for teacher professional development.

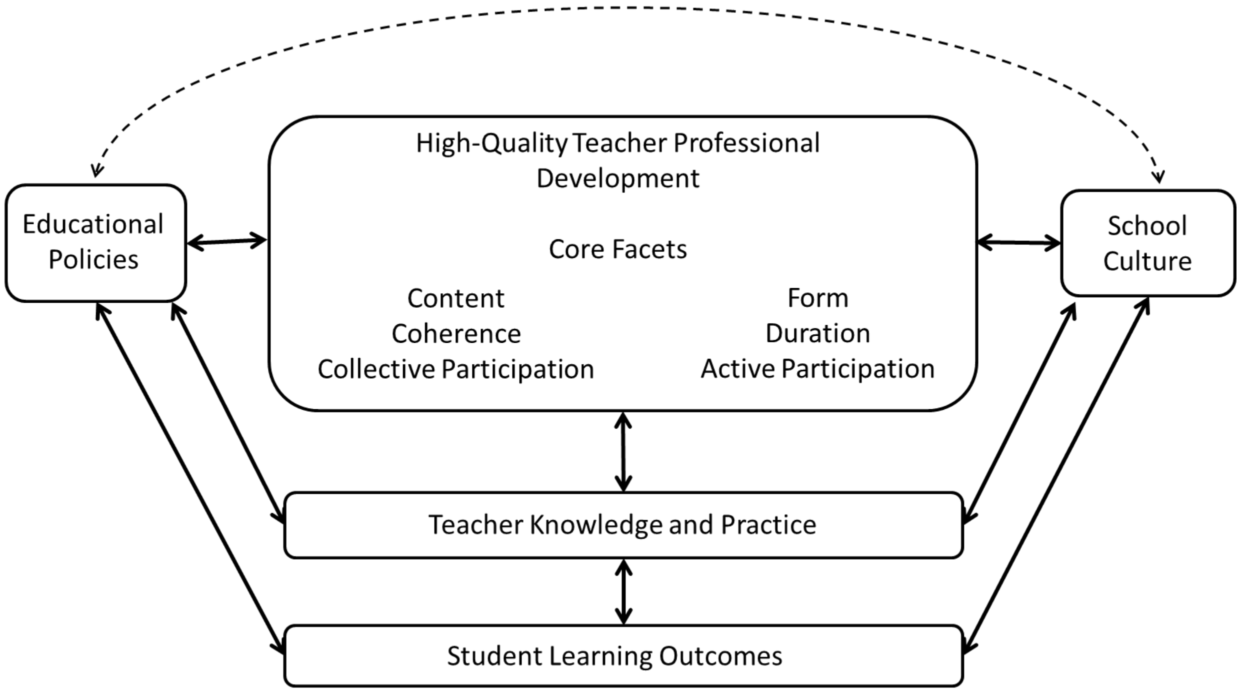

Figure 2-3. A model for the study of high-quality teacher professional development. (Adopted from Borko, 2004; Guskey & Sparks, 1996)

CHAPTER 3
METHODS

Chapter 1 described the justification for examining the influence high-quality teacher professional development on teacher perceptions, as well as introduced the Train-the-trainer (TtT) model of teacher professional development. The principal focus of this study was to describe the relationships between various aspects of TtT professional development and teacher perceptions of IBI.

Chapter 2 provided the study's theoretical and conceptual frameworks, as well as highlighted the important research related to the study's conceptual model. This study was philosophically guided by constructivism and grounded in Guskey and Sparks' (1996) model for staff development and improvements in student learning, as well as Borko's (2004) elements of effective professional development. A review of literature aligning with the study's conceptual model focused on core facets of high-quality professional development and the features of Train-the-trainer model of teacher professional developments.

Chapter 3 describes the methods utilized to address the study's research objectives. The Chapter provides information on the research design, procedures, population and sample, intervention, instrumentation, data collection procedures and methods of data analysis.

Research Design

This was a quantitative study that used a quasi-experimental design. This research design allowed the researcher to describe the various groups within the study, compare the differences between the groups, investigate the relationships between the independent and dependent variables and determine the predictive value of the independent variables on the dependent variables (Ary, Jacobs, & Sorenson, 2010). The dependent variables of this study were science integration in agriculture and inquiry-based instruction (IBI). The independent variables in this study were the core facets of high-quality teacher professional development, school culture, and teacher variables.

Randomized subjects, post-test-only comparison groups were used. The randomization of subjects into groups controls for extraneous variables and ensured initial differences between the groups are attributed only to chance (Ary et al., 2010). "Comparison groups receiving different treatments provide the same control over alternative explanations, as does comparison of treated and untreated groups" (p. 270), making it possible to draw well-founded conclusions form the findings of the study (Ary et al., 2010). The use of this design is recommended for research on changing attitudes and perceptions and is useful for studies in which a pretest is not available or appropriate (Ary, et al., 2010).

According to Campbell and Stanley (1963), the posttest-only comparison group design controls for all factors of internal validity: history, maturation, testing, instrumentation, regression, subject selection, mortality, and the interaction effects. However, Ary et al. (2010) identified mortality is a threat because of the lack of a pre-test. Researchers are unable to determine differences in participants who drop out of the study and those who completed the study due to the lack of pretest (Ary et al., 2010). The researcher monitored instances of mortality and evaluated differences between the experimental and comparison group. Additionally, the time-series element of the design created two threats to internal validity: history and instrumentation

(Campbell & Stanley, 1963). According to Campbell and Stanley (1963) history threats occur when specific events occur during the extended time between the observation points of the study. To control for history threats, a comparison group was utilized. Instrumentation threats occur when changes in observers or scores used may produce changes in measurements (Campbell & Stanley, 1963). To control for instrumentation threats the measurement of the instruments was standardized, and a comparison group was used. Table 3.1 includes a complete list of threats and the design controls.

Professional Development Program

The National Agriscience Teacher Ambassador Academy (NATAA) is one of the longest running, national professional development experiences for secondary agriculture teachers. The NATAA program utilizes a train-the-trainer form of professional development. The program is sponsored by Dupont® and coordinated by the National Association of Agricultural Education. The first generation of the program provides an in-depth training for secondary agriculture teachers. The participants of this generation of the professional development are selected through an application process and represent a wide variety of states and secondary agriculture programs; they all value science integration and improving their teaching practice. Once selected, the participants attend an intensive, one-week program in Maryland.

Each day of the one-week program provides an intensive mixture of activities, from a series of short lectures about IBI and science education to completing science laboratory activities utilizing IBI methods. The instruction content of the labs and lessons vary from activity to activity, but they include a variety of agricultural concepts, including animal science, plant science, environmental science, water issues, food science and natural resources. The participants are also engaged in cooperative lesson planning and sharing as well as provided personal reflection time.

Once the participants complete the week-long program, they become the NATAA trainers and are expected to provide workshops at the National FFA convention and the National Convention for NAAE. The trainers work in groups of 2-3 to provide IBI workshops that enhance teachers' knowledge of IBI teaching techniques, by using one of the laboratory activities that the trainers completed during their professional development. The workshops presented at the conventions by the trainers become the second generation of the TtT design of professional development, which is the focus of this study.

Procedures

The initial experience for participants was attendance at a 2012 NATAA workshop. These workshops focused on implementing inquiry-based instruction into secondary agricultural classrooms. Teachers engaged in professional development designed by the NATAA trainers, which used a variety of content areas (water conservation, photosynthesis, alternative energy, animal science, plant science, and aquaculture) to implement IBI methods. The NATAA workshops varied in duration from 60 to 95 minutes depending on the specific convention and session they occurred. The NATAA workshops implemented a number of active learning and collaboration techniques to assist teachers in developing IBI knowledge and skills. NATAA staff collected contact information from all participants.

Following the initial professional development experience, the participants were randomly assigned to two groups; the experimental group and the comparison group. The experimental group received the follow-up intervention designed by the researcher, while the comparison groups did not. Teacher perceptions of science integration in agriculture and IBI were assessed at each data collection point. The study's design is illustrated below:

Ex	X_W	$X_{FU}O$	$X_{FU}O$	$X_{FU}O$	$X_{FU}O$
Com	X_W	O	O	O	O

Key
Ex- Experimental Group
Com – Comparison Group
X – Treatment
W – Workshop
FU –Follow-up Intervention
O- Observation

Population

The study's population was secondary agricultural education teachers who attended NATAA workshops at the 2012 National FFA Convention and the 2012 National Association of Agriculture Educators National Convention. This study was a census of all teachers attending workshops at the 2012 conventions (N=261). A census was chosen due to the relatively small population and the ability to contact the complete population (Jupp, 2006). Contact information for each workshop participant was collected by NATAA at the beginning of the workshop and shared with the researcher. Additionally, by including the entire population, the researcher hoped to receive an increased number of respondents who completed surveys at all four data collection points.

Intervention

The intervention for this study consisted of email follow-up support for 2012 NATAA workshop participants. The support was broken down into two levels of email follow-up: resource reminders and content reminders.

An NATAA ask-an-expert email address was created that was staffed by a NATAA trainer to answer and assist teachers in implementing workshop IBI content. The email address was provided at the conclusion of all 2012 NATAA workshops. Additionally, all participants were reminded of the NATAA ask-the-expert email follow-up support when provided with the initial survey point.

Participants randomly assigned to the experimental group received an initial email from the ask-an-expert email address that explained the follow-up support program and encouraged participation in the follow-up. For the first 5 months, monthly emails were sent from the ask-an-expert to the experimental group to remind them that the support resource was available to them (resource reminders) (see Appendix A). These emails encouraged participants to use the email resources to assist with lesson planning and IBI implementation though didn't provide any extra information concerning IBI implementation. Beginning in June 2013 the email reminders were altered to include more active support of IBI implementation. The monthly emails for the duration of the study included consisted of content reminders (Appendix B) which were developed by the researcher, based on practices taught in the NATAA trainer professional development. The material of the content reminders was reviewed by the NATAA trainer staffing the ask-an-expert email for content validity. The active emails included frequently asked questions and answers, mini-lesson ideas, and the key components of IBI.

Instrumentation

The survey instrument used in this study was based on two instruments used by other researchers examining science integration and inquiry-based instruction related to agriscience education (Dunbar, 2002; Layfield, Minor, & Waldvogel, 2001; Thompson &

Balschweid, 1999; Thompson & Schumacher, 1998). Additional questions were added to the survey instrument, concerning professional development experiences and school culture that related to the objectives of the study. A panel of experts consisting of faculty from the University of Florida reviewed the instrument for face and content validity.

The Integrative Science Survey (ISS) instrument developed by Thompson and Schumacher (1998) was used to identify participant perceptions of integrating science and agriculture (see Appendix C). The instrument used 5-point Likert-type scales to assess teacher perceptions related to preparation for, barriers to, and support for integrating science into agriculture programs. Previous studies utilizing the ISS reported the internal consistency using Cronbach's alpha of .80 and .88 (Myers, Thoron, & Thompson, 2009; Thompson & Schumacher, 1998). Constructs of the ISS assessed agriscience teacher perceptions towards the integration of science, preparation to integrate science, support for integration, student impact of integration, barriers to integration, collaboration, and level of integration.

The Inquiry-based Teaching Techniques (ITT) instrument was used to examine teachers perceptions related to their use of inquiry-based teaching practices (see Appendix D). Previous studies that used the ITT instrument reported an internal consistency using Cronbach's alpha of .90 and .81 (Dunbar, 2002; Myers, Thoron, & Thompson, 2009). The ITT instrument asked teachers to report the frequency of engagement in inquiry-based instructional practices and their perceptions of IBI on student learning outcomes. The ITT focused its assessment scales on frequency of IBI teacher practices and frequency of IBI student practices.

Additional questions were added to the surveys to assist in gathering additional information that utilized to the model of high-quality teacher professional development. These included questions related to the core facets of professional development, additional professional development experiences, school culture, teacher attitudes towards professional development and demographic information.

The School Culture Survey (SCS) was developed by Gruenert and Valentine (1998), based on literature related to school culture, effective school cultures and collaborative school cultures (see Appendix E). Many previous studies have utilized the SCS (Fraley, 2007; Gruenert, 1998; Herndon, 2007; Mitchell, 2008; Sullivan, 2010). The instrument included 35 Likert-type questions, from strongly disagree to strongly agree, that examined six factors related to school culture (Gruenert, 1998). The six factors were: (a) collaborative leadership, (b) teacher collaboration, (c) professional development, (d) collegial support, (e) unity of purpose, and (f) learning partnerships. The description and reliability coefficient (Gruenert, 1998) for each of the factors is shown below:

- Collaborative leadership measures the degree to which school leaders establish and maintain collaborative relationships with school staff (Cronbach's alpha of .91).
- Teacher collaboration measures teacher engagement in constructive dialogue that furthers the purpose and vision of the school (Cronbach's alpha of .83)
- Professional development measures the extent to which teachers valued continuous personal and professional development and school-wide improvement (Cronbach's alpha of .87).
- Collegial support measures the degree to which teachers work together effectively (Cronbach's alpha of .83).
- Unity of purpose measures the level of teachers' work together towards a common mission for the school (Cronbach's alpha of .82).

- Learning partnerships measures the extent that teachers, parents and students work together for common student learning outcomes (Cronbach's alpha of .66).

The Teacher Attitudes about Professional Development (TAP) scale was developed by Torff, Sessions, and Brynes (2005) to assess how favorably teachers respond to professional development initiatives (see Appendix F). The TAP scale used five Likert-type questions (strongly agree to strongly disagree) to measure how professional development impacts teaching practices.

Teacher demographic characteristics were measured using researcher-created items that were included on the instrument. Demographic items consisted of gender, teaching experience, grade levels and subjects taught, age, teaching licensure, and highest level of education with coordinating majors. All items were constructed according to recommendations by Dillman, Smyth and Christian (2009).

Data Collection

A longitudinal panel study was used to administer the questionnaires to the teacher participants. According to Ary, Jacobs and Sorensen (2010), a longitudinal panel study gathers information from the same subjects over an extended period of time. This survey method allowed for researchers to see changes in individuals' behaviors and perceptions and investigate reasons for the change (Ary, Jacobs, & Sorensen, 2010).

This research project was approved by the Institutional Review Board at the University of Florida (Appendix H). Upon IRB approval, data were collected over a 12 month time period following the conclusion of the 2012 NAAE convention. Data were collected using online survey software, Qualtrics ®.

The questionaire was administered to teacher participants at four points in time over the year after their attendance at the 2012 convention workshops. At the time of the initial survey email, participants were provided with the IRB protocol (Appendix H) and informed of the confidentiality of responses and the voluntary nature of the research. Participants were also informed that there were no risks or benefits of participating in the study, and UF IRB office contact information was provided.

Each data collection point included a different version of the instrument due to the accumulation of SCS and TAP to assess additional elements of high-quality teacher professional development. These were spread out over the course of the time series, to ensure that the time required for teachers to complete the survey was not too lengthy. The initial survey instrument included the ISS, ITT and demographic information questions. In the second survey instrument the participants completed the ISS and ITT scales. The third survey point used the ISS, ITT, and SCS to gather participants' data. The final survey utilized the ISS, ITT, TAP, and additional survey questions related to the professional development experiences over the past year. Procedures from the first administration was used during all subsequent survey administrations. Table 3.2 shows the timeline of the administration of the data collection points.

Data Analysis

The researcher was interested in the data from all participants who completed the instrument at each data collection point. Data were analyzed through SPSS version 20. Table 3.3 aligns the research objectives with instrumentation and data analysis methods.

Research Objective One and Two

Research objectives one and two were to describe NATAA workshop participants' perceptions of science integration in agriculture and inquiry-based instruction over time after a trainer-led professional development workshop. Data for each element were analyzed using descriptive statistics (measures of central tendency and frequencies) for each data collection point.

Research Objective Three

Research objective three was to describe workshop participants' use of NATAA follow-up support over the course of the year. To accomplish this objective, data were collected from the ask-the expert email account and survey instruments. These data were analyzed using descriptive statistics (measures of central tendency and frequencies) at each data collection point.

Research Objective Four

Research objective four was to determine the effects of follow-up with NATAA workshop participants' on their perceptions of science integration in agriculture and IBI. The appropriate ANOVA statistics were run to determine significant mean differences among groups.

Research Objective Five

Research objective five was to determine the relationships between NATAA workshop participants' perceptions of science integration in agriculture and IBI with the selected elements of the high-quality teacher professional development model. To accomplish this objective, the direction and strength of the relationships between variables were calculated using the Pearson's product-moment correlation coefficients. Data were examined to determine if the assumptions of Pearson's coefficient linearity and equal variance were met. The relationships explained the degree of linear relationship between the dependent variables (science integration in agriculture and IBI) and selected independent variables (teacher variables, process variables, school culture and other professional development).

Research Objective Six

Research objective six was to explain the variance in teacher perceptions of science integration in agriculture and IBI based on elements of the high-quality teacher professional development model. Based on significant relationships identified in objective five, multiple regression was utilized to determine if the elements of high-quality teacher professional development predicted the change in participants' perceptions of science integration in agriculture and IBI. The stepwise regression method was utilized, as this method allows for variables that do not contribute to the prediction of dependent variables to be removed from the overall model (Agresti & Finlay, 2009). Four assumptions of multiple regression have been identified, tested and controlled. Regression assumes that variables have normal distributions, that the relationship between dependent and independent variables is linear in nature, variables are measured without error, and that the variance of errors is the same across all levels of the independent variable (Osborne & Waters, 2001).

Summary

Chapter 3 detailed the methods used in this study through reporting of the research design and procedures, population, data collection instruments and procedures and data analysis. The dependent variables of focus in this study were the participants' perceptions of science integration into agriculture education and the implementation of IBI. The dependent variables of the core facets of high-quality teacher professional development, school culture, and teacher variables were utilized as the independent variables of this study. The treatment group received additional follow-up support throughout the year following the NATAA workshop experience. The experimental intervention was an ask-an-expert email resource to support workshop participants' implementation of IBI methods. The dependent variables in the study were teacher participants' perceptions of science integration in agriculture and IBI.

This was a quantitative study that used a quasi-experimental design. The study employed randomized subjects and posttest-only comparison groups. The population of the study consisted of the NATAA workshop participants from the 2012 National FFA and the National NAAE conventions. Teacher participants were assessed through online survey instruments, teacher trainers were also assessed through online survey instruments and NATAA workshops were assessed using the participants' evaluations of the individual workshops. Teachers placed randomly into an experimental group received monthly reminders of the follow-up support provided by the researcher developed Ask-an-Expert NATAA email.

Table 3-1. Internal validity threats and controls

Threat	Description	Control Methods
History	Events occurring during the observation points in the study, in addition to the experimental variable.	Used a comparison group Random assignment
Maturation	Processes within the respondents operating as a function of the passage of time.	Used a comparison group Random assignment
Testing	The effect of taking a test on the scores of a second test.	Used a comparison group Lengthened time between test points
Instrumentation	Changes in calibration of measuring instrument or change in observers or scores that may produce changes in test measurement.	Used a comparison group Standardized measurement procedure
Regression to the Mean	Selection of groups based on extreme scores.	Used a comparison group Use of reliable measures
Selection	Biases influence the placement of respondents into the comparison groups.	Used a comparison group Random assignment
Mortality	Loss of respondents from the study.	Used a comparison group Monitored instances of mortality
Interaction effects	Interactions of 2 or more of the threats due to multiple group design.	Used a comparison group Random assignment

Note. Identification and description of threats adapted from Campbell & Stanley (1963)

Table 3-2. Data collection timeline

	NATAA Workshop	Survey 1	Survey 2	Survey 3	Survey 4
Dates	October & November 2012	Jan. 7th, 2013	May 6th, 2013	Sept. 3rd, 2013	Dec. 2nd, 2013
Instruments		ISS, ITT, Demographics	ISS, ITT	ISS, ITT, SCS	ISS, ITT, SCS,TAP, Demographics

Table 3-3. Aligned research objectives with instrumentation and data analysis

Research Objective	Data Collection	Data Analysis Method
Objective 1: To describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture after a trainer-led professional development workshop.	ISS ITT	Descriptive statistics
Objective 2: To describe the NATAA workshop participants' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation after a trainer-led professional development workshop.	ISS ITT	Descriptive statistics
Objective 3: To describe the NATAA workshop participants' utilization of NATAA follow-up support after a trainer-led professional development workshop.	Ask-an-expert Email Descriptive Questions	Descriptive statistics Frequencies
Objective 4: To determine the effects of follow-up on NATAA workshop participants' perceptions of science integration in agriculture and IBI.	ISS ITT Follow-up utilization	ANOVA
Objective 5: To determine the relationship between NATAA workshop participants' perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model (teacher variables, workshop content and process variables, School culture and other professional development).	ISS ITT SCS TAP Demographics	Pearson product-moment correlation coefficient Point biserial correlations
Objective 6: To predict teacher perceptions of science integration in agriculture and IBI based on the elements of the high-quality teacher professional development model.	ISS ITT SCS TAP	Multiple regression

CHAPTER 4
RESULTS

Chapter 1 established the need for examining high-quality professional development for secondary agriculture teachers. This study was designed to describe the influence of the train-the trainer form of professional development on workshop participants' perceptions of science integration in agriculture and inquiry-based instruction. The specific objectives of this research study were to:

- describe the National Agriscience Teacher Ambassador Academy (NATAA) workshop participants' immediate and long-term perceptions of science integration in agriculture following a Trainer-led professional development workshop.
- describe the NATAA workshop participants' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a Trainer-led professional development workshop.
- describe the NATAA workshop participants' utilization of NATAA follow-up support after a Trainer-led professional development workshop.
- determine the effects of follow-up on NATAA workshop participant's perceptions of science integration in agriculture and IBI.
- determine the relationship between NATAA workshop participants' perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model (teacher variables, professional development program variables, school culture and other professional development).
- determine the predictive variation of teacher perceptions of science integration in agriculture and IBI based on elements of the high-quality teacher professional development model.

Chapter 2 introduced the model for the study of high-quality teacher professional development that utilized a train-the-trainer model for professional development, which guided the study. The background for the conceptual framework was given and empirical evidence was provided to support the conceptual framework of this study. The review of literature contained a synthesis of research concerning the core facets for high-quality teacher professional development, components of train-the-trainer models of professional development, teacher knowledge and practice, educational policy, school culture and student learning outcomes in relation to teacher professional development.

Chapter 3 provided the research methodology of this study, including a description of the research design, population, instrumentation, data collection procedures and data analysis. Using a census of secondary agriculture teachers who attended NATAA workshop, the quasi-experimental design utilized a questionnaire at four data collection points throughout the year following the workshop to assess teacher perceptions of science integration and inquiry-based instruction. Data analysis consisted of descriptive statistics, analysis of covariance, Pearson's Product Moment and bi-point serial correlations, and regression. The dependent variables in this study were participants' perceptions of science integration in agriculture and implementation of inquiry-based instruction. The independent variables in this study were the core facets of high-quality teacher professional development, school culture, and teacher variables. The treatment group received additional follow-up support throughout the year following the NATAA workshop experience.

Chapter 4 provides the results of the data analysis, which are listed by objective.

Response Rates

The population of this study consisted of teachers who attended NATAA workshops presented by NATAA trainers at the 2012 National FFA convention and/or the 2012 NAAE Convention. The entire population was accessible, therefore making this a census of the population. A total of 242 participants attended the workshops (see Table 4-1). Chapter 3 outlined the research design and four data collection points throughout the study. Following the initial participation email, 14 participants from the control group and 14 participants from the treatment group asked to be removed from the study leaving a total of 214 participants. Additionally, the database provided to the researcher contained incorrect contact information for 42 participants; 16 were members of the control group, 26 were members of the treatment group. The researcher attempted to utilize the Internet and state teacher databases to find correct contact information, but was unable to locate email or phone numbers for these participants. Additional participants were unable to be contacted for the third and fourth survey; 12 members of the control group and 12 members of the treatment group were removed at this time. Only 21 responded to surveys at all four data collection points.

Each instrument used in the study was administered at separate times, and responses rates were reported for each instrument. The response rate varied from 16.89% to 30.81% (see Table 4-2). Nonresponse error can occur in studies with response rates less than 100% (Miller & Smith, 1983). For the initial data collection point, a simple random sample, comprised of 15% of the non-respondents, were contacted to compare their response to those of the initial responses (Lindner, Murphy, & Briers, 2001; Miller & Smith, 1983). However, only three individuals were reached and provided responses to the questionnaire. This method of dealing with non-response was chosen by the researcher, as opposed to the comparison of early and late responders, because 30 is the minimum number of late respondents needed to conduct a comparison between early and late responders to address non-response issues (Lindner, Murphy, & Briers, 2001). Non-response does not greatly impact the study, because this study is a census and is not generalizable to the general population (Fowler, 2014).

PostHoc Reliability of Instruments

Cronbach's alpha was utilized to determine the post-hoc reliability of the instruments used in the study (Table 4-3). Ary, Jacobs, and Sorensen (2010) reported that modest reliability coefficients, .50-.60, are acceptable for making decisions about groups and for research purposes. All of the reliability coefficients in this study fell above this acceptable range.

The Integrative Science Survey (ISS) instrument developed, by Thompson and Schumacher (1998), assessed teacher perceptions related to preparation for, barriers to, and support for integrating science into agriculture programs. The reliability coefficients for the ISS ranged from .89 to .96, over the four data collection points. The Inquiry-based Teaching Techniques (ITT) instrument has been used to examine teachers' perceptions related to their use of inquiry-based teaching practices (Dunbar, 2002). The reliability coefficients for the ITT varied from .86 to .99 throughout the study.

The School Culture Survey (SCS) developed by Gruenert and Valentine (1998), included six factors: (a) collaborative leadership, (b) teacher collaboration, (c) professional development, (d) collegial support, (e) unity of purpose, and (f) learning partnerships. The overall SCS construct reliability ranged from .94, to .95 for the September and December data collection points, respectively. Previous literature reports an overall SCS reliability coefficient, as well as coefficients for the individual constructs. The following represented the individual constructs and their reliability coefficients for the September and December data collection points, respectively.

- Collaborative leadership measures the degree to which school leaders establish and maintain collaborative relationships with school staff (.88 and .85).
- Teacher collaboration measures teacher engagement in constructive dialogue that furthers the purpose and vision of the school (.79 and .81)
- Professional development measures the extent to which teachers valued continuous personal and professional development and school-wide improvement (.79 and .76).
- Collegial support measures the degree to which teachers work together effectively (.78 and .69).
- Unity of purpose measures the level to which teachers work together towards a common mission for the school (.81 and .88).
- Learning partnerships measures the extent that teachers, parents and students work together for common student learning outcomes (.69 and .73).

The Teacher Attitudes about Professional Development (TAP) scale was developed by Torff, Sessions, and Brynes (2005) to assess how favorably teachers respond to professional development initiatives. The TAP scale was administered in the December data collection point and had a reliability coefficient of .75. Two additional scales related to the core facets of high-quality professional development were utilized to assess participants' perceptions of the NATAA professional development's use of coherence and active participation. The reliability coefficients for the Core Facet of Coherence (CF-Co) were .91 and .84 in the final two data collection points, respectively. The reliability coefficients for the Core Facet of Active Participation (CF-Ap) for the final two data collection points were .92 and .84, respectively.

Description of the Population

To describe the respondents, a number of demographic and professional characteristics were analyzed. Table 4-4 gives an overview of the descriptive statistics of the respondents. A majority of respondents in this study were female (control =

61.8%, treatment = 59.1%), and the mean age of respondents was 39 for the control group and 41 for the treatment group. The average number of years of teaching experience for the respondents was similar in both the control group (15.03, SD = 9.76) and treatment groups (14.61, SD = 7.99). Both the control and treatment group reported the number of years they had been at their current school to be similar, 9.11 (SD = 7.13) and 9.67(SD = 7.13), respectively. Many of the respondents have previously attended an NATAA workshop (control 58.3%, treatment 43.5%) and a majority had attended other workshops focused on science integration in agriculture (control 54.1%, treatment 56.5%). Additionally, many respondents of both the control group and treatment group reported conducting scientific research, 41.7% and 45%, respectively. Respondents had a variety of post-secondary education levels, ranging from a bachelor's degree to a doctoral degree.

Respondents completed the Teachers' Attitudes about Professional Development (TAP) scale in December to assess their attitudes towards professional development (see Table 4-5). The scale included five questions, two of which were reverse coded to moderate response bias. The respondents responded to the statements on a 5-point Likert-type scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). The grand mean for the TAP construct was 3.93 (SD = .45), indicating respondents had generally positive attitudes towards professional development. All of the respondents believed the professional development events they had attended enriched their teaching practice. All of the control group respondents and a vast majority of the treatment group respondents (81.3%) agreed that professional development helped teachers develop new teaching techniques. A majority of the respondents reported professional development has had an impact on their teaching (control = 68.2%, treatment = 75.1%), and professional development events were worth their time (control = 77.3%, treatment = 87.5%). However, only 18.1% of the control group and 43.8% of the treatment group disagreed with the statement “if I did not attend inservice workshops they would not be able to improve their teaching”.

The School Culture Survey (SCS) was composed of 35 items, with 6 subscales: collaborative leadership (SCS-CL), teacher collaboration (SCS-TC), professional development (SCS-PD), unity of purpose (SCS-UoP), collegial support (SCS-CS), and learning partnerships (SCS-LP). Each item was reported on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). The mean score and standard deviation for the scale and each subscale are shown in Table 4-6. The mean score of the overall SCS scale was 3.20 (SD = .57) in September and 3.31 (SD = .56) in December. In September, the mean score for each of the six subscales fell between 2.73 and 3.43. The subscale of professional development had the highest mean (3.43, SD = .72) indicating it was the most agreed with and the subscale of teacher collaboration had the lowest mean (2.73, SD = .67) indicating it was the most disagreed with. In December, the mean scores for each of the six subscales fell between 2.79 and 3.60. The subscale of collegial support had the highest mean (3.60, SD = .60) indicating that respondents agreed with it the most, while the subscale of teacher collaboration had the lowest mean (2.79, SD = .71), indicating that respondents disagreed with this subscale of school culture more. It should be noted that only 3 subscales had a mean outside of neutral. In September, both the subscales of collaborative leadership and teacher collaboration were below neutral, while in December only the scale of teacher collaboration was below neutral.

Table 4-7 presents the SCS item frequencies for each statement for the September respondents. A majority of both the control group and treatment group disagreed with “teachers spend considerable time planning together” (control = 77.8%, treatment 66.7%), “teachers take time to observe each other teaching” (control = 66.6%, treatment = 66.7%), and “teachers are generally aware of what others are teaching” (control = 88.9%, treatment = 50.0%). All of these statements are part of the teacher collaboration sub-scale. Respondents from both groups agreed most with the statement “teachers utilize professional networks to obtain information and resources for classroom instruction” (control = 88.9%, treatment = 100%), which is part of the professional development subscale.

Table 4-8 presents the SCS item frequencies for each statement for the December respondents. A majority of the control group disagreed with “teachers are rewarded for experimenting with new ideas and techniques” (50.0%), and “teachers take time to observe each other teaching” (66.7%). A majority of the treatment group also disagreed with “teachers take time to observe each other teaching” (71.2%), in addition to “teachers are generally aware of what other teachers are teaching” (64.2%). Respondents from both groups agreed most with the statements “teachers utilize professional networks to obtain information and resources for classroom instruction” (control = 80.0%, treatment = 86.7%), “the faculty values school improvement” (control = 94.4%, treatment = 85.7%), and “teachers support the mission of the school” (control = 88.9%, treatment = 85.7%).

A series of questions related to the core facets of high-quality professional development, such as duration, collective participation, coherence and active participation, was also assessed in this study.

The first core facet examined related to the participants' perceptions of duration of the NATAA workshops (see Table 4-9). In September, 77.8% of the control group and 83.3% of the treatment group reported the length of time spent in the workshop to be adequate for them to gain the knowledge and practices needed to implement the workshop content in their classrooms. In December, 59.1% of the control group and 75% of the treatment group indicated the workshop was an adequate amount of time.

The second core facet examined was the participants' perceptions of collective participation during the NATAA workshops (see Table 4-10). In September, 100% of the control group and 83.3% of the treatment group reported that there were no teachers or administrators from their school who participated in the NATAA workshop with them. However, a majority of the respondents reported that a teacher or administrator from their state participated in the NATAA workshop with them (control = 55.6%, treatment 66.7). In December, respondents also indicated that they attended the workshop with more teachers and/or administrators from their state (control = 41.7%, treatment = 46.7%) than from their school or school district.

The third core facet examined related to participants' perceptions of the NATAA workshops in terms of the extent to which the workshop was coherent with their individual beliefs, prior knowledge, and educational policies and practices (see Table 4-11). The scale included 6 items which asked the respondents to indicate their level of agreement on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). The grand mean for the core facet of coherence (CF-Co) in September was 3.61 (SD = .94), and in December it was 3.93 (SD = .43). In September, respondents reported the workshop aligned with their individual beliefs concerning science integration (control = 77.8%, treatment = 83.3%) and their prior knowledge about science integration (control = 88.9%, treatment = 83.4%). Only 44% of the control group reported that the workshop aligned with their teaching practices related to science integration, while 83.3% of the treatment group reported workshop alignment. September respondents generally agreed that the NATAA workshop aligned with their school or school district policies (control = 44.4%, treatment = 66.7%) and state and national policies (control = 44.4%, treatment = 66.7%). Also in September, a majority of respondents agreed the workshops aligned with their previous professional development experiences (control = 55.5%, treatment = 83.3%).

The December respondents agreed that the NATAA workshop aligned with their individual beliefs (control = 88.9%, treatment = 93.4%), prior knowledge (control = 94.3%, treatment = 73.4%), and teaching practices (control = 88.9%, treatment = 71.4%) related to science integration. Additionally, a majority of respondents agreed that the NATAA workshop aligned with both their school and school district policies (control = 85.7%, treatment = 66.7%) and the state and national policies (control = 71.4%, treatment = 66.7%). December respondents also agreed the workshop aligned with their previous professional development experiences (control = 83.4%, treatment = 78.6%).

The final core facet examined in this study was the respondents' perceptions of active participation during the NATAA workshop (see Table 4-12). The respondents responded to eight statements on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree), which indicated elements of active participation during the NATAA workshop. The grand mean for the core facet of active participation (CF-Ap) in September was 3.71 (SD = .89), while in December it was 3.92 (SD = .54), indicating that the teachers were generally active respondents of the NATAA workshops. In September, a vast majority of respondents agreed they had the opportunity to ask questions during the workshops (control = 87.5%, treatment = 100%), and complete the student activity/experiment provided by the workshop (control = 87.5%, treatment = 83.3%). The most distinguishable differences between the control and treatment group in September that concerned active participation related to the respondents' perceptions of the opportunity to work with other agriculture teachers in planning for the implementation of the content; 62.5% of the control group disagreed with the item that indicated they did not have the opportunity to work with others, while only 16.7% of the treatment group reported disagreeing with the same statement.

A vast majority of the December respondents agreed they had the opportunity to ask questions during the workshops (control = 94.2%, treatment = 88.7%) and complete the student activity/experiment provided by the workshop (control = 88.2%, treatment = 92.9%). Additionally more December respondents indicated they had the opportunity to discuss the student activity/experiment provided by the workshop (control = 100%, treatment = 85.7%) and participate in activities that enhance their ability to teach the workshop content area in their own classrooms (control = 94.1%, treatment = 85.7%).

Objective One

Objective one was to describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture following a trainer-led professional development workshop. The Integrative Science Survey (ISS) asked participants to complete subscales assessing their perceptions towards: integration of science, preparation to integrate science, support for integration, and the student impact of integration, barriers to integration, and their level of integration. The ISS was administered at all four data collection points and the grand means were as follows: January was 3.74 (SD = .37), May was 3.79 (SD = .27), September was 3.66 (SD = .30) and December 3.82 (SD = .39). The grand means indicate respondents' tendencies to have favorable perceptions of science integration overall.

The first subscale of ISS assessed participants' perceptions of the integration of science into agricultural programs. The participants responded to eleven statements on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). In January (see Table 4-13), 100% of the respondents from both the control group and the treatment group agreed that science concepts are easier for students to understand when science is integrated into an agricultural education program and that students are better prepared in science after they have complete a course in agriculture education that integrates science. Additionally, most of the respondents also agreed that integrating science into agriculture classes increases the ease with which teachers can teach problem solving (control = 81.5%, treatment = 100%) and that students are more aware of the connections between science and agriculture when science concepts are an integral part of their agricultural instruction (control = 81.5%, treatment = 82.4%). In January, many respondents indicated that "less effort is required to integrate science in advanced courses as compared to introductory courses" (control = 48.1%, treatment = 44.1%), and "it is more appropriate to integrate science in advanced courses than into introductory courses" (control = 44.4%, treatment = 64.7%).

In May (see Table 4-14), nearly all of the respondents agreed that students learn more about agriculture when science concepts are integrated (control = 88%, treatment = 96%), that science concepts become easier for students to understand when integrated into agricultural education programs (control = 88%, treatment = 96%), and that students are better prepared in science after completing an agricultural course which integrated science (control = 84.0%, treatment = 96%). Similar to the January responses, many May respondents indicated "less effort is required to integrate science in advance courses as compared to introductory courses" (control = 48%, treatment = 36%), and "it is more appropriate to integrate science in advanced courses than into introductory courses" (control = 68%, treatment = 44%).

In September (see Table 4-15), 100% of all responses agreed that science concepts are easier for students to understand when science is integrated into an agricultural program. Additionally, nearly all respondents agreed that students are better prepared in science after completing an agricultural course that integrated science (control = 100%, treatment = 90%) and become more aware of the connection between scientific principles and agriculture when science is integrated into agricultural curriculum (control = 92.3%, treatment = 90%). Similar to the initial data collection points, in September respondents indicated that “less effort is required to integrate science in advanced courses as compared to introductory courses” (control = 76.9%, treatment = 40%), and “it is more appropriate to integrate science in advanced courses than into introductory courses” (control = 69.2%, treatment = 60%).

In December (see Table 4-16), 100% of all responses agreed that students are more aware of the connection between scientific principles and agriculture when science is integrated into agricultural program. Additionally more than half of the respondents agree with nine out of the eleven items, which indicated positive perceptions towards the integration of science. Once again many respondents in September disagreed with “less effort is required to integrate science in advanced courses as compared to introductory courses” (control = 59.1%, treatment = 31.3%), and “it is more appropriate to integrate science in advanced courses than into introductory course” (control = 54.5%, treatment = 56.3%).

The second subscale of the ISS examined participants’ perceptions of preparation to integrate science into their curriculum, assessing seven items on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). In January (see Table 4-17), fewer respondents reported feeling prepared to teach integrated physical science concepts (control = 66.7%, treatment = 58.9%) than integrated biological science concepts (control = 84.1%, treatment = 76.5%). A majority of respondents indicated teacher preparation programs in agricultural education should provide instruction on science integration (control = 81.5%, treatment = 94.1%) and expect the cooperating teachers of student teachers to model science integration (control = 77.7%, treatment = 76.5%). In January, 66.7% of control group respondents agreed that teacher preparation programs should require students to have early field experiences and conduct student teaching internships with agricultural teachers and programs that integrate science. However, only 47% of the treatment group agreed that students should be required to complete their early field experiences with teachers who integrate science, while 64.7% of them agreed that students should conduct student teaching internships with teachers who integrate science into the agricultural education program.

In May (see Table 4-18), more than half of the respondents agreed with all five statements concerning teacher preparation programs' provision of student instruction and experiences with science integration in agricultural programs, indicating respondents felt it was essential to prepare future teachers to integrate science. Also in May, fewer respondents reported feeling prepared to teach integrated physical science concepts (control = 60%, treatment = 72%) than integrated biological science concepts (control = 72%, treatment = 84%).

In September (see Table 4-19), there differences in the groups' levels of agreement concerning requiring pre-service students to conduct early field experiences (control = 30.8%, treatment = 90%) and student teaching internships (control = 38.5%, treatment = 80%) with teachers who integrated science into an agricultural education program. However, nearly all respondents agreed that teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture (control = 92.3%, treatment = 100%). September also had fewer respondents who reported feeling prepared to teach integrated physical science concepts (control = 76.9%, treatment = 60%) than integrated biological science (control = 84.6%, treatment = 70%).

December (see Table 4-20) respondents once again indicated that they felt less prepared to teach integrated physical science concepts (control = 86.4%, treatment = 81.2%) than integrated biological science concepts (control = 90.9%, treatment = 93.7%). However 100% of the respondents agreed that teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.

The third subscale of the ISS examined participants' perceptions of the impact science integration has on student recruitment. Participants responded to how they thought integrating science into the agricultural education program would affect the enrollment of students from five different groups on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). In January (see Table 4-21), almost all respondents indicated a perceived increase in program enrollment for all groups or neither an increase nor decrease in enrollment. The exception was that 37.5% of the treatment group indicated they perceived a decrease in the enrollment of low achieving students when science is integrated into an agricultural program. Nearly all of the respondents in the control group (95.2%) indicated a perceived increase in total program enrollment, as well as enrollment of average achieving students.

May (see Table 4-22) respondents perceived a decrease in enrollment from low achieving students (control = 20.8%, treatment = 4.5%) and minority students (control = 4.2%, treatment = 4.3%). More than two thirds of the respondents perceived an increase in enrollment from high achieving students (control = 70.8%, treatment = 78.2%), average achieving students (control = 75.0%, treatment = 72.7%), and for the total agricultural education program (control = 75.0%, treatment = 73.9%).

In September (see Table 4-23), more than half of the respondents perceived an increase in enrollment for high achieving (control = 66.7%, treatment = 88.9%), average achieving (control = 75.0%, treatment = 77.8%), and low achieving students (control = 50%, treatment = 55.5%), as well as in the total program enrollment (control = 75.0%, treatment = 77.8%). Only 8.3% of the control group and 22.2% of the treatment group reported a perceived decrease in enrollment from low achieving students.

In December (see Table 4-24) 31.8% of the control group and 6.7% of the treatment group perceived a decrease in enrollment of low achieving students when integrating science into agricultural programs. Additionally, 13.6% of the control group and 6.7% of the treatment group reported a perceived decrease in the enrollment of minority students. Nearly all of the respondents perceived an increase in high achieving students enrollment (control = 86.4%, treatment = 100%) when integrating science into their agricultural program.

The fourth subscale of the ISS gathered participant perceptions of the barriers to integrating science into agricultural curriculum using 17 items on a five-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree). It should be noted that all items in this scale were reverse coded, so disagreement with the statement indicated positive perceptions of science integration. In January (see Table 4-25), most respondents agreed with the notion that science integration is necessary (control = 66.6%, treatment = 47.1%), and there is a lack of administrative support for science integration (control = 74.1%, treatment = 47.0%). The most agreed with statements were “concerns about large class size” (control = 44.4%, treatment = 53.0%), “insufficient time and support to plan for implementation” (control = 48.1%, treatment = 52.9%), and “don’t have the necessary materials” (control = 44.4%, treatment = 41.1%), indicating these are barriers to science integration into agriculture courses.

In May (see Table 4-26), a majority of the respondents from both groups disagreed with twelve out of the seventeen items. Similar to January’s respondents, most May respondents disagreed with the notion that science integration is unnecessary (control = 95.7%, treatment = 61.1%), and that there is a lack of administrative support for science integration (control = 66.6%, treatment = 72.2%). Compared to other times during the year, May respondents agreed the most with the statements “concerns about large class size” (control = 41.6%, treatment = 31.6%), “insufficient time and support to plan for implementation” (control = 37.5%, treatment = 57.9%), and “insufficient funding” (control = 58.3%, treatment = 38.9%).

In September (see Table 4-27), all respondents disagreed with the notion that science integration is unnecessary. Additionally, more than half of the respondents disagreed that a lack of parent and community support, lack of support from the local science teacher, concerns about discipline, lack of integrated science curriculum in the courses indicating that these are not barriers to science integration. Although, the lack of administrative support and an insufficient background in science content were identified as barriers to science integration. September respondents agreed the most with the statements “insufficient time and support to plan for implementation” (control =

54.6%, treatment = 88.9%), “insufficient funding” (control = 36.4%, treatment = 66.7%), and “don’t have the necessary materials” (control = 27.3%, treatment = 44.4%), indicating these were also barriers to science integration.

December (see Table 4-28) respondents disagreed that concerns about discipline (control = 90.9%, treatment = 60.0%), the notion that science integration in necessary (control = 100%, treatment = 86.7%), the reluctance to diminish emphasis on agricultural production (control = 77.3%, treatment = 66.7%), doubts about students capacity to handle materials (control = 81.1%, treatment = 60.0%), and insufficient background in science content(control = 68.2%, treatment = 60.0%) were barriers to science integration into the agricultural curriculum. The most agreed with statements in December were “concerns about large class size” (control = 51.4%, treatment = 40.1%), “insufficient time and support to plan for implementation” (control = 40.9%, treatment = 73.3%), “insufficient funding” (control = 31.8%, treatment = 46.7%), and “don’t have the necessary materials” (control = 40.9%, treatment = 33.3%), indicating these are perceived barriers to integrating science into agricultural programs.

In the ISS, participants also indicated their perceived levels of science integration (see Table 4-29). A majority of respondents from both the control and treatment group reported they had integrated science into their agricultural education program (Jan. control = 84%, treatment = 100%; May control = 86.4%, treatment = 94.4%; Sept. control = 100%, treatment = 100%; Dec. control = 95.5%, treatment = 93.8%). The percentage of respondents who indicated they were content with the level to which they were currently integrating science varied between data collection point and group. In January, a majority of both the control and treatment group indicated that they were not content with their levels of science integration (control = 64%, treatment = 69.2). In May, 56.5% of the control group and 47.1% of the treatment group indicated that they were not content with their levels of science integration. In September, Only 9.1% of the control group reported that they were not content with their levels of science integration, while 66.7 of the treatment group indicated that they were not content with their levels of science integration. Finally, in December, 45.5% of the control group and 63.5% of the treatment group indicated that they were not content with the levels to which they integrate science.

Those respondents who indicated that they had integrated science into their agricultural programs were asked to indicate their perceptions of how integration affected the program's enrollment. A majority of teachers indicated that science integration had either no effect on enrollment or an increase in enrollment. The respondents from January and May control groups were the only ones to indicate any decrease in enrollment (Jan. 12%, May 10.5%). Respondents were also asked how about their future plans for the integration of science into their agriculture programs. A majority of respondents indicated they planned to increase science integration in their agriculture programs, at all data collection points (ranging from 62.5% to 83.3%). Only 8.3% of the January control group indicated that they planned to decrease science integration into their programs. A range of respondents, 16.7% to 37.5%, indicated they had no plans for changing their levels of science integration in the future.

Objective Two

Objective two was to describe the NATAA workshop participants' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a Trainer-led professional development workshop. The Inquiry-based Teaching

Techniques (ITT) instruments asks participants to respond to item on two subscales assessing the frequency of IBI teacher practices and IBI student practices. The ITT was administered at all four data collection points and the grand sums were as follows, on a scale of 1 to 210: January was 99.66 (SD = 23.48), May was 95.91 (SD = 20.51), September was 111.88 (SD = 18.00), and December 99.67 (SD = 22.73). Because the two subscales had different selection scales, a grand mean could not be calculated.

The initial subscale assessed by the ITT examined the participants' perceptions of the extent to which they used different teaching methods and activities in general for all of their classes. There was a 7-point Likert scale (0 = Never, 1 = less than once a week, 2 = once a week, 3 = twice a week, 4 = three times a week, 5 = four times a week, and 6 = five times a week). It should be noted that two items were reverse coded. In January (see Table 4-32), the frequency of which the respondents' perceived implementing the different IBI techniques greatly varied. However, the respondents reported using a textbook as the primary method for studying agriscience the least; 32% of the control group and 23.5% of the treatment group reported never using a textbook, while 24% of the control group and 17.6% of the treatment group reported using a textbook less than once a week. This item on the scale represented a non-IBI method. Respondents also reported that they encouraged students to design and conduct experiments less than once per week (control = 22.2%, treatment = 29.4%). In January, 80% of the control group and 70.6% of the treatment group perceived using open-ended questions that encouraged observation, investigation and scientific thinking most frequently, more than once a week. Additionally, more than half of the respondents from both the control group (51.8%) and the treatment group (53%) provided students with a wide variety of resource materials for scientific investigations more than once a week.

In May (see Table 4-33), a number of respondents from both groups chose to omit or skip specific items in this scale. All respondents reported using each of the items at some point in their planning and instruction when implementing IBI. However, 32% of both the control and treatment group reported using a textbook as the primary method for studying agriscience less than once per week. There was great variation in the rest of the responses in May.

In September (see Table 4-34), 100% of the control group and 89.9% of the treatment group reported using a textbook as the primary method for studying agriscience less than once a week. Additionally, respondents perceived that they asked a question or conducted an activity that called for a single correct answer less than once a week (control = 63.7%, treatment = 55.5%). Nearly all respondents perceived having facilitated and encouraged student dialogues about science most frequently (control = 90.9%, treatment = 77.7%), as well as having used open-ended questions that encouraged observation, investigations and scientific thinking (control = 81.9%, treatment = 88.8%). Additionally, more than half of the respondents' reported encouraging students to initiate further investigation (control = 81.9%, treatment = 55.5%), encouraging students to defend the logic of statements or findings (control = 63.7%, treatment = 66.6%), and providing students with a wide variety of resources for scientific investigations (control = 63.7%, treatment = 77.8%) more than once a week.

In December (see Table 4-35), the two most frequently implemented activities were using open-ended questions that encouraged scientific thinking (control = 81.8%, treatment = 75.1%) and providing students with a variety of resources for scientific investigations (control = 72.7%, treatment = 68.9%). Also in December, the respondents reported using a textbook as the primary method for studying agriscience (control = 86.4%, treatment = 75.0%) and asking questions or conducting an activity that calls for a single correct answer (control = 40.9%, treatment = 18.8%) less than once a week.

The respondents were also asked to complete the initial subscale with one specific class in mind, as opposed to a general extent to which they use the different teaching methods and activities. When considering a specific class, the May respondents reported that they used all nine teaching activities at some point (see Table 4-36). Respondents reported using a textbook as the primary method for studying agriscience less than once a week (control = 37.5%, treatment = 47.4%). Also in May, more than two-thirds of all respondents reported using the IBI related items more than once a week.

However, in September (see Table 4-37), there was greater variance in the frequencies with which respondents' reported using the teaching activities. In September, 63.1% of the control group and 100% of the treatment group reported using a textbook less than once a week or never. Additionally, 45.5% of the control group and 44.4% of the treatment group reported using questions or activities that call for a single correct answer less than once a week. Overall, in September no respondents reported using any method more than four times a week.

Similar to the earlier data collection points, December (see Table 4-38) respondents reported never using a textbook (control = 45.5%, treatment = 50.0%) or using it less than once per week (control = 36.4%, treatment = 31.3%). More than half of the respondents indicated using the IBI methods more than once a week, with the exception of encouraging students to design and conduct experiments (control = 40.9%, treatment = 18.9%).

The second subscale of the ITT assessed the participants' perceptions of the frequency of student activities during their classroom instruction. The participants reported how often they asked students in their classroom to complete 12 different activities on a six point scale (0 = never, 1 = once a year, 2 = once a semester, 3 = once a month, 4 = once a week, 5 = once a day). In January (see Table 4-39), a majority of the responses indicated that most respondents perceived using the student activities between once per day and once per month. About 59% of the respondents in the treatment group reported having students seek and recognize patterns once per week. Additionally, 55.6% of the control group reported using drawings, graphing, or charting to convey new information from an agriscience activity. In May (see Table 4-40), all of the respondents reported using the each student activity at some point during the year, however most frequently selected response in May for this scale was once per day.

In September (see Table 4-41), nearly all responses indicated that respondents were asking students to use all the items on the scale at least once a month. The only activity teachers reported never having a student do in their classrooms was memorize scientific facts or information separately from activities (control = 38.5%, treatment = 20.0%), while in December (see Table 4-42), 27.3% of the control group and 12.5% of the treatment group reported never having students memorize facts. The respondents reported asking students once a day to offer explanations from previous experiences and from knowledge gained during investigations (control = 45.5%, treatment = 31.3%)

and make connections to previously held ideas (control = 50.0%, treatment = 37.6%). However, the most frequently selected answer for this subscale in December indicated that respondents asked students to complete all activities once per week.

Objective Three

Objective three was to describe the NATAA workshop participants' utilization of NATAA follow-up support after a Trainer-led professional development workshop. To assess this objective, each participant's correspondence with the Ask-an-expert email was recorded. Additional descriptive questions were asked in the May, September, and December surveys to help assess the teachers' perceptions of follow-up support as they implemented what they learned in the NATAA workshops.

Throughout the study only three participants (1 control group, 2 treatment group) ever contacted the Ask-an-expert email (see Table 4-43). Two of the emails were received in August and one was received in September. Each email was introductory in nature and confirming that they had attended the NATAA workshop and wanted to ensure they had the correct email address if they needed support. The researcher provided the confirmation for each participant within a day of receiving the email. However, none of the participants' ever contacted the Ask-an-expert email again to seek support with science integration in agriculture and implementing IBI.

Respondents were asked to respond to a series of questions related to their support while implementing the NATAA workshop content (see Table 4-44). A majority of respondents reported seeking support for implementing the content of the NATAA workshop. However, no respondents reported utilizing the Ask-an-Expert email support system. Additionally, majority of respondents reported that they the person they sought support from did not attend the NATAA workshop with them. When asked if there were other support structures that could be developed to help teachers implement NATAA workshop content, the respondents were split between wanting supports and not wanting supports.

In December, respondents were asked to explain why they had not utilized the ask-an-expert email. The most frequent response indicated the respondent was unaware of the existence of the ask-an-expert follow-up support (control = 5, treatment = 6). Other respondents indicated they didn't know enough about ask-an-expert to use it (control = 1, treatment = 4). Additional respondents indicated they didn't think about using the ask-an-expert (control = 4, treatment = 0) or they forgot about it (control = 2, treatment = 1). One respondent from the control group indicated they utilized a personal contact, while another indicated they didn't feel they needed the support. Six respondents (control = 4, treatment = 2) indicated lack of time was the reason they did not utilize the ask-an-expert email support system.

Objective Four

Objective four was to determine the effects of follow-up on NATAA workshop participant's perceptions of science integration in agriculture and IBI. Due to the lack of participation in experimental follow-up, an analysis of the effects of the follow up could not be completed.

Objective Five

Objective five was to determine the relationship between NATAA workshop participants' perceptions of agriscience integration and IBI and selected elements of the high-quality teacher professional development model (teacher variables, professional development program variables, school culture and other professional development). To accomplish this objective, Pearson's Product Moment Correlations were calculated between the selected variables with continuous data, and point biserial correlations were calculated for dichotomous data. As the previous objective found no significant difference between the control group and the treatment group, the correlations were calculated for the total respondents. The magnitudes of the associations among variables were reported using Davis's conventions (1971), which denotes zero as no association between variables and 1.00 as a perfect relationship. Additionally, Davis noted that relationships between .01 and .09 were reported to be negligible, those between .10 and .29 were low, those between .30 and .49 were moderate, and those greater than .50 were substantial. Table 4-47 shows the matrix of the correlations in January, Table 4-48 shows the matrix for May, Table 4-49 shows the matrix for September and Table 4-50 shows the matrix for December.

The two dependent variables within this study, agriscience Integration (ISS scale) and IBI (ITT scale), were found to have moderate positive relationships at three of the data collection points (Jan. r = .35, Sept. r = .45, Dec. r = .43). Additionally, a low positive correlation was found between science integration in agriculture and IBI in May (r = .21).

Only three positive substantial relationships were found between the study's dependent variables and independent variables related to high-quality professional development. In September and December, a positive substantial correlation existed between the ISS and the Core Facet of Coherence (Sept. r = .59, Dec. r = .68). In December, an additional positive substantial correlation was calculated between the ISS and respondents' who reported that they had conducted scientific research (r = .65). Three negative substantial correlations were calculated in the September data, between the ISS and the core facet of time (*r* = -.50), the collaborative leadership construct of school culture (*r* = -.52), and the professional development construct of school culture (*r* = -.52).

In January, moderate and low magnitude correlations were found when examining the relationship between the ISS and ITT, and the elements of high-quality professional development (see Table 4-47). A positive moderate correlation was found between the ISS and the number of years respondents reported being a teacher (*r* = .32). Also in January, a positive low relationship existed between the ISS and those respondents who were female (*r* = .12) as well as between the ISS and the respondents' ages (*r* = .16).

Additionally in January, negative low relationships were found between the ISS and respondents who had formed collaborative relationships (*r* = -.28), respondents who had previously participated in an NATAA workshop (*r* = -.18), and respondents who reported they had conducted scientific research (*r* = -.10). There were also low positive and negative correlations found in relation to the respondents ITT. A low positive relationship was found between the ITT and respondents who had previously attended a NATAA workshop (*r* = .10), respondents who were female (*r* = .12), and respondents who had formed collaborative relationships (*r* = .15). A low negative relationship was found between ITT and respondents who had previously conducted scientific research (*r* = .22).

In May, two positive low correlations were found between the ISS and two independent variables; those who has sought support for science integration (*r* = .14) and those who had integrated science into the curriculum (*r* = -.22) (see Table 4-48). In regards to relationships between ITT and the independent variables both moderate and low correlations were found. There was a positive moderate correlation between the ITT and respondents who had integrated science into the curriculum (*r* = .40) and those who were content with their levels of science integration (*r* = .31). Two low positive relationships were identified between the ITT and those who had formed collaborative relationships (*r* =.23) and those who had sought support for science integration (*r* = .29).

In September, three moderate correlations were found between the ISS and independent variables (see Table 4-49). A positive moderate correlation was found between the ISS and the core facet of active participation (*r* = .40) as well as for respondents who had sought support for science integration (*r* = .33). A negative moderate correlation as found between the ITT and the overall school culture survey (*r* = -.52). Additional low associations were identified in September in relation to the ISS. The ISS was found to have a positive relationship of low magnitude with the teacher collaboration construct of school culture (*r* = .21) and respondents who had formed collaborative relationships (*r* = .26). A low negative association was identified between the ISS and unity of purpose of school culture (*r* = -.17) and collegial support in school culture (*r* = -.16).

Additional associations were found between ITT and the independent variables of the study in September (see Table 4-49). The ITT was found to be moderately negatively associated with the constructs of the core facet element of time (*r* = -.35), the collaborative leadership element of school culture (*r* = -.45) and respondents who sought support for science integration (*r* = -.39). A positive moderate association existed between the ITT and the core facet of active participation (*r* = .35). The ITT was also found to have positive low associations with the core facet of coherence (*r* = .15) and the respondents' perceptions of teacher collaboration in school culture (*r* = .29). Negative low correlations were found between the ITT and their overall perceptions of school culture (*r* = -.21), perceptions of professional development in school culture (*r* = -.24), the unity of purpose in school culture (*r* = -.24), the collegial support in school culture (*r* = -.13), and those teachers who formed collaborative relationships (*r* = -.19).

In December, positive and negative low associations were found between the ISS and independent variables (see Table 4-50). The teachers' perceptions of science integration in agriculture were positively associated in low magnitude with the core facet of active participation (*r* = .14), respondents who had integrated science into their curriculum (*r* = .26), and respondents who reported they had formed collaborative relationships (*r* = .21). Additionally, low negative associations were found between the ISS and teachers perceptions of school culture: overall school culture(*r* = -.17), collaborative leadership in school culture (*r* = -.22), teacher collaboration in school culture (*r* = -.23), professional development in school culture (*r* = -.23) and learning partnerships in school culture (*r* = -.12).

Also in December, moderate and low associations were found between teachers' use of IBI and various independent variables (see Table 4-50). The ITT was found to be moderately positively associated with teachers who reported that they integrated science into their curriculum (*r* = .30), formed collaborative relationships (*r* = .40), and conducted scientific research (*r* = .34). The ITT was also found to have a low positive association with teachers' attitudes towards professional development (*r* = .13). The ITT was found to be moderately negatively associated with teachers' perceptions of school culture: overall school culture (r = -.42), teacher collaboration in school culture (r = -.31), professional development in school culture (r = -.33), unity of purpose in school culture (r = -.33) and learning partnerships in school culture (r = -.31). Additional negative correlations of low magnitude were found between ITT and the core facet of coherence (r = -.15), and active participation (r = -.17), as well as teachers' perceptions of collaborative leadership in school culture (r = -.26), and collegial support in school culture (r = -.17).

Objective Six

Objective six was to predict teacher perceptions of science integration in agriculture and IBI based on the elements of the high-quality teacher professional development model. Regression analyses were performed for each of the dependent variables to better explain the contributions of the independent variables. All regression models used a variety of the independent variables - Integrated Science Scale, Inquiry-based Teaching Techniques, School Culture Survey, Core Facets of Coherence and Active Participation, and the Teacher Attitudes towards Professional Development - at different data collection points throughout the study.

First, regression analyses were conducted in relation to the teachers' integrated science scores (ISS) as the dependent variable. Five models were discovered which provided significant predictors to science integration in agriculture as a dependent variable. In January, the regression model included only the ITT (R^2_{adj} = .346, p < .05), which was found to be a significant predictor. In September, two models were found to be significant predictors of the ISS. Model two included the ITT (p = .002) and SCS (p = .002) as significant predictors (R^2_{adj} = .875, p < .01) , while model three included ITT (p = .015), SCS (p = .003), core facet of coherence (p = .441) and core facet of active participation (p = .224) as significant predictors of the ISS(R^2_{adj} = .940, p < .01). In December, two additional models were found to be significant. The portion of the ISS due to model three, which included the ITT (p = .086), SCS (p = .219), and the core facet of coherence (p = .004) (R^2_{adj} = .652, p < .01), was significant. Additionally, the portion of ISS due to model four, which included the ITT (p = .080), SCS (p = .197), core facet of coherence (p = .004), and the TAP (p = .410), was also found to be a significant predictor (R^2_{adj} = .674, p < .01).

Additional multiple regression analysis were conducted with the ITT as the dependent variable. Only 3 models were found to be significant predictors of the ITT throughout the duration of the study. In January, the ISS was found to be a significant predictor of the ITT (R^2_{adj} = .346, p < .05). Additionally, in September, the second model, which included the ISS (p = .002) and SCS (p = .005), was found to be significant predictors of the ITT (R^2_{adj} = .828, p < .01). Also in September, the third model, which included the ISS (p = .015), SCS (p = .019), core facet of coherence (p = .775), and core facet of active participation (p = .317), was found to be a significant predictor (R^2_{adj} = .877, p < .05).

Table 4-1. Treatment group membership and participant totals

Treatment Group	# of Teachers	Requested Removal	Incomplete Contact Information in January	Totals in January	Incomplete Contact Information in September	Totals in September
Control Group	121	14	16	91	12	79
Experimental Group	121	14	26	81	12	69
Total	242			172		148

Table 4-2. Response rates for data collection components

	N	*n*	Response Rate
January Data Collection	172	53	30.81%
May Data Collection	172	50	29.06%
September Data Collection	148	25	16.89%
December Data Collection	148	38	25.67%

Table 4-3. PostHoc reliability of instruments

	Reliability Coefficient (α)			
Instrument	January	May	September	December
ISS	.96	.96	.86	.89
ITT	.99	.90	.86	.92
SCS			.94	.95
Collaborative Leadership			.88	.85
Teacher Collaboration			.79	.81
Professional Development			.79	.76
Unity of Purpose			.81	.88
Collegial Support			.78	.69
Learning Partnerships			.69	.73
Core Facets				
Coherence			.91	.84
Active Participation			.92	.84
TAP				.75

Table 4-4. Demographic profile of respondents

	Control Group	Treatment Group
Years of teaching experience	*M* = 15.03 (SD = 9.76)	*M* = 14.61 (SD = 7.99)
Years taught at current school	*M* = 9.11 (SD = 7.13)	*M* = 9.67 (SD = 7.12)
Age	*M* = 38.92 (SD = 12.29)	*M* = 41.08 (SD = 10.32)
Number of students who participate in the Agriscience Fair each year	*M* = 13.71 (SD = 29.87)	*M* = 25.212 (SD = 17.56)
Gender		
Female	61.8%	59.1%
Male	38.2%	40.9%
Highest level of post-secondary education		
Bachelor's degree	13.9%	8.3%
Bachelor's degree plus some graduate courses	19.4%	29.2%
Master's degree	38.9%	37.5%
Master's degree plus additional graduate courses	25%	12.5%
Specialist's degree	2.8%	8.3%
Doctoral degree	0.0%	4.2%
Previously attended an NATAA workshop	58.3%	43.5%
Attended other Agriscience Integration workshops	54.1%	56.5%
Conducted scientific research	41.7%	45.8%

Note. Control group n = 37, Treatment group n = 23.

Table 4-5. December respondents' attitude toward professional development[a]

	Percent					
	SD[b]	D	N	A	SA	O
Professional development workshops often help teachers to develop new teaching techniques.	0.0 0.0	0.0 6.3	0.0 6.3	40.9 50.0	40.9 31.3	18.2 6.3
If I did not have to attend inservice workshops I would not be able to improve my teaching.	4.5 6.3	13.6 37.5	9.1 0.0	27.3 31.3	22.7 12.5	22.7 12.5
Professional development events are worth the time they take.	13.6 6.3	4.5 6.3	4.5 0.0	45.5 37.5	31.8 50.0	0.0 0.0
I have been enriched by the teacher training events I have attended.	0.0 0.0	0.0 0.0	0.0 0.0	55.6 46.7	44.4 53.3	0.0 0.0
Staff development initiatives have NOT had much impact on my teaching.[c]	27.3 31.3	40.9 43.8	9.1 12.5	13.6 12.5	4.5 0.0	4.5 0.0

Note. [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 16). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted. [c] Item is reverse coded.

Table 4-6. Means for school culture survey

	September		December	
	Mean	SD	Mean	SD
	Scale			
School Culture Survey	3.20	.57	3.31	.56
	Subscale			
Collaborative Leadership	2.96	.62	3.36	.58
Teacher Collaboration	2.73	.67	2.79	.71
Professional Development	3.43	.72	3.48	.78
Unity of Purpose	3.23	.74	3.56	.69
Collegial Support	3.28	.82	3.59	.60
Learning Partnerships	3.15	.63	3.07	.75

Note. September *n* = 20. December n = 38

Table 4-7. September respondents' perceptions of school culture[a]

	Percent				
	SD[b]	D	N	A	SA
Collaborative Leadership					
Leaders value teachers' ideas.	0.0 0.0	0.0 0.0	33.3 16.7	55.6 83.3	11.1 0.0
Leaders in this school trust the professional judgments of teachers.	11.1 0.0	11.1 0.0	22.2 33.3	44.4 50.0	11.1 16.7
Leaders take time to praise teachers that perform well.	11.1 16.7	11.1 33.3	11.1 33.3	66.7 16.7	0.0 0.0
Teachers are involved in the decision-making process.	11.1 0.0	11.1 16.7	44.4 50.0	33.3 16.7	0.0 16.7
Leaders in our school facilitate teachers working together.	11.1 0.0	11.1 40.0	22.2 40.0	55.6 20.0	0.0 0.0
Teachers are kept informed on current issues in the school.	11.1 16.7	33.3 50.0	11.1 0.0	44.4 33.3	0.0 0.0
My involvement in policy or decision making is taken seriously.	11.1 16.7	11.1 0.0	33.3 33.3	44.4 50.0	0.0 0.0
Teachers are rewarded for experimenting with new ideas and techniques.	0.0 0.0	11.1 16.7	55.6 33.3	33.3 33.3	0.0 16.7
Leaders support risk-taking and innovation in teaching.	0.0 0.0	33.3 50.0	11.1 0.0	55.6 50.0	0.0 0.0
Administrators protect instruction and planning time.	11.1 16.7	22.2 16.7	22.2 0.0	33.3 66.7	11.1 0.0
Teachers are encouraged to share ideas.	11.1 16.7	11.1 0.0	0.0 33.3	77.8 33.3	0.0 16.7
Teacher Collaboration					
Teachers have opportunities for dialogue and planning across grades and subjects.	0.0 0.0	11.1 16.7	33.3 16.7	33.3 33.3	22.2 33.3
Teachers spend considerable time planning together.	11.1 16.7	66.7 50.0	11.1 0.0	11.1 33.3	0.0 0.0
Teachers take time to observe each other teaching.	22.2 50.0	44.4 16.7	11.1 16.7	22.2 16.7	0.0 0.0
Teachers are generally aware of what other teachers are teaching.	0.0 0.0	88.9 50.0	11.1 16.7	0.0 33.3	0.0 0.0
Teachers work together to develop and evaluate programs and projects.	0.0 0.0	22.2 50.0	33.3 16.7	44.4 33.3	0.0 0.0
Teaching practice disagreements are voiced openly and discussed.	0.0 0.0	44.4 66.7	44.4 16.7	11.1 16.7	0.0 0.0

Table 4-7. Continued

	SD	D	N	A	SA
	Percent				
Professional Development					
Teachers utilize professional networks to obtain information and resources for classroom instruction.	0.0 0.0	0.0 0.0	11.1 0.0	77.8 66.7	11.1 33.3
Teachers regularly seek ideas from seminars, colleagues, and conferences.	11.1 0.0	11.1 50.0	11.1 16.7	66.7 33.3	0.0 0.0
Professional development is valued by the faculty.	11.1 16.7	33.3 0.0	0.0 50.0	55.6 33.3	0.0 0.0
Teachers maintain a current knowledge base about the learning process.	11.1 0.0	11.1 16.7	0.0 50.0	77.8 33.3	0.0 0.0
The faculty values school improvement.	0.0 16.7	11.1 16.7	11.1 0.0	66.7 66.7	11.1 0.0
Unity of Purpose					
Teachers support the mission of the school.	0.0 16.7	22.2 13.3	22.2 16.7	55.6 16.7	0.0 16.7
The school mission provides a clear sense of direction for teachers.	11.1 0.0	22.2 16.7	11.1 33.3	55.6 50.0	0.0 0.0
Teachers understand the mission of the school.	0.0 0.0	33.3 33.3	22.2 16.7	44.4 50.0	0.0 0.0
The school mission statement reflects the values of the community.	0.0 0.0	33.3 0.0	22.2 16.7	44.4 83.3	0.0 0.0
Teaching performance reflects the mission of the school.	0.0 16.7	22.2 16.7	0.0 33.3	77.8 33.3	0.0 0.0
Collegial Support					
Teachers trust each other.	0.0 0.0	22.2 33.3	11.1 0.0	55.6 50.0	11.1 16.7
Teachers are willing to help out whenever there is a problem.	0.0 0.0	22.2 33.3	11.1 16.7	55.6 33.3	11.1 16.7
Teachers' ideas are valued by other teachers.	11.1 0.0	11.1 50.0	0.0 0.0	77.8 33.3	0.0 16.7
Teachers work cooperatively in groups.	11.1 0.0	33.3 33.3	44.4 16.7	11.1 50.0	0.0 0.0
Learning Partnerships					
Teachers and parents have common expectations for student performance.	0.0 0.0	22.2 33.3	22.2 33.3	44.4 33.3	11.1 0.0
Parents trust teachers' professional judgments.	11.1 33.3	22.2 33.3	44.4 16.7	22.2 16.7	0.0 0.0
Teachers and parents communicate frequently about student performance.	0.0 0.0	0.0 16.7	11.1 33.3	88.9 16.7	0.0 33.3
Students generally accept responsibility for their schooling, for example they engage mentally in class and complete homework assignments.	0.0 16.7	33.3 16.7	22.2 33.3	44.4 33.3	0.0 0.0

Note. [a] Control group data are presented on the first level within a row (*n* = 13), Treatment group data are on the second level (*n* = 6). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-8. December respondents' perceptions of school culture[a]

	Percent				
	SD[b]	D	N	A	SA
Collaborative Leadership					
Leaders value teachers' ideas.	20.0 6.7	5.0 0.0	5.0 20.0	60.0 73.3	10.0 0.0
Leaders in this school trust the professional judgments of teachers.	13.6 6.7	13.6 13.3	13.6 20.0	50.0 60.0	9.1 0.0
Leaders take time to praise teachers that perform well.	11.1 0.0	16.7 7.1	11.1 21.4	55.6 64.3	5.6 7.1
Teachers are involved in the decision-making process.	5.6 0.0	22.2 14.3	16.7 28.6	55.6 57.1	0.0 0.0
Leaders in our school facilitate teachers working together.	5.6 7.1	22.2 14.3	5.6 7.1	66.7 64.3	0.0 7.1
Teachers are kept informed on current issues in the school.	5.6 0.0	22.2 21.4	16.7 14.3	55.6 64.3	0.0 0.0
My involvement in policy or decision making is taken seriously.	0.0 0.0	16.7 14.3	38.9 21.4	44.4 64.3	0.0 0.0
Teachers are rewarded for experimenting with new ideas and techniques.	5.6 14.3	44.4 28.6	22.2 28.6	27.8 28.6	0.0 0.0
Leaders support risk-taking and innovation in teaching.	5.6 0.0	27.8 28.6	22.2 14.3	44.4 57.1	0.0 0.0
Administrators protect instruction and planning time.	0.0 14.3	22.2 14.3	22.2 21.4	55.6 50.0	0.0 0.0
Teachers are encouraged to share ideas.	0.0 7.1	11.1 0.0	11.1 21.4	72.2 64.3	5.6 7.1
Teacher Collaboration					
Teachers have opportunities for dialogue and planning across grades and subjects.	10.5 0.0	15.8 35.7	5.3 21.4	63.2 42.9	5.3 0.0
Teachers spend considerable time planning together.	10.0 26.7	30.0 26.7	30.0 20.0	20.0 20.0	10.0 6.7
Teachers take time to observe each other teaching.	16.7 21.4	50.0 50.0	16.7 7.1	16.7 21.4	0.0 0.0
Teachers are generally aware of what other teachers are teaching.	11.1 7.1	38.9 57.1	27.8 0.0	16.7 35.7	5.6 0.0
Teachers work together to develop and evaluate programs and projects.	5.6 14.3	16.7 21.4	16.7 28.6	55.6 35.7	5.6 0.0
Teaching practice disagreements are voiced openly and discussed.	0.0 14.3	41.2 21.4	35.3 42.9	23.5 21.4	0.0 0.0

Table 4-8. Continued

Professional Development					
Teachers utilize professional networks to obtain information and resources for classroom instruction.	10.0 6.7	5.0 0.0	5.0 6.7	55.0 80.0	25.0 6.7
Teachers regularly seek ideas from seminars, colleagues, and conferences.	5.6 0.0	11.1 21.4	22.2 21.4	44.4 42.9	16.7 14.3
Professional development is valued by the faculty.	5.6 7.1	27.8 7.1	22.2 28.6	44.4 42.6	0.0 14.3
Teachers maintain a current knowledge base about the learning process.	0.0 7.1	5.6 14.3	22.2 0.0	66.7 71.4	0.0 7.1
The faculty values school improvement.	0.0 7.1	5.6 0.0	0.0 7.1	88.9 78.6	5.6 7.1
Unity of Purpose					
Teachers support the mission of the school.	0.0 0.0	5.6 0.0	5.6 14.3	83.3 85.7	5.6 0.0
The school mission provides a clear sense of direction for teachers.	11.1 0.0	5.6 21.4	16.7 21.4	61.1 50.0	5.6 7.1
Teachers understand the mission of the school.	11.1 0.0	11.1 0.0	11.1 28.6	61.1 71.4	5.6 0.0
The school mission statement reflects the values of the community.	5.6 7.1	11.1 7.1	33.3 28.6	44.4 57.1	5.6 0.0
Teaching performance reflects the mission of the school.	0.0 7.1	0.0 7.1	38.9 14.3	55.6 71.4	5.6 0.0
Collegial Support					
Teachers trust each other.	19.0 6.7	4.8 6.7	23.8 33.3	42.9 46.7	9.5 6.7
Teachers are willing to help out whenever there is a problem.	9.1 6.7	9.1 13.3	22.7 6.7	45.5 60.0	13.6 13.3
Teachers' ideas are valued by other teachers.	5.6 0.0	0.0 7.1	11.1 21.4	77.8 71.4	5.6 0.0
Teachers work cooperatively in groups.	0.0 14.3	16.7 14.3	33.3 14.3	50.0 57.1	0.0 0.0
Learning Partnerships					
Teachers and parents have common expectations for student performance.	5.6 7.1	27.8 35.7	22.2 28.6	44.4 21.4	0.0 7.1
Parents trust teachers' professional judgments.	11.1 7.1	11.1 21.4	33.3 35.7	44.4 35.7	0.0 0.0
Teachers and parents communicate frequently about student performance.	0.0 14.3	11.1 14.3	33.3 7.1	55.6 57.1	0.0 7.1
Students generally accept responsibility for their schooling, for example they engage mentally in class and complete homework assignments.	0.0 21.4	38.9 21.4	27.8 21.4	27.8 35.7	5.6 0.0

Note. [a] Control group data are presented on the first level within a row (n = 22), Treatment group data are on the second level (n = 16). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-9. Respondents' perceptions of the core facet of professional development of duration during NATAA workshops[a]

	Percent Yes	Percent No
September		
Length of time was adequate for you to gain the knowledge and practices needed to implement content in my classroom	77.8 83.3	22.2 16.7
December		
Length of time was adequate for you to gain the knowledge and practices needed to implement content in my classroom	59.1 74.9	40.9 25.1

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. September: Control group *n* = 9, Treatment group *n* = 6. December: Control group *n* = 17, Treatment group *n* = 16.

Table 4-10. Respondents' perceptions of the core facets of professional development of collective participation during NATAA workshops[a]

	Percent Yes	Percent No
September		
Teachers and/or administrators from my <u>school</u> participated in the workshop with me.	0.0 16.7	100 83.3
Teachers and/or administrators from my <u>school district</u> participated in the workshop with me.	0.0 33.3	100 66.7
Teachers and/or administrators from my <u>state</u> participated in the workshop with me.	55.6 66.7	44.4 33.3
December		
Teachers and/or administrators from my <u>school</u> participated in the workshop with me.	5.6 13.3	94.4 86.7
Teachers and/or administrators from my <u>school district</u> participated in the workshop with me.	5.6 13.3	94.4 86.7
Teachers and/or administrators from my <u>state</u> participated in the workshop with me.	41.7 46.7	58.3 53.3

Note: [a] Control group data is presented on the first level within a row, Treatment group data is on the second level. September: Control group *n* = 8, Treatment group n = 6. December: Control group *n* = 18, Treatment group *n* = 15.

Table 4-11. September respondents' perceptions of the core facets of professional development of coherence during NATAA workshops[a]

	Percent				
	SD[b]	D	N	A	SA
September					
The workshop aligned with my individual beliefs concerning science integration in agriculture.	11.1 0.0	0.0 0.0	11.1 16.7	55.6 50.0	22.2 33.3
The workshop aligned with my prior knowledge about science integration in agriculture.	11.1 0.0	0.0 16.7	0.0 0.0	77.8 66.7	11.1 16.7
The workshop aligned with my teaching practices related to science integration in agriculture.	11.1 0.0	22.2 16.7	22.2 0.0	33.3 50.0	11.1 33.3
The workshop aligned with the policies or practices in my school or school district.	11.1 0.0	11.1 16.7	33.3 16.7	33.3 50.0	11.1 16.7
The workshop aligned with the policies or practices at the state or national level.	11.1 0.0	11.1 0.0	33.3 33.3	33.3 50.0	11.1 16.7
The workshop aligned with my previous professional development experiences.	11.1 16.7	0.0 0.0	33.3 0.0	44.4 50.0	11.1 33.3
December					
The workshop aligned with my individual beliefs concerning science integration in agriculture.	0.0 0.0	5.6 0.0	5.6 6.7	77.8 66.7	11.1 26.7
The workshop aligned with my prior knowledge about science integration in agriculture.	0.0 0.0	5.6 6.7	0.0 20.0	77.8 46.7	16.7 26.7
The workshop aligned with my teaching practices related to science integration in agriculture.	0.0 0.0	5.6 7.1	5.6 21.4	72.2 57.1	16.7 14.3
The workshop aligned with the policies or practices in my school or school district.	0.0 0.0	4.8 13.3	9.5 20.0	76.2 66.7	09.5 0.0
The workshop aligned with the policies or practices at the state or national level.	14.3 6.7	4.8 0.0	9.5 26.7	57.1 66.7	14.3 0.0
The workshop aligned with my previous professional development experiences.	0.0 0.0	0.0 0.0	16.7 21.4	77.8 64.3	5.6 14.3

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. September : Control group n = 9, Treatment group n = 6; December: Control group n = 18, Treatment group n = 15. [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-12. December respondents' perceptions of the core facets of professional development of active participation during NATAA workshops[a]

	Percent				
	SD[b]	D	N	A	SA
September					
I had the opportunity to witness modeling of inquiry-based instructional strategies.	12.5 0.0	0.0 0.0	0.0 16.7	50.0 16.7	37.5 66.7
I had the opportunity to ask questions and have them answered.	12.5 0.0	0.0 0.0	0.0 0.0	62.5 33.3	25.0 66.7
I had the opportunity to discuss my concerns about implementation of workshop content in my own classrooms.	12.5 0.0	25.0 0.0	25.0 16.7	25.0 66.7	12.5 16.7
I had the opportunity to participate in activities that enhanced my ability to teach the content area in my own classroom.	12.5 0.0	0.0 0.0	0.0 0.0	62.5 50.0	25.0 50.0
I had the opportunity to discuss examples of students' work related to the workshop content.	12.5 0.0	0.0 16.7	37.5 50.0	37.5 33.3	12.5 0.0
I had the opportunity to work with other agriculture teachers in planning for the implementation of the workshop content.	25.0 0.0	37.5 16.7	25.0 33.3	12.5 33.3	0.0 16.7
I had the opportunity to discuss the student activity/experiment provided by the workshop.	12.5 0.0	25.0 0.0	0.0 16.7	50.0 50.0	12.5 33.3
I had the opportunity to complete the student activity/experiment provided by the workshop.	12.5 0.0	0.0 16.7	0.0 0.0	62.5 50.0	25.0 33.3
December					
I had the opportunity to witness modeling of inquiry-based instructional strategies.	19.0 0.0	4.8 0.0	4.8 7.1	57.1 57.1	14.3 35.7
I had the opportunity to ask questions and have them answered.	0.0 0.0	5.9 0.0	0.0 0.0	82.4 76.9	11.8 11.8
I had the opportunity to discuss my concerns about implementation of workshop content in my own classrooms.	0.0 7.1	11.8 7.1	5.9 0.0	70.3 78.6	11.8 7.1
I had the opportunity to participate in activities that enhanced my ability to teach the content area in my own classroom.	0.0 0.0	5.9 0.0	0.0 14.3	70.6 50.0	23.5 35.7
I had the opportunity to discuss examples of students' work related to the workshop content.	0.0 7.1	11.8 7.1	5.9 28.6	70.6 35.7	11.8 21.4
I had the opportunity to work with other agriculture teachers in planning for the implementation of the workshop content.	0.0 7.1	17.6 21.4	5.9 7.1	64.7 57.1	11.8 7.1
I had the opportunity to discuss the student activity/experiment provided by the workshop.	0.0 7.1	0.0 0.0	0.0 7.1	88.2 78.6	11.8 7.1
I had the opportunity to complete the student activity/experiment provided by the workshop.	0.0 0.0	5.9 7.1	5.9 0.0	70.6 78.6	17.6 14.3

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. September: Control group n = 8, Treatment group n = 6; December: Control group n = 22, Treatment group n = 16. [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-13. January respondents' perceptions toward the integration of science[a]

	Percent				
	SD[b]	D	N	A	SA
Students learn more about agriculture when science concepts are an integral part of their instruction.	18.5 5.9	3.7 0.0	3.7 0.0	29.6 47.1	44.4 47.1
Students are more motivated to learn when science is integrated into the agricultural education program.	0.0 0.0	0.0 0.0	29.6 29.4	44.4 41.2	25.9 29.4
Agriculture concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	3.7 11.8	14.8 17.6	48.1 41.2	33.3 29.4
Science concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	0.0 0.0	0.0 0.0	22.2 11.8	77.8 88.2
Integrating science into the agricultural education program requires more preparation time than teaching a more traditional agriculture curriculum.	0.0 0.0	3.7 11.8	14.8 23.5	33.3 17.6	48.1 47.1
Less effort is required to integrate science in advanced courses as compared to introductory courses.	3.7 17.6	44.4 23.5	25.9 41.2	3.7 5.9	22.2 11.8
Integrating science into agriculture classes increases the ability to teach students to solve problems.	3.7 0.0	11.1 0.0	3.7 0.0	25.9 47.1	55.6 52.9
Integrating science into the agricultural education curriculum more effectively meets the needs of special population students (i.e. learning disabled).	3.7 5.9	0.0 0.0	22.2 41.2	51.9 17.6	22.2 29.4
It is more appropriate to integrate science in advanced courses than into introductory courses.	18.5 17.6	25.9 47.1	29.6 17.6	14.8 17.6	7.4 0.0
Students are more aware of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction in agricultural education.	3.7 5.9	11.1 5.9	3.7 5.9	18.5 35.3	63.0 47.1
Students are better prepared in science after they completed a course in agricultural education that integrates science.	0.0 0.0	0.0 0.0	0.0 0.0	18.5 29.4	81.5 70.6

Note: [a] Control group data are presented on the first level within a row (*n* = 27), Treatment group data are on the second level (*n* = 17). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-14. May respondents' perceptions toward the integration of science [a]

	Percent					
	SD[b]	D	N	A	SA	O
Students learn more about agriculture when science concepts are an integral part of their instruction.	0.0 0.0	0.0 0.0	8.0 4.0	40.0 44.4	48.8 52.0	4.0 0.0
Students are more motivated to learn when science is integrated into the agricultural education program.	0.0 0.0	8.0 0.0	16.0 16.0	40.0 44.0	32.0 36.0	4.0 4.0
Agriculture concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	8.0 0.0	8.0 12.0	40.0 48.0	40.0 36.0	4.0 4.0
Science concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	0.0 0.0	8.0 0.0	28.0 24.0	60.0 72.0	4.0 4.0
Integrating science into the agricultural education program requires more preparation time than teaching a more traditional agriculture curriculum.	4.0 0.0	8.0 12.0	8.0 20.0	40.0 28.0	36.0 40.0	4.0 0.0
Less effort is required to integrate science in advanced courses as compared to introductory courses.	4.0 8.0	44.0 28.0	20.0 28.0	20.0 24.0	8.0 8.0	4.0 4.0
Integrating science into agriculture classes increases the ability to teach students to solve problems.	0.0 0.0	0.0 0.0	4.0 15.0	48.0 40.0	40.0 48.0	8.0 0.0
Integrating science into the agricultural education curriculum more effectively meets the needs of special population students (i.e. learning disabled).	0.0 0.0	16.0 4.0	28.0 36.0	24.0 44.0	20.0 12.0	12.0 4.0
It is more appropriate to integrate science in advanced courses than into introductory courses.	16.0 4.0	52.0 40.0	24.0 32.0	0.0 16.0	0.0 8.0	8.0 0.0
Students are <u>more aware</u> of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction in agricultural education.	0.0 0.0	0.0 0.0	4.0 8.0	48.0 36.0	36.0 36.0	12.0 0.0
Students are <u>better prepared</u> in science after they completed a course in agricultural education that integrates science.	0.0 0.0	0.0 0.0	12.0 4.0	24.0 32.0	60.0 64.0	4.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 25), Treatment group data are on the second level (*n* = 25). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted.

Table 4-15. September respondents' perceptions toward the integration of science[a]

	Percent				
	SD[b]	D	N	A	SA
Students learn more about agriculture when science concepts are an integral part of their instruction.	0.0 0.0	15.4 0.0	7.7 0.0	38.5 20.0	38.5 80.0
Students are more motivated to learn when science is integrated into the agricultural education program.	0.0 0.0	15.4 0.0	23.1 10.0	30.8 30.0	30.8 60.0
Agriculture concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	23.1 0.0	15.4 10.0	46.2 30.0	15.4 60.0
Science concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0 0.0	0.0 0.0	0.0 0.0	23.1 10.0	76.9 90.0
Integrating science into the agricultural education program requires more preparation time than teaching a more traditional agriculture curriculum.	0.0 0.0	53.8 10.0	0.0 60.0	7.7 10.0	38.5 20.0
Less effort is required to integrate science in advanced courses as compared to introductory courses.	0.0 10.0	76.9 30.0	0.0 30.0	23.1 0.0	0.0 20.0
Integrating science into agriculture classes increases the ability to teach students to solve problems.	0.0 0.0	23.1 0.0	23.1 10.0	23.1 50.0	30.8 40.0
Integrating science into the agricultural education curriculum more effectively meets the needs of special population students (i.e. learning disabled).	0.0 0.0	38.5 0.0	7.7 10.0	30.8 60.0	23.1 30.0
It is more appropriate to integrate science in advanced courses than into introductory courses.	7.7 20.0	61.5 40.0	30.8 0.0	0.0 20.0	0.0 20.0
Students are <u>more aware</u> of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction in agricultural education.	0.0 0.0	0.0 0.0	7.7 0.0	23.1 40.0	69.2 60.0
Students are <u>better prepared</u> in science after they completed a course in agricultural education that integrates science.	0.0 0.0	0.0 0.0	0.0 10.0	7.7 0.0	92.3 90.0

Note: [a] Control group data are presented on the first level within a row (*n* = 13), Treatment group data are on the second level (*n* = 10). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-16. December respondents' perceptions toward the integration of science[a]

	Percent					
	SD[b]	D	N	A	SA	O
Students learn more about agriculture when science concepts are an integral part of their instruction.	0.0	4.5	9.1	36.5	50.0	0.0
	0.0	0.0	12.5	37.5	50.0	0.0
Students are more motivated to learn when science is integrated into the agricultural education program.	0.0	9.1	18.2	36.4	36.4	0.0
	0.0	6.3	18.8	43.8	31.3	0.0
Agriculture concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0	9.1	13.6	50.0	27.3	0.0
	0.0	0.0	18.8	62.5	18.8	0.0
Science concepts are easier for students to understand when science is integrated into the agricultural education program.	0.0	0.0	0.0	40.9	59.1	0.0
	0.0	0.0	6.3	25.0	68.8	0.0
Integrating science into the agricultural education program requires more preparation time than teaching a more traditional agriculture curriculum.	0.0	9.1	31.8	27.3	31.8	0.0
	0.0	6.3	37.5	18.8	31.3	6.3
Less effort is required to integrate science in advanced courses as compared to introductory courses.	9.1	50.0	18.2	18.2	4.5	0.0
	6.3	25.0	25.0	25.0	18.8	0.0
Integrating science into agriculture classes increases the ability to teach students to solve problems.	0.0	4.5	13.6	50.0	31.8	0.0
	0.0	0.0	0.0	50.0	50.0	0.0
Integrating science into the agricultural education curriculum more effectively meets the needs of special population students (i.e. learning disabled).	0.0	13.6	18.2	36.4	31.8	0.0
	0.0	0.0	43.8	50.0	6.3	0.0
It is more appropriate to integrate science in advanced courses than into introductory courses.	4.5	50.0	22.7	18.2	4.5	0.0
	12.5	43.8	6.3	25.0	12.5	0.0
Students are more aware of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction in agricultural education.	0.0	0.0	0.0	59.1	40.9	0.0
	0.0	0.0	0.0	31.3	68.8	0.0
Students are better prepared in science after they completed a course in agricultural education that integrates science.	0.0	0.0	4.5	40.9	50.0	4.5
	0.0	0.0	12.5	37.5	50.0	0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 16). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted.

Table 4-17. January respondents' perceptions of preparation to integrate science[a]

	Percent				
	SD[b]	D	N	A	SA
I feel prepared to teach integrated biological science concepts.	0.0 0.0	7.4 17.6	7.4 5.9	43.4 35.3	40.7 41.2
I feel prepared to teach integrated physical science concepts.	0.0 0.0	14.8 29.4	18.5 11.8	51.9 47.1	14.8 11.8
Teacher preparation programs in agriculture should require students to take more science courses (biology, chemistry, physics, etc.).	0.0 0.0	14.8 23.5	25.9 29.4	40.7 29.4	18.5 17.6
Teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.	0.0 0.0	3.7 0.0	14.8 5.9	22.2 41.2	59.3 52.9
When placing student teachers, teacher preparation programs should expect cooperating teachers to model science integration.	3.7 0.0	3.7 0.0	14.8 23.5	37.0 41.2	40.7 35.3
Teacher preparation programs should require that students conduct their early field experience program prior to student teaching with a teacher who integrates science into the agricultural education program.	0.0 0.0	14.8 5.9	18.5 47.1	37.0 17.6	29.6 29.4
Teacher preparation programs should require that students conduct student teaching internships with a teacher who integrates science into the agricultural education program.	0.0 0.0	0.0 0.0	33.3 35.3	40.7 35.3	25.9 29.4

Note: [a] Control group data are presented on the first level within a row (*n* = 27), Treatment group data are on the second level (*n* = 17). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-18. May respondents' perceptions of preparation to integrate science[a]

	Percent					
	SD[b]	D	N	A	SA	O
I feel prepared to teach integrated biological science concepts.	0.0 0.0	8.0 4.0	16.0 12.0	52.0 68.0	20.0 16.0	4.0 0.0
I feel prepared to teach integrated physical science concepts.	0.0 0.0	12.0 8.0	20.0 20.0	56.0 64.0	4.0 8.0	8.0 0.0
Teacher preparation programs in agriculture should require students to take more science courses (biology, chemistry, physics, etc.).	0.0 0.0	12.0 12.0	36.0 20.0	32.0 56.0	16.0 12.0	4.0 0.0
Teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.	0.0 0.0	0.0 0.0	0.0 12.0	36.0 48.0	60.0 40.0	4.0 0.0
When placing student teachers, teacher preparation programs should expect cooperating teachers to model science integration.	0.0 0.0	0.0 0.0	16.0 16.0	44.0 80.0	36.0 4.0	4.0 0.0
Teacher preparation programs should require that students conduct their early field experience program prior to student teaching with a teacher who integrates science into the agricultural education program.	0.0 0.0	8.0 8.0	32.0 28.0	28.0 52.0	28.0 12.0	4.0 0.0
Teacher preparation programs should require that students conduct student teaching internships with a teacher who integrates science into the agricultural education program.	0.0 0.0	8.0 4.0	32.0 28.0	28.0 48.0	28.0 16.0	4.0 4.0

Note: [a] Control group data are presented on the first level within a row (n = 25), Treatment group data are on the second level (n = 25). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted.

Table 4-19. September respondents' perceptions of preparation to integrate science[a]

	Percent				
	SD[b]	D	N	A	SA
I feel prepared to teach integrated biological science concepts.	0.0 0.0	0.0 0.0	15.4 30.0	53.8 60.0	30.8 10.0
I feel prepared to teach integrated physical science concepts.	7.7 0.0	0.0 10.0	15.4 30.0	76.9 60.0	0.0 0.0
Teacher preparation programs in agriculture should require students to take more science courses (biology, chemistry, physics, etc.).	0.0 0.0	7.7 0.0	46.2 50.0	38.5 20.0	7.7 30.0
Teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.	0.0 0.0	0.0 0.0	7.7 0.0	46.2 30.0	46.2 70.0
When placing student teachers, teacher preparation programs should expect cooperating teachers to model science integration.	0.0 0.0	0.0 0.0	15.4 20.0	46.2 40.0	38.5 40.0
Teacher preparation programs should require that students conduct their early field experience program prior to student teaching with a teacher who integrates science into the agricultural education program.	0.0 0.0	15.4 0.0	53.8 10.0	15.4 60.0	15.4 30.0
Teacher preparation programs should require that students conduct student teaching internships with a teacher who integrates science into the agricultural education program.	0.0 0.0	23.1 0.0	38.5 20.0	23.1 60.0	15.4 20.0

Note: [a] Control group data are presented on the first level within a row (*n* = 13), Treatment group data are on the second level (*n* = 10). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-20. December respondents' perceptions of preparation to integrate science[a]

	Percent				
	SD[b]	D	N	A	SA
I feel prepared to teach integrated biological science concepts.	0.0 0.0	0.0 0.0	9.1 6.3	63.6 56.3	27.3 37.5
I feel prepared to teach integrated physical science concepts.	0.0 0.0	9.1 12.5	4.5 6.3	72.7 62.5	13.6 18.7
Teacher preparation programs in agriculture should require students to take more science courses (biology, chemistry, physics, etc.).	0.0 0.0	4.5 18.7	31.8 43.8	54.5 18.7	9.1 18.7
Teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.	0.0 0.0	0.0 0.0	0.0 0.0	59.1 37.5	40.9 62.5
When placing student teachers, teacher preparation programs should expect cooperating teachers to model science integration.	0.0 0.0	4.5 6.3	9.1 12.5	54.5 50.0	31.8 31.3
Teacher preparation programs should require that students conduct their early field experience program prior to student teaching with a teacher who integrates science into the agricultural education program.	0.0 0.0	9.1 0.0	31.8 18.7	40.9 50.0	18.2 31.3
Teacher preparation programs should require that students conduct student teaching internships with a teacher who integrates science into the agricultural education program.	0.0 0.0	9.1 0.0	27.3 31.3	40.9 50.0	22.7 18.7

Note: [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 16). [b] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree.

Table 4-21. January respondents' perceptions of the impact of science integration on student recruitment[a]

	Percent					
	Greatly Decrease	Decrease	Neither	Increase	Greatly Increase	NA[b]
High achieving students	0.0 0.0	0.0 0.0	19.2 18.8	30.8 43.8	46.2 37.5	3.8 0.0
Average achieving students	0.0 0.0	0.0 0.0	4.8 43.8	76.2 56.3	19.0 0.0	0.0 0.0
Low achieving students	0.0 0.0	0.0 37.5	19.0 31.3	52.4 18.8	28.6 12.5	0.0 0.0
Minority students	0.0 0.0	0.0 0.0	11.5 58.8	65.4 23.5	11.5 11.8	11.5 5.9
Total program enrollment	0.0 0.0	0.0 0.0	4.8 25.0	76.2 62.5	19.0 12.5	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 26), Treatment group data are on the second level (*n* = 16). [b] Not Applicable.

Table 4-22. May respondents' perceptions of the impact of science integration on student recruitment[a]

	Percent					
	Greatly Decrease	Decrease	Neither	Increase	Greatly Increase	NA[b]
High achieving students	0.0 0.0	0.0 0.0	29.2 21.7	45.8 39.1	25.0 39.1	0.0 0.0
Average achieving students	0.0 0.0	0.0 0.0	25.0 27.3	50.0 63.6	25 9.1	0.0 0.0
Low achieving students	0.0 0.0	20.8 4.5	25.0 50.0	33.3 40.9	20.8 9.1	0.0 0.0
Minority students	4.2 0.0	0.0 4.3	54.2 65.2	25.0 21.7	8.3 4.3	8.3 4.3
Total program enrollment	0.0 0.0	0.0 0.0	25.0 26.1	66.7 69.6	8.3 4.3	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 24), Treatment group data are on the second level (*n* = 23). [b] Not Applicable.

Table 4-23. September respondents' perceptions of the impact of science integration on student recruitment[a]

	Percent					
	Greatly Decrease	Decrease	Neither	Increase	Greatly Increase	NA[b]
High achieving students	0.0 0.0	0.0 0.0	33.3 11.1	41.7 55.6	25.0 33.3	0.0 0.0
Average achieving students	0.0 0.0	0.0 0.0	25.0 22.2	50.0 0.0	25.0 77.8	0.0 0.0
Low achieving students	0.0 0.0	8.3 22.2	41.7 22.2	33.3 11.1	16.7 44.4	0.0 0.0
Minority students	0.0 0.0	8.3 0.0	25.0 66.7	33.3 0.0	8.3 30.0	25.0 0.0
Total program enrollment	0.0 0.0	0.0 0.0	25.0 22.2	66.7 55.6	8.3 22.2	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* =12), Treatment group data are on the second level (*n* = 9). [b] Not Applicable.

Table 4-24. December respondents' perceptions of the impact of science integration on student recruitment[a]

	Percent					
	Greatly Decrease	Decrease	Neither	Increase	Greatly Increase	NA[b]
High achieving students	0.0 0.0	0.0 0.0	13.6 0.0	77.3 66.7	9.1 33.3	0.0 0.0
Average achieving students	0.0 0.0	0.0 0.0	31.8 13.3	50.0 46.7	18.0 40.0	0.0 0.0
Low achieving students	0.0 0.0	31.8 6.7	27.3 33.3	22.7 40.0	18.2 20.0	0.0 0.0
Minority students	0.0 0.0	13.6 6.7	40.9 53.4	31.8 20.0	0.0 13.3	13.6 6.7
Total program enrollment	0.0 0.0	0.0 0.0	31.8 6.7	63.6 80.0	4.5 13.3	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 15). [b] Not Applicable.

Table 4-25. January respondents' perceptions of barriers to science integration[ab]

	Percent					
	SD[c]	D	N	A	SA	O
Reluctance to give up the role of primary source of classroom information	22.2 11.8	33.3 23.5	14.8 17.6	14.8 11.8	7.4 5.9	7.4 29.4
Lack of experience in science integration	7.4 11.8	37.0 23.5	18.5 5.9	14.8 29.4	14.8 0.0	7.4 29.4
Lack of parent and community support for science integration	11.1 17.6	33.3 17.6	25.9 29.4	14.8 0.0	3.7 0.0	11.1 35.3
Have tried it and it was unsuccessful	29.6 17.6	44.4 35.3	0.0 11.8	7.4 5.9	0.0 0.0	18.5 29.4
Lack of support from local science teacher(s)	22.2 11.8	14.8 35.3	14.8 5.9	25.9 11.8	11.1 0.0	11.1 35.3
Concerns about discipline	37.0 11.8	22.2 23.5	0.0 17.6	18.5 17.6	14.8 0.0	7.4 29.4
Concerns about large class size	3.7 0.0	22.2 5.9	18.5 5.9	22.2 47.1	22.2 5.9	11.1 35.3
Insufficient time and support to plan for implementation	0.0 5.9	25.9 11.8	14.8 0.0	29.6 29.4	18.5 23.5	11.1 29.4
Lack of integrated science curriculum in courses I teach	3.7 11.8	48.1 23.5	3.7 5.9	14.8 23.5	18.5 0.0	11.1 35.3
Disagreement with the notion that science integration is necessary	33.3 35.3	33.3 11.8	7.4 11.8	7.4 5.9	11.1 0.0	7.4 35.3
Reluctance to diminish emphasis on agricultural production	18.5 5.9	29.6 23.5	7.4 11.8	14.8 29.4	22.2 0.0	7.4 29.4
Doubts about students' capacity to handle material	14.8 17.6	25.9 23.5	29.6 5.9	14.8 11.8	0.0 5.9	14.8 35.3
Lack of administrative support for science integration	22.2 23.5	51.9 23.5	11.1 17.6	7.4 5.9	0.0 0.0	7.4 29.4
Insufficient funding	3.7 5.9	25.9 17.6	18.5 11.8	14.8 11.8	29.6 23.5	7.4 29.4
Insufficient background in science content	18.5 23.5	44.4 11.8	22.2 17.6	3.7 11.8	0.0 5.9	11.1 29.4
Don't have the necessary materials	3.7 11.8	22.2 17.6	18.5 0.0	37.0 17.6	7.4 23.5	11.1 29.4
Lack of agriscience jobs in the local community	33.3 11.8	14.8 23.5	7.4 11.8	29.6 17.6	0.0 5.9	14.8 29.4

Note: [a] Control group data are presented on the first level within a row (n = 27), Treatment group data are on the second level (n = 17). [b]All items are reverse coded. [c] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted

Table 4-26. May respondents' perceptions of barriers to science integration[ab]

	Percent				
	SD[c]	D	N	A	SA
Reluctance to give up the role of primary source of classroom information	16.7 5.3	58.3 47.4	4.2 26.3	20.8 21.1	0.0 0.0
Lack of experience in science integration	4.2 4.0	54.2 47.4	29.2 26.3	8.3 21.1	4.2 0.0
Lack of parent and community support for science integration	12.5 4.0	54.2 44.0	12.5 16.0	16.7 8.0	4.2 4.0
Have tried it and it was unsuccessful	20.8 21.1	45.8 42.1	25.0 36.8	8.3 0.0	0.0 0.0
Lack of support from local science teacher(s)	25.0 21.1	29.2 31.6	16.7 31.6	20.8 10.5	8.3 5.3
Concerns about discipline	29.2 26.3	41.7 26.3	4.2 42.1	25.0 5.3	0.0 0.0
Concerns about large class size	8.3 15.8	33.3 21.1	16.7 31.6	33.3 26.3	8.3 5.3
Insufficient time and support to plan for implementation	8.3 0.0	41.7 21.1	12.5 21.1	25.0 36.8	12.5 21.1
Lack of integrated science curriculum in courses I teach	8.3 15.8	58.3 36.8	16.7 31.6	8.3 15.8	8.3 0.0
Disagreement with the notion that science integration is necessary	43.5 44.4	52.2 16.7	4.3 27.8	0.0 11.1	0.0 0.0
Reluctance to diminish emphasis on agricultural production	33.3 31.6	38.5 21.1	16.7 10.5	12.5 26.3	0.0 10.5
Doubts about students' capacity to handle material	12.5 27.8	58.3 27.8	8.3 33.3	20.8 11.1	0.0 0.0
Lack of administrative support for science integration	20.8 33.3	45.8 38.9	25.0 16.7	0.0 5.6	8.3 5.6
Insufficient funding	8.3 11.1	12.5 22.2	20.8 27.8	20.8 22.2	37.5 16.7
Insufficient background in science content	20.8 5.6	50.0 50.0	12.5 22.2	16.7 22.2	0.0 0.0
Don't have the necessary materials	4.2 5.6	29.2 33.3	8.3 44.4	41.7 11.1	16.7 5.6
Lack of agriscience jobs in the local community	16.7 27.8	50.0 38.9	12.5 22.2	8.3 5.6	12.5 5.6

Note: [a] Control group data are presented on the first level within a row (n = 24), Treatment group data are on the second level (n = 19). [b] All items are reverse coded. [c] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted

Table 4-27. September respondents' perceptions of barriers to science integration[ab]

	Percent				
	SD[c]	D	N	A	SA
Reluctance to give up the role of primary source of classroom information	27.3 0.0	63.6 33.3	0.0 66.7	9.1 0.0	0.0 0.0
Lack of experience in science integration	18.2 11.1	54.5 33.3	0.0 44.4	27.3 11.1	0.0 0.0
Lack of parent and community support for science integration	27.3 11.1	54.5 44.4	9.1 22.2	9.1 22.2	0.0 0.0
Have tried it and it was unsuccessful	27.3 33.3	0.0 33.3	72.7 33.3	0.0 0.0	0.0 0.0
Lack of support from local science teacher(s)	27.3 0.0	27.3 55.6	0.0 22.2	45.5 11.1	0.0 11.1
Concerns about discipline	36.4 44.4	63.6 11.1	0.0 22.2	0.0 0.0	0.0 22.2
Concerns about large class size	27.3 11.1	27.3 33.3	9.1 33.3	27.3 22.2	9.1 0.0
Insufficient time and support to plan for implementation	9.1 0.0	36.4 11.1	0.0 0.0	27.3 66.7	27.3 22.2
Lack of integrated science curriculum in courses I teach	45.5 11.1	36.4 55.6	9.1 11.1	9.1 22.2	0.0 0.0
Disagreement with the notion that science integration is necessary	81.8 77.8	18.2 22.2	0.0 0.0	0.0 0.0	0.0 0.0
Reluctance to diminish emphasis on agricultural production	27.3 0.0	36.4 44.4	9.1 33.3	18.2 22.2	9.1 0.0
Doubts about students' capacity to handle material	9.1 0.0	63.6 44.4	0.0 22.2	18.2 33.3	9.1 0.0
Lack of administrative support for science integration	45.5 11.1	45.5 66.7	0.0 11.1	9.1 11.1	0.0 0.0
Insufficient funding	18.2 0.0	45.5 11.1	0.0 22.2	27.3 55.6	9.1 11.1
Insufficient background in science content	63.6 0.0	9.1 66.7	0.0 33.3	27.3 0.0	0.0 0.0
Don't have the necessary materials	0.0 0.0	36.4 33.3	36.4 22.2	9.1 22.2	18.2 22.2
Lack of agriscience jobs in the local community	18.2 0.0	45.5 44.4	9.1 11.1	27.3 44.4	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (n = 11), Treatment group data are on the second level (n = 9). [b]All items are reverse coded. [c] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted

Table 4-28. December respondents' perceptions of barriers to science integration[ab]

	Percent				
	SD[c]	D	N	A	SA
Reluctance to give up the role of primary source of classroom information	22.7 6.7	54.5 13.3	18.2 53.3	4.5 26.7	0.0 0.0
Lack of experience in science integration	18.2 20.0	50.0 20.0	13.6 20.0	18.2 40.0	0.0 0.0
Lack of parent and community support for science integration	22.7 13.3	50.0 20.0	13.6 20.0	18.2 40.0	0.0 0.0
Have tried it and it was unsuccessful	27.3 26.7	54.5 46.7	18.2 20.0	0.0 6.7	0.0 0.0
Lack of support from local science teacher(s)	45.5 20.0	18.2 26.7	13.6 40.0	18.2 6.7	4.5 6.7
Concerns about discipline	40.9 33.3	50.0 26.7	13.6 40.0	18.2 6.7	4.5 6.7
Concerns about large class size	22.7 26.7	31.8 13.3	0.0 20.0	37.8 26.7	13.6 13.3
Insufficient time and support to plan for implementation	18.2 0.0	40.9 6.7	0.0 20.0	27.3 60.0	13.6 13.3
Lack of integrated science curriculum in courses I teach	22.7 13.3	59.1 33.3	9.1 40.0	0.0 6.7	9.1 6.7
Disagreement with the notion that science integration is necessary	50.0 46.7	50.0 40.0	0.0 13.3	0.0 0.0	0.0 0.0
Reluctance to diminish emphasis on agricultural production	31.8 20.0	45.5 46.7	13.6 13.3	9.1 20.0	0.0 0.0
Doubts about students' capacity to handle material	27.3 20.0	54.5 40.0	4.5 20.0	13.6 20.0	0.0 0.0
Lack of administrative support for science integration	31.8 25.0	50.0 50.0	9.1 12.5	9.1 6.3	0.0 0.0
Insufficient funding	13.6 13.3	27.3 20.0	22.7 20.0	18.2 26.7	13.6 20.0
Insufficient background in science content	22.7 20.0	45.5 40.0	18.2 33.3	4.5 6.7	9.1 0.0
Don't have the necessary materials	4.5 15.3	31.8 26.7	18.2 26.7	40.9 20.0	0.0 13.3
Lack of agriscience jobs in the local community	18.2 6.7	45.5 60.0	18.2 20.0	13.6 6.7	0.0 6.7

Note: [a] Control group data are presented on the first level within a row (n = 22), Treatment group data are on the second level (n = 15). [b]All items are reverse coded. [c] SD = Strongly Disagree, D = Disagree, N = Neither Disagree nor Agree, A = Agree, SA = Strongly Agree, O = Omitted

Table 4-29. Respondents' levels of science integration[a]

	Percent	
	Yes	No
January		
Have you integrated science into your agricultural education program	84.0 100.0	16.0 0.0
Are you content with the level to which you currently ingrate science	36.0 30.8	64.0 69.2
May		
Have you integrated science into your agricultural education program	86.4 94.4	13.6 5.6
Are you content with the level to which you currently ingrate science	43.5 52.9	56.5 47.1
September		
Have you integrated science into your agricultural education program	100 100	0.0 0.0
Are you content with the level to which you currently ingrate science	90.9 33.3	9.1 66.7
December		
Have you integrated science into your agricultural education program	95.5 93.8	4.5 6.3
Are you content with the level to which you currently ingrate science	54.5 37.5	45.5 62.5

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. January: Control group n = 25, Treatment group n = 13. May: Control group n = 22, Treatment group n = 18. September: Control group n = 9, Treatment group n = 11.December: Control group n = 22, Treatment group n = 16.

Table 4-30. Respondents' perceptions of science integrations program enrollment[a]

	Percent		
	Decrease	No Affect	Increase
January	12.0 0.0	32.0 61.5	44.0 38.5
May	10.5 0.0	31.6 52.9	57.9 47.1
September	0.0 0.0	36.4 66.7	63.6 33.3
December	0.0 0.0	54.5 37.5	45.4 62.6

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. January: Control group n = 25, Treatment group n = 13. May: Control group n = 22, Treatment group n = 18. September: Control group n = 11, Treatment group n = 9.December: Control group n = 22, Treatment group n = 16.

Table 4-31. Respondents' future plans for integration of science[a]

	Percent		
	Decrease	No Change	Increase
January	8.3 0.0	20.8 16.7	70.8 83.3
May	0.0 0.0	20.8 38.9	79.2 61.1
September	0.0 0.0	37.5 16.7	62.5 83.3
December	0.0 0.0	31.8 25.0	68.2 75.0

Note: [a] Control group data are presented on the first level within a row, Treatment group data are on the second level. January: Control group n = 25, Treatment group n = 13. May: Control group n = 22, Treatment group n = 18. September: Control group n = 11, Treatment group n = 9.December: Control group n = 22, Treatment group n = 16.

Table 4-32. January respondents' perceptions of general activities and planning when implementing inquiry based instruction[a]

On average, to what extent do you…	Percent						
	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
Use a textbook as the primary method for studying agriscience.	32.0 23.5	24.0 17.6	28.0 17.6	12.0 29.4	4.0 11.8	0.0 0.0	0.0 0.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	8.0 0.0	0.0 0.0	12.0 29.4	32.0 17.6	16.0 41.2	12.0 5.9	20.0 5.9
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	12.0 11.8	24.0 52.9	36.0 23.5	20.0 5.9	4.0 5.9	4.0 0.0
Encourage students to initiate further investigation.	12.0 5.9	16.0 29.4	12.0 23.5	20.0 11.8	28.0 11.8	8.0 11.8	4.0 0.0
Ask a question or conduct an activity that calls for a single correct answer.	7.4 5.9	14.8 17.6	14.8 29.4	11.1 11.8	18.5 5.9	11.1 11.8	14.8 17.6
Facilitate and encourage student dialogue about science.	0.0 0.0	4.0 11.8	28.0 41.2	16.0 5.9	24.0 17.6	20.0 17.6	8.0 5.9
Encourage students to defend the adequacy or logic of statements and findings.	0.0 0.0	11.1 17.6	14.8 35.3	7.4 11.8	29.6 11.8	22.2 11.8	7.4 11.8
Make readily available to students a wide variety of resource materials for scientific investigations.	0.0 5.9	18.5 23.5	22.2 11.8	11.1 17.6	25.9 11.8	3.7 11.8	11.1 11.8
Encourage students to design and conduct experiments.	3.7 0.0	22.2 29.4	25.9 29.4	14.8 5.9	18.5 17.6	3.7 11.8	3.7 5.9

Note: [a] Control group data are presented on the first level within a row (n = 25), Treatment group data are on the second level (n = 17).

Table 4-33. May respondents' perceptions of general activities and planning when implementing inquiry based instruction[a]

On average, to what extent do you…	Percent							
	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week	Omit
Use a textbook as the primary method for studying agriscience.	0.0 0.0	32.0 32.0	28.0 24.0	20.0 20.0	8.0 0.0	4.0 0.0	0.0 4.0	8.0 20.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	0.0 0.0	4.0 8.0	20.0 12.0	20.0 16.0	32.0 12.0	20.0 32.0	4.0 20.0
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	4.0 0.0	8.0 12.0	36.0 12.0	20.0 4.0	16.0 32.0	12.0 16.0	4.0 24.0
Encourage students to initiate further investigation.	0.0 0.0	0.0 0.0	8.0 12.0	28.0 12.0	20.0 12.0	24.0 20.0	12.0 24.0	8.0 20.0
Ask a question or conduct an activity that calls for a single correct answer.	0.0 0.0	4.0 0.0	24.0 4.0	32.0 36.0	4.0 24.0	8.0 16.0	20.0 0.0	8.0 20.0
Facilitate and encourage student dialogue about science.	0.0 0.0	0.0 0.0	8.0 8.0	28.0 20.	12.0 24.0	32.0 8.0	16.0 16.0	4.0 24.0
Encourage students to defend the adequacy or logic of statements and findings.	0.0 0.0	8.0 4.0	8.0 16.0	28.0 12.0	28.0 20.0	16.0 16.0	8.0 12.0	4.0 20.0
Make readily available to students a wide variety of resource materials for scientific investigations.	0.0 0.0	4.0 4.0	24.0 16.0	8.0 8.0	24.0 16.0	8.0 16.0	24.0 16.0	8.0 24.0
Encourage students to design and conduct experiments.	0.0 0.0	4.0 0.0	24.0 24.0	28.0 20.	20.0 32.0	8.0 0.0	8.0 0.0	8.0 24.0

Note: [a] Control group data are presented on the first level within a row (n = 25), Treatment group data are on the second level (n = 25).

Table 4-34. September respondents' perceptions of general activities and planning when implementing inquiry based instruction[a]

On average, to what extent do you…	Percent Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
Use a textbook as the primary method for studying agriscience.	72.7 77.8	27.3 9.1	0.0 0.0	0.0 0.0	0.0 11.1	0.0 0.0	0.0 0.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	9.1 11.1	9.1 0.0	45.5 22.2	18.2 44.4	18.2 22.2	0.0 0.0
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	9.1 0.0	27.3 22.2	27.3 22.2	27.3 22.2	9.1 22.2	0.0 11.1	0.0 0.0
Encourage students to initiate further investigation.	9.1 0.0	9.1 44.4	0.0 11.1	45.5 22.2	36.4 11.1	0.0 11.1	0.0 0.0
Ask a question or conduct an activity that calls for a single correct answer.	18.2 33.3	45.5 22.2	18.2 0.0	9.1 33.3	9.1 11.1	0.0 0.0	0.0 0.0
Facilitate and encourage student dialogue about science.	9.1 0.0	0.0 11.1	0.0 11.1	54.5 33.3	18.2 22.2	18.2 22.2	0.0 0.0
Encourage students to defend the adequacy or logic of statements and findings.	18.2 11.1	0.0 11.1	18.2 11.1	36.4 33.3	18.2 22.2	9.1 11.1	0.0 0.0
Make readily available to students a wide variety of resource materials for scientific investigations.	9.1 0.0	18.2 11.1	9.1 11.1	0.0 0.0	27.3 22.2	36.4 55.6	0.0 0.0
Encourage students to design and conduct experiments.	9.1 11.1	36.4 22.2	18.2 44.4	27.3 0.0	9.1 22.2	0.0 0.0	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (*n* = 13), Treatment group data are on the second level (*n* = 10).

Table 4-35. December respondents' perceptions of general activities and planning when implementing inquiry based instruction[a]

On average, to what extent do you…	Percent						
	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
Use a textbook as the primary method for studying agriscience.	45.5 37.5	40.9 37.5	4.5 18.8	9.1 0.0	0.0 6.3	0.0 0.0	0.0 0.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	0.0 6.3	18.2 18.8	36.4 18.8	13.6 12.5	9.1 12.5	22.7 31.3
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	0.0 12.5	40.9 25.0	22.7 12.5	22.7 18.8	4.5 12.5	9.1 18.8
Encourage students to initiate further investigation.	0.0 0.0	4.5 6.3	36.4 50.0	13.6 6.3	9.1 6.3	22.7 18.8	13.6 12.5
Ask a question or conduct an activity that calls for a single correct answer.	4.5 6.3	36.4 12.5	22.7 18.8	4.5 12.5	18.2 18.8	13.6 6.3	0.0 25.0
Facilitate and encourage student dialogue about science.	0.0 0.0	4.5 6.3	13.6 31.3	31.8 6.3	22.7 25.0	9.1 18.8	18.2 12.5
Encourage students to defend the adequacy or logic of statements and findings.	0.0 0.0	4.5 12.5	27.3 43.8	22.7 6.3	13.6 25.0	9.1 6.3	13.6 6.3
Make readily available to students a wide variety of resource materials for scientific investigations.	0.0 0.0	4.5 6.3	22.7 25.0	13.6 6.3	18.2 6.3	13.6 6.3	27.3 50.0
Encourage students to design and conduct experiments.	0.0 0.0	22.7 37.5	27.3 25.0	18.2 12.5	13.6 0.0	4.5 18.8	13.6 6.3

Note: [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 16).

Table 4-36. May respondents' perceptions of teaching activities and planning when implementing inquiry based instruction in a specific class[a]

On average, to what extent do you…	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
	Percent						
Use a textbook as the primary method for studying agriscience.	0.0 0.0	37.5 47.4	29.2 26.3	20.8 21.1	4.2 0.0	8.3 0.0	0.0 5.3
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	4.2 0.0	4.2 5.3	12.5 21.1	16.7 15.8	33.3 21.1	29.2 36.9
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	0.0 0.0	8.3 0.0	25.0 33.3	29.2 22.2	12.5 27.8	25.0 16.6
Encourage students to initiate further investigation.	0.0 0.0	0.0 0.0	12.5 5.6	33.3 38.9	12.5 27.8	20.8 11.1	20.9 16.7
Ask a question or conduct an activity that calls for a single correct answer.	0.0 0.0	4.2 0.0	16.7 5.3	29.2 42.1	12.5 26.3	24.4 0.0	10.5 26.3
Facilitate and encourage student dialogue about science.	0.0 0.0	0.0 0.0	12.5 0.0	12.5 21.1	12.5 21.1	41.7 42.1	20.8 15.8
Encourage students to defend the adequacy or logic of statements and findings.	0.0 0.0	0.0 0.0	8.3 10.5	25.0 31.6	25.0 5.3	29.2 31.6	12.5 21.1
Make readily available to students a wide variety of resource materials for scientific investigations.	0.0 0.0	0.0 5.3	29.2 5.3	8.3 31.6	8.3 10.5	25.0 26.3	29.2 21.1
Encourage students to design and conduct experiments.	0.0 0.0	8.3 0.0	20.8 21.1	29.2 31.6	12.5 21.1	16.6 21.1	12.5 5.3

Note: [a] Control group data are presented on the first level within a row (n = 24), Treatment group data are on the second level (n = 19).

Table 4-37. September respondents' perceptions of teaching activities and planning when implementing inquiry based instruction in a specific class[a]

On average, to what extent do you…	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
	Percent						
Use a textbook as the primary method for studying agriscience.	54.0 77.8	9.1 11.1	36.4 0.0	0.0 0.0	0.0 11.1	0.0 0.0	0.0 0.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	0.0 11.1	18.2 22.2	36.4 22.2	27.3 22.2	18.2 22.2	0.0 0.0
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	27.3 33.3	9.1 33.3	27.3 22.2	27.3 11.1	9.1 0.0	0.0 0.0
Encourage students to initiate further investigation.	9.1 11.1	9.1 11.1	0.0 44.4	54.5 22.2	18.2 11.1	9.1 0.0	0.0 0.0
Ask a question or conduct an activity that calls for a single correct answer.	18.2 22.2	27.3 22.2	27.3 33.3	9.1 11.1	0.0 11.1	9.1 0.0	0.0 0.0
Facilitate and encourage student dialogue about science.	0.0 0.0	9.1 11.1	9.1 0.0	45.5 44.4	0.0 33.3	36.4 11.1	0.0 0.0
Encourage students to defend the adequacy or logic of statements and findings.	9.1 11.1	18.2 11.1	0.0 33.3	36.4 33.3	27.3 11.1	9.1 0.0	0.0 0.0
Make readily available to students a wide variety of resource materials for scientific investigations.	9.1 11.1	18.2 0.0	9.1 0.0	0.0 22.2	18.2 11.1	45.5 55.6	0.0 0.0
Encourage students to design and conduct experiments.	9.1 11.1	36.4 33.3	0.0 11.1	18.2 0.0	27.3 44.4	9.1 0.0	0.0 0.0

Note: [a] Control group data are presented on the first level within a row (n = 24), Treatment group data are on the second level (n = 19).

Table 4-38. December respondents' perceptions of teaching activities and planning when implementing inquiry based instruction in a specific class[a]

On average, to what extent do you…	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
	Percent						
Use a textbook as the primary method for studying agriscience.	45.5 50.0	36.4 31.3	4.5 18.8	13.6 0.0	0.0 0.0	0.0 0.0	0.0 0.0
Use open-ended questions that encourage observation, investigations, and scientific thinking.	0.0 0.0	0.0 12.5	18.2 25.0	27.3 12.5	22.7 63.0	9.1 6.3	22.7 37.5
Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0.0 0.0	0.0 18.8	36.4 25.0	27.3 12.5	22.7 12.5	0.0 18.8	13.6 12.5
Encourage students to initiate further investigation.	0.0 0.0	4.5 18.8	27.3 25.0	13.6 12.5	22.7 18.8	9.1 6.3	22.7 18.8
Ask a question or conduct an activity that calls for a single correct answer.	4.5 6.3	27.3 6.3	27.3 25.0	4.5 18.8	27.3 18.8	4.5 0.0	4.5 25.0
Facilitate and encourage student dialogue about science.	0.0 0.0	4.5 6.3	13.6 37.5	18.2 0.0	27.3 31.3	13.6 6.3	22.7 18.8
Encourage students to defend the adequacy or logic of statements and findings.	0.0 0.0	0.0 25.0	27.3 18.8	22.7 18.8	27.3 12.5	9.1 6.3	13.6 18.8
Make readily available to students a wide variety of resource materials for scientific investigations.	0.0 0.0	4.5 18.8	22.7 18.8	18.2 12.5	18.2 0.0	4.5 12.5	31.8 37.5
Encourage students to design and conduct experiments.	0.0 6.3	13.6 37.5	45.5 37.5	18.2 6.3	0.0 0.0	9.1 6.3	13.6 6.3

Note: [a] Control group data are presented on the first level within a row (n = 22), Treatment group data are on the second level (n = 16).

Table 4-39. January respondents' perceptions of student activities during classroom instruction[a]

How often do you ask students in your classroom to:	Never	1x per Year	1x per Semester	1x per Month	1x per Week	1x per Day	Omit
	Percent						
Memorize scientific facts or information separately from activities.	7.4	7.4	22.2	29.6	22.2	3.7	7.4
	17.6	11.8	11.8	52.9	5.9	0.0	0.0
Use data to construct a reasonable explanation.	8.3	0.0	8.3	54.2	20.8	8.3	11.1
	0.0	5.9	17.6	35.3	41.2	0.0	0.0
Seek and recognize patterns (trends in the data or observations).	0.0	0.0	14.8	29.6	40.7	7.4	7.4
	0.0	11.8	5.9	23.5	58.8	0.0	0.0
Follow a set series of steps to get the right answer to a question.	0.0	0.0	7.4	18.5	40.7	25.9	7.4
	0.0	0.0	5.9	47.1	35.3	11.8	0.0
Ask questions during investigations that lead to further ideas, questions, and investigations.	0.0	3.7	14.8	3.7	40.7	29.6	7.4
	0.0	5.9	0.0	41.2	29.4	23.5	0.0
Wait to act until the teacher gives instructions for the next step in the investigation.	3.7	7.4	7.4	29.6	22.2	22.2	7.4
	11.8	17.6	0.0	41.2	11.8	17.6	0.0
Choose appropriate tools for an investigation.	3.7	3.7	7.4	22.2	33.3	22.2	7.4
	5.9	0.0	17.6	35.3	29.4	11.8	0.0
Offer explanations from previous experiences and from knowledge gained during investigations.	0.0	0.0	7.4	14.8	37.0	33.3	7.4
	0.0	0.0	0.0	47.1	29.4	23.5	0.0
Make connections to previously held ideas (or revise previous conceptions/assumptions).	0.0	0.0	7.4	3.7	48.1	33.3	7.4
	0.0	0.0	11.8	23.5	41.2	23.5	0.0
Communicate investigations and explanations (purposes, procedures, and/or results of investigations) to others.	0.0	0.0	3.7	14.8	48.1	25.9	7.4
	0.0	0.0	17.6	29.4	41.2	5.9	0.0
Listen carefully to peers as they discuss scientific investigations.	0.0	0.0	18.5	18.5	29.6	22.2	11.1
	0.0	5.9	17.6	47.1	17.6	5.9	0.0
Use drawing, graphing, or charting to convey new information from an agriscience activity.	0.0	3.7	14.8	18.5	55.8	55.6	7.4
	0.0	0.0	17.6	29.4	35.3	11.8	0.0

Note: [a] Control group data are presented on the first level within a row (n = 27), Treatment group data are on the second level (n = 17).

Table 4-40. May respondents' perceptions of student activities during classroom instruction[a]

How often do you ask students in your classroom to:	Never	1x per Year	1x per Semester	1x per Month	1x per Week	1x per Day	Omit
	Percent						
Memorize scientific facts or information separately from activities.	0.0 0.0	16.0 20.0	12.0 0.0	12.0 16.0	20.0 36.0	24.0 20.0	16.0 0.0
Use data to construct a reasonable explanation.	0.0 0.0	0.0 0.0	0.0 0.0	8.0 20.0	48.0 36.0	32.0 32.0	12.0 12.0
Seek and recognize patterns (trends in the data or observations).	0.0 0.0	0.0 0.0	4.0 0.0	20.0 12.0	24.0 48.0	40.0 32.0	12.0 8.0
Follow a set series of steps to get the right answer to a question.	0.0 0.0	4.0 0.0	0.0 0.0	0.0 4.0	28.0 36.0	56.0 36.0	12.0 24.0
Ask questions during investigations that lead to further ideas, questions, and investigations.	0.0 0.0	0.0 0.0	0.0 0.0	12.0 4.0	28.0 32.0	48.0 48.0	12.0 16.0
Wait to act until the teacher gives instructions for the next step in the investigation.	0.0 0.0	12.0 8.0	0.0 0.0	12.0 20.0	16.0 8.0	44.0 40.0	16.0 24.0
Choose appropriate tools for an investigation.	0.0 0.0	0.0 4.0	8.0 0.0	8.0 28.0	32.0 20.0	40.0 32.0	12.0 16.0
Offer explanations from previous experiences and from knowledge gained during investigations.	0.0 0.0	0.0 0.0	0.0 0.0	0.0 0.0	32.0 48.0	44.0 36.0	24.0 16.0
Make connections to previously held ideas (or revise previous conceptions/assumptions).	0.0 0.0	0.0 0.0	0.0 0.0	16.0 32.0	44.0 36.0	32.0 24.0	8.0 8.0
Communicate investigations and explanations (purposes, procedures, and/or results of investigations) to others.	0.0 0.0	0.0 0.0	0.0 0.0	8.0 0.0	28.0 40.0	52.0 40.0	12.0 20.0
Listen carefully to peers as they discuss scientific investigations.	0.0 0.0	4.0 0.0	12.5 4.0	8.3 12.0	33.3 52.0	41.7 20.0	4.0 12.0
Use drawing, graphing, or charting to convey new information from an agriscience activity.	0.0 0.0	0.0 0.0	8.0 4.0	8.0 8.0	36.0 52.0	28.0 28.0	20. 8.0

Note: [a] Control group data are presented on the first level within a row (*n* = 25), Treatment group data are on the second level (*n* = 25).

Table 4-41. September respondents' perceptions of student activities during classroom instruction[a]

How often do you ask students in your classroom to:	Percent Never	1x per Year	1x per Semester	1x per Month	1x per Week	1x per Day	Omit
Memorize scientific facts or information separately from activities.	38.5 20.0	0.0 0.0	15.4 20.0	30.8 40.0	7.7 20.0	0.0 0.0	7.7 0.0
Use data to construct a reasonable explanation.	0.0 0.0	0.0 0.0	23.1 0.0	23.1 30.0	30.8 60.0	15.4 10.0	0.0 0.0
Seek and recognize patterns (trends in the data or observations).	0.0 0.0	0.0 0.0	0.0 0.0	61.5 50.0	30.8 50.0	0.0 0.0	0.0 0.0
Follow a set series of steps to get the right answer to a question.	0.0 0.0	0.0 0.0	15.4 0.0	30.8 0.0	46.2 60.0	0.0 40.0	0.0 0.0
Ask questions during investigations that lead to further ideas, questions, and investigations.	0.0 0.0	0.0 0.0	7.7 0.0	23.1 10.0	38.5 10.0	23.1 80.0	0.0 0.0
Wait to act until the teacher gives instructions for the next step in the investigation.	0.0 0.0	0.0 0.0	23.1 10.0	30.8 50.0	38.5 40.0	0.0 0.0	0.0 0.0
Choose appropriate tools for an investigation.	0.0 0.0	0.0 0.0	7.7 10.	30.8 20.0	46.2 50.0	0.0 20.0	15.4 0.0
Offer explanations from previous experiences and from knowledge gained during investigations.	0.0 0.0	0.0 0.0	0.0 10.0	7.7 0.0	38.5 80.0	38.5 10.0	15.4 0.0
Make connections to previously held ideas (or revise previous conceptions/assumptions).	0.0 0.0	0.0 0.0	0.0 0.0	7.7 10.0	30.8 10.0	53.8 70.0	7.7 0.0
Communicate investigations and explanations (purposes, procedures, and/or results of investigations) to others.	0.0 0.0	0.0 0.0	15.4 10.0	46.2 10.0	15.4 70.0	15.4 0.0	7.7 10.0
Listen carefully to peers as they discuss scientific investigations.	0.0 0.0	0.0 0.0	15.4 10.0	46.2 20.0	30.8 40.0	0.0 20.0	7.7 0.0
Use drawing, graphing, or charting to convey new information from an agriscience activity.	0.0 0.0	0.0 0.0	7.7 10.0	38.5 70.0	38.5 10.0	7.7 0.0	7.7 10.0

Note: [a] Control group data are presented on the first level within a row (*n* =13), Treatment group data are on the second level (*n* = 10).

Table 4-42. December respondents' perceptions of student activities during classroom instruction[a]

How often do you ask students in your classroom to:	Percent Never	1x per Year	1x per Semester	1x per Month	1x per Week	1x per Day
Memorize scientific facts or information separately from activities.	27.3 12.5	0.0 6.3	9.1 25.0	36.4 37.5	27.3 18.8	0.0 0.0
Use data to construct a reasonable explanation.	0.0 0.0	0.0 0.0	13.6 6.3	18.2 50.0	50.0 25.0	18.2 18.8
Seek and recognize patterns (trends in the data or observations).	0.0 0.0	0.0 0.0	9.1 12.5	31.8 56.3	45.5 25.0	9.1 6.3
Follow a set series of steps to get the right answer to a question.	0.0 6.3	4.5 0.0	9.1 6.3	18.2 12.5	54.5 62.5	9.1 12.5
Ask questions during investigations that lead to further ideas, questions, and investigations.	0.0 0.0	0.0 0.0	4.5 0.0	18.2 25.0	40.9 56.3	36.4 18.8
Wait to act until the teacher gives instructions for the next step in the investigation.	4.5 6.3	9.1 0.0	9.1 18.8	18.2 18.8	54.5 37.5	4.5 18.8
Choose appropriate tools for an investigation.	0.0 6.3	0.0 0.0	4.5 6.3	27.3 37.5	45.5 31.3	22.7 18.8
Offer explanations from previous experiences and from knowledge gained during investigations.	0.0 0.0	0.0 0.0	0.0 6.3	9.1 18.8	45.5 43.8	45.5 31.3
Make connections to previously held ideas (or revise previous conceptions/assumptions).	0.0 0.0	0.0 0.0	0.0 0.0	9.1 31.3	40.9 31.3	50.0 37.6
Communicate investigations and explanations (purposes, procedures, and/or results of investigations) to others.	0.0 0.0	0.0 0.0	4.5 12.5	13.6 18.8	50.0 43.8	31.8 18.8
Listen carefully to peers as they discuss scientific investigations.	0.0 0.0	0.0 12.5	22.7 12.5	22.7 31.3	40.9 37.5	13.6 0.0
Use drawing, graphing, or charting to convey new information from an agriscience activity.	0.0 0.0	0.0 0.0	13.6 6.3	18.2 50.0	50.0 31.3	18.2 6.3

Note: [a] Control group data are presented on the first level within a row (*n* = 22), Treatment group data are on the second level (*n* = 16).

Table 4-43. Ask-an-expert email correspondence

	# of participants	Month of Contact	Nature of Email
Control group	1	August	Introductory
Treatment group	2	August	Introductory
		September	Introductory

Table 4-44. Participants support for implementing IBI[a]

	Percent	
	Yes	No
May		
Sought support	58.3 61.1	41.7 38.9
Have you used AskAnExpert email for support in implementing the NATAA workshop content	0.0 0.0	100 100
September		
Sought support	55.6 83.3	44.4 16.7
Did the support person attend the same NATAA workshop	22.2 33.4	88.8 50.1
Have you used AskAnExpert email for support in implementing the NATAA workshop content	0.0 0.0	100 100
Are there other ways you could be supported in your efforts to incorporate the workshop content	50.0 50.0	50.0 50.0
December		
Sought support	59.1 56.3	40.9 43.9
Did the support person attend the same NATAA workshop	38.5 33.3	61.5 66.7
Have you used AskAnExpert email for support in implementing the NATAA workshop content	0.0 0.0	100 100
Are there other ways you could be supported in your efforts to incorporate the workshop content	45.5 43.8	54.5 56.3

Note: May: Control group n = 34, Treatment group n = 18. September: Control group n = 9, Treatment group n = 6.December: Control group n = 22, Treatment group n = 16.

Table 4-45. Participant explanation for non-use of ask-an-expert follow-up support

	Frequency	
	Control Group	Treatment Group
Unaware of existence of Ask-an-Expert Follow-up Support	5	6
Didn’t know enough about the Ask-an-Expert	1	4
Didn’t think of using Ask-an-Expert	4	0
Forgot about it	2	1
Used personal contacts or peer teachers	1	0
Lack of Time	4	2
Didn’t need it	1	0
Other	3	0

Note. n = 34.

Table 4-46. Correlations between variables in January

	1	2	3	4	5	6	7	8	9	10
1. ISS	--	.35	.09	.00	-.28	-.18	-.10	.12	.32	.16
2. ITT		--	-.04	-.02	-.15	.10	-.19	.22	.10	.02
3. IS into C			--	.57	.66	.51	-.02	.10	-.33	-.65
4. C with I				--	.35	.82	-.06	.54	-.30	-.64
5. Formed CR					--	.29	.08	.01	-.42	-.56
6. Prior NATAA Participation						--	.02	.68	-.29	-.62
7. CSR							--	-.02	-.13	-.08
8. Gender								--	-.41	-.51
9. Years Teaching									--	.82
10. Age										--

Note. ISS = Integrative Science Scale; ITT = Inquiry-Based Teaching Techniques Scale; IS into C = Integrated Science into Curriculum; C with I = Content with levels of integration; Formed CR = Formed collaborative relationships; Prior NATAA Participation = had previously participated in a NATAA workshop; CSR = Conducted Scientific Research; Gender = Men were the baseline; Years Teaching = Number of years teaching. n = 53.

Table 4-47. Correlations between variables in May

	1	2	3	4	5	6
1. ISS	--	.21	.07	-.22	-.07	.14
2. ITT		--	.40	-.31	.23	.26
3. IS into C			--	.11	.01	.22
4. C with I				--	.06	.04
5. Formed CR					--	.29
6.SS for SI						--

Note. ISS = Integrative Science Scale; ITT = Inquiry-Based Teaching Techniques Scale; IS into C = Integrated Science into Curriculum; C with I = Content with levels of integration; Formed CR = Formed collaborative relationships; SSforSI = Sought Support for Science Integration. n = 50.

Table 4-48. Correlations between variables in September

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. ISS	--	.45	.59	.40	-.50	-.34	-.52	.21	-.25	-.17	-.16	-.01	-.02	.26	.33
2. ITT		--	.15	.35	-.39	-.21	-.45	.29	-.24	-.24	-.13	.03	-.09	-.19	-.39
3. CF - C			--	.80	-.06	.56	.48	.44	.31	.41	.49	.38	.20	.01	.11
4. CF – AP				--	.05	.57	.64	.23	.54	.34	.42	.09	.01	-.14	-.01
5. CF - Time					--	.17	.12	-.18	.21	.17	.03	-.32	.08	-.29	.35
6. SCS						--	.89	.60	.75	.85	.93	.69	.12	-.28	-.05
7. SCS – CL							--	.34	.77	.65	.71	.42	.14	-.35	-.07
8. SCS – TC								--	-.01	.45	.74	.49	.17	-.06	-.04
9. SCS – PD									--	.58	.51	.19	-.06	-.26	-.17
10. SCS – UofP										--	.78	.69	-.24	.19	.19
11. SCS – CS											--	.69	.07	-.05	-.10
12. SCS – LP												--	-.21	.41	-.23
13. C with I													--	-.65	.11
14. Formed CR														--	.14
15. SS for SI															--

Note. ISS= Integrative Science Scale; ITT = Inquiry-Based Teaching Techniques Scale; CF-C = Coherence Core Facet; CF-AP = Active Participation Core Facet; CF-Time = Adequate amount of time in PD; SCS = School Culture Scale; SCS-CL = Collaborative Leadership in SCS; SCS-TC = Teacher Collaboration in SCS; SCS-PD = Professional Development in SCS; SCS-UofP = Unity of Purpose in SCS; SCS-CS = Collegial Support in SCS; SCS-LP = Learning Partnership in SCS; C with I = Content with levels of integration; Formed CR = Formed Collaborative Relationships; SSforSI = Sought Support for Science Integration. n = 25.

Table 4-49. Correlations between variables in December

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. ISS	--	.43	.67	.14	-.06	-.17	-.22	-.23	-.23	-.02	-.04	-.12	.04	.26	.21	.04	.65	.08
2. ITT		--	-.15	-.17	.01	-.42	-.26	-.31	-.33	-.33	-.17	-.31	.09	.30	.40	-.01	.34	-.01
3. CF - C			--	.27	-.12	.15	.01	-.01	.02	.34	.30	-.00	.20	.12	.08	-.28	.14	-.14
4. CF – AP				--	-.40	.18	.20	.17	.16	.10	.07	-.14	.15	-.11	.07	.05	-.14	-.01
5. CF - Time					--	.03	.06	.09	.09	-.07	-.03	-.03	.09	.08	.22	-.28	.16	.08
6. SCS						--	.93	.84	.81	.92	.88	.63	.30	.05	.02	-.15	-.31	-.25
7. SCS – CL							--	.72	.67	.86	.79	.52	.26	.05	.03	-.05	-.28	-.17
8. SCS – TC								--	.98	.67	.64	.42	.20	.20	.08	-.16	-.20	-.33
9. SCS – PD									--	.66	.61	.40	.20	.16	.04	-.18	-.24	-.30
10. SCS–UofP										--	.85	.49	.33	.09	-.08	-.20	-.31	.23
11. SCS–CS											--	.48	.32	.10	.08	-.17	-.28	-.19
12. SCS–LP												--	.14	-.23	.18	-.06	-.23	-.13
13. TAP													--	-.03	.11	-.09	-.06	-.07
14. IS into C														--	.29	-.19	.14	.11
15. FormedCR															--	.03	.08	-.21
16. SSforSI																--	-.06	.22
17. CSR																	--	-.13
18. YT																		--

Note. ISS = Integrative Science Scale; ITT = Inquiry-Based Teaching Techniques Scale; CF-C = Coherence Core Facet; CF-AP = Active Participation Core Facet; CF-Time = Adequate amount of time in PD; SCS = School Culture Scale; SCS-CL = Collaborative Leadership in SCS; SCS-TC = Teacher Collaboration in SCS; SCS-PD = Professional Development in SCS; SCS-UofP = Unity of Purpose in SCS; SCS-CS = Collegial Support in SCS; SCS-LP = Learning Partnership in SCS; TAP =Teacher Attitudes towards Professional Development; IS into C = Integrated Science into Curriculum; Formed CR = Formed Collaborative Relationships; SSforSI = Sought Support for Science Integration. CSR = Conducted Scientific Research; YT = Number of years teaching. n = 38.

Table 4-50. Regression analysis of respondents' perceptions of science integration in January, May September and December

	B	*SE*	Beta	*t*	*p*	R^2_{adj}
			January			
ISS						
ITT	.014	.007	.346	2.017	.053	.346*
			May			
ISS						
ITT	-.027	.026	-.206	-1.050	.304	.042
			September			
ISS						
ITT	.011	.006	.548	1.736	.126	.301
ISS						
ITT	.015	.003	.768	5.117	.002	
SCS	-.668	.127	-.789	-5.260	.002	.875*
ISS						
ITT	.012	.003	.627	4.075	.015	
SCS	-.686	.108	-.810	-6.323	.003	
CF-Co	.101	.118	.141	.855	.441	
CF-Ap	.137	.100	.195	1.365	.224	.940*
			December			
ISS						
ITT	.007	.004	.431	1.789	.095	.186
ISS						
ITT	.005	.004	.314	1.248	.234	
SCS	-.226	.174	-.328	-1.303	.215	.280
ISS						
ITT	.005	.003	.342	1.874	.086	
SCS	-.164	.127	-.238	-1.296	.219	
CF-Co	.647	.181	.615	3.580	.004	.652*
ISS						
ITT	.006	.003	.358	1.929	.080	
SCS	-.177	.129	-.257	-1.373	.197	
CF-Co	.656	.183	.624	3.584	.004	
TAP	.125	.146	.151	.857	.410	.674*

Note. * Model Significant at $\alpha = .05$. January $n = 53$, May $n = 50$, September $n = 25$, December $n = 38$.

Table 4-51. Regression analysis of respondents' perceptions of inquiry-based teaching techniques in January, May September and December

	B	*SE*	Beta	*t*	*p*	R^2_{adj}
			January			
ITT						
ISS	8.294	4.113	.346	2.017	.053	.346*
			May			
ITT						
ISS	-1.562	1.487	-.206	-1.050	.304	.042
			September			
ITT						
ISS	27.529	15.862	.548	1.736	.126	.301
ITT						
ISS	53.194	10.396	1.060	5.117	.002	
SCS	37.741	8.803	.888	4.287	.005	.828**
ITT						
ISS	64.484	15.825	1.285	4.075	.015	
SCS	45.667	12.075	1.075	3.782	.019	
CF-Co	-2.789	9.106	-.078	-.306	.775	
CF- Ap	-8.648	7.572	-.246	-1.142	.317	.877*
			December			
ITT						
ISS	27.328	15.275	.431	1.789	.095	.186
ITT						
ISS	21.568	17.277	.340	1.248	.234	
SCS	-9.017	11.907	-.207	-.757	.462	.220
ITT						
ISS	41.938	22.385	.662	1.874	.086	
SCS	-5.322	11.838	-.122	-.450	.661	
CF-Co	-29.174	21.310	-.438	-1.369	.196	.326
ITT						
ISS	44.765	23.205	.707	1.929	.080	
SCS	-3.353	12.404	-.077	-.270	.792	
CF-Co	-31.596	22.029	-.474	-1.434	.179	
TAP	-9.339	13.144	-.177	-.711	.492	.355

*Note.** Model Significant at α = .05. ** Model Significant at α = .01. January *n* = 53, May *n* = 50, September *n* = 25, December *n* = 38.

CHAPTER 5
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The purpose of this study was to describe the influence of the train-the-trainer professional development model on NATAA workshop participants' perceptions of science integration in agriculture and inquiry-based instruction, as well as the relationships between the components of high-quality teacher professional development. The study implemented an experimental online follow-up support system for the professional development.

Chapter 1 established the importance of examining high-quality professional development for secondary agriculture teachers. The Chapter also offered an overview of the national need to explore models of teacher professional development. Further, it provided the history and need for high-quality teacher professional development and detailed the importance of research examining the impacts of professional development on teachers' perceptions and practice.

Chapter 2 provided the model of high-quality teacher professional development that utilized a train-the-trainer form for professional development, which guided the study. Constructivism guided this study's conceptual framework, which was described and supported by empirical evidence. The review of literature contained a synthesis of research concerning the core facets for high-quality teacher professional development, the components of train-the-trainer models of professional development, as well as the role of teacher knowledge and practice, educational policy, school culture and student learning outcomes in teacher professional development.

Chapter 3 provided the research methodology of this study, including a description of the research design, population, instrumentation, data collection procedures, and data analysis. The dependent variables in this study were the participants' perceptions of science integration in agriculture and implementation of inquiry-based instruction. The independent variables were the core facets of high-quality teacher professional development, school culture, and individual teacher variables. The treatment group received additional follow-up support throughout the year following the NATAA workshop experience. Using a census of secondary agriculture teachers who attended National Agriscience Teacher Ambassador Academy (NATAA) workshops, the quasi-experimental design utilized a questionnaire at four data collection points throughout the year following the workshop to assess teacher perceptions of science integration in agriculture and inquiry-based instruction. Data analysis consisted of descriptive statistics, analysis of covariance, Pearson's Product Moment and bi-point serial correlations, and regression methods.

Chapter 4 presented findings related to each of the six objectives. A full description of the results related to each objective was provided.

Chapter 5 offers a summary of the study and provides conclusions grounded in each objective's findings. Additionally, the chapter presents recommendations for future research, teacher preservice education, professional development programs.

Objectives

This study was designed to describe the influence of the train-the trainer professional development model of workshop participants' perceptions of science integration in agriculture and inquiry-based instruction. The specific objectives guiding this research study were to:

- describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture following a trainer-led professional development workshop.

- describe the NATAA workshop participants’ immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a trainer-led professional development workshop.
- describe the NATAA workshop participants’ utilization of NATAA follow-up support after a trainer-led professional development workshop.
- determine the effects of follow-up on NATAA workshop participant’s perceptions of science integration in agriculture and IBI.
- determine the relationship between NATAA workshop participants’ perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model (teacher variables, professional development program variables, school culture and other professional development).
- determine the predictive variation of teacher perceptions of science integration in agriculture and IBI based on elements of the high-quality teacher professional development model.

Methods

This study utilized a quasi-experimental, posttest-only comparison group design (Campbell & Stanley, 1963). Dependent variables included teachers’ perceptions of science integration in agriculture and implementation of inquiry-based instruction (IBI). Independent variables included in this study were the core facets of high-quality teacher professional development, school culture, and teacher variables.

The study’s population was secondary agricultural teachers who attended NATAA workshops at the 2012 National FFA Convention and the 2012 National Association of Agriculture Educators (NAAE) National Convention. This study was a census, so all member of the population were contacted to participate in the study.

The primary event for this study was the workshops at the 2012 National FFA and NAAE conventions. An experimental intervention was created consisting of an email follow-up support which provided participants with the opportunity to answer questions that arose as they implemented the workshop content in their classrooms.

The NATAA ask-an-expert email was created and staffed by a NATAA trainer to answer and assist participants in implementing the NATAA workshop content. Participants were informed to the support service offered by the ask-the-expert email at the conclusion of all NATAA workshops and were reminded of the NATAA ask-an-expert follow-up support during the initial data collection point email.

Participants randomly assigned to the experimental group received an initial email from the ask-an-expert email address that explained the follow-up support program and encouraged participation in the follow-up. For the first 5 months passive monthly emails were sent from the ask-an-expert to the experimental group to remind them that the ask-the-expert support resource was available to them. These emails encouraged participants to use the email resources to assist with lesson planning and IBI implementation, though didn't provide any extra information concerning IBI implementation. Beginning in June 2013 the email reminders were altered to include more active support of IBI implementation. The monthly emails for the duration of the study included two to three frequently asked question from the ask-the-expert, as well as mini-lesson ideas, key components of IBI and strategies to support implementation of IBI.

The survey instruments used in this study were based on previously implemented surveys. To assess the dependent variables the Integrative Science Survey (ISS) instrument and the Inquiry-based Teaching Techniques (ITT) instrument were used. The ISS was developed was used to identify participant perceptions of integrating science and agriculture. The instrument used 5-point Likert-type scales to assess teacher perceptions related to preparation for, barriers to, and support for integrating science into agriculture programs. The ITT instrument was used to examine teachers' perceptions related to their use of inquiry-based teaching practices by having teachers to report the frequency of engagement in inquiry-based instructional practices and their perceptions of IBI on student learning outcomes.

A variety of surveys were utilized to assess the independent variables. Researcher-developed questions were utilized to assess the teachers' perceptions of the core facets of teacher professional development of the NATAA workshops as well as the demographic information of the participants. The School Culture Survey (SCS) and the Teacher Attitudes about Professional Development (TAP) scale were also utilized. The SCS included 35 Likert-type questions, from strongly disagree to strongly agree, that examined six factors related to school culture (Gruenert, 1998). The six factors were: (a) collaborative leadership, (b) teacher collaboration, (c) professional development, (d) collegial support, (e) unity of purpose, and (f) learning partnerships. The TAP scale used five Likert-type questions to assess how favorably teachers respond to professional development initiatives.

There were four data collection points within this study. The initial survey instrument included the ISS, ITT and demographic information questions in January. The second survey instrument completed by the participants included the ISS and ITT scales in May. The third data collection point used the ISS, ITT, and SCS to gather participants' perceptions in September. In December, the final survey utilized the ISS, ITT, SCS, TAP, and additional survey questions related to the professional development experiences over the past year.

Data were analyzed through SPSS version 20. Data corresponding to each objective were analyzed through the use of descriptive statistics, analysis of covariance, Pearson's Product Moment and bi-point serial correlations, as well as regression methods.

Summary of Findings

Findings are summarized following the study's objectives. There were 172 teachers who originally able to contacted and consented to participate in the study in January and May (control = 100, treatment = 90). Additional participants were unable to be contacted at the final two data collections points leading to 148 participants in September and December (control = 88, treatment = 78). It should be noted that the response rates for varied for each objective and data collection point, and only 21 participants responded at all four data collection points.

Description of Population

The population in this study consisted of secondary school-based agricultural education teachers who attended an NATAA workshop at the 2012 National FFA Convention or the 2012 National Association. A majority of respondents in this study were female (control = 61.8%, treatment = 59.1%). The mean age (control = 39, treatment = 59.1) and average numbers of years teaching (control = 15.03, treatment = 14.61) were similar for both the control and treatment group.

Additional data were collected to assist in describing the participants' perceptions of their attitude towards professional development, their perceptions of school culture, and the facets of high-quality teacher professional development that occurred at the NATAA workshops.

Respondents indicated generally positive attitudes towards professional development, and reported that professional development helped teachers develop new teaching techniques. All of the respondents agreed their teaching had been enriched by professional development events.

In relation to teachers' perceptions of school culture, the subscale of teacher collaboration was the least agreed with, indicating that a majority of respondents felt that teachers were unaware of what others were teaching and that teachers didn't spend time planning together or observing each other teaching. The respondents agreed most with concept that teachers utilize professional networks to obtain information and resources for classroom instruction, which was part of the professional development subscale. The two most agreed with subscales were professional development and collegial support.

The respondents' perceptions of four facets of high-quality teacher professional development were assessed: duration, collective participation, coherence, and active participation. A majority of respondents reported the length of time spent in the workshop was adequate for them to gain the knowledge and practice need to implement the workshop content in their classrooms. A majority of respondents did not attend the NATAA workshop with any teachers or administrators from their school. However, almost half of all respondents indicated that they attended the workshop with teachers or administrators from their state. A vast majority of respondents indicated that the workshop aligned with their individual beliefs concerning science integration and their prior knowledge about science integration and IBI. More than half of the respondents indicated that the NATAA workshop aligned with their school or school district, state, and national policies. In regards to active participation in the NATAA workshop, a majority of respondents indicated that they had the opportunity to ask questions during the workshops and complete the student activity/experiment that was provided by the workshop.

Objective One

Objective one sought to describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture following a trainer-led professional development workshop. The results indicated that the respondents had favorable perceptions of science integration overall and most respondents indicated they planned to increase the levels of science integration in their agricultural programs. Nearly all respondents indicated they had integrated science into their agricultural education programs, though the percentage of respondents who indicated they were content with the level to which they currently integrate science varied between data collection point and group. The Integrative Science Survey (ISS) asked respondents to complete subscales assessing their perceptions towards: integration of science, preparation to integrate science, support for integration, and the student impact of integration, barriers to integration, and their level of integration.

The first subscale of ISS assessed respondents' perceptions of the integration of science into agricultural programs. At all data collection points, a vast majority of respondents agreed that science concepts are easier for students to understand when science is integrated into an agricultural education program and that students are better prepared in science after they have completed a course in agriculture education that integrates science. Additionally, in September and December, a majority of respondents indicated that students are better able to make connections between scientific principles and agriculture when science is integrated into agricultural education programs. At all four data collection points respondents disagreed with the statements that ‘less effort is required to integrate science in advance courses as compared to introductory courses’ and ‘it is more appropriate to integrate science in advanced courses than into introductory courses’.

The second subscale of the ISS examined respondents’ perceptions of preparation to integrate science into their curriculum. At all data collection points, fewer respondents reported feeling prepared to teach integrated physical science concepts than integrated biological science concepts. A vast majority of respondents at all data collection points indicated teacher preparation programs in agricultural education should provide instruction on science integration. Though there was support for providing preservice teachers with cooperating teachers who model science integration as well as early field experiences and student teaching internships with teachers and programs that integrate science, there was great variation in the level of agreement over the four data collection points.

The third subscale of the ISS examined respondents’ perceptions of the impact science integration has on student recruitment. At all data collection points, a majority of respondents reported a perceived increase in total program enrollment. In May, September, and December, a majority of responses indicated a perceived increase in high achieving students’ enrollment in agriculture programs that integrated science content. A perceived decrease in enrollment in agricultural programs when integrating science related to low achieving students was most commonly reported at all four data collection points.

The fourth subscale of the ISS gathered respondents' perceptions of the barriers to integrating science into agricultural classes and programs. It should be noted that all items in this scale are reverse coded, denoting that disagreement with the statement indicates positive perceptions of science integration. A vast majority of respondents from all data collection points disagreed with the notion that science integration is not necessary and there is a lack of administrative support for science integration. The most agreed-with statements were related to concerns about insufficient time and support to plan implementation, lack of funding and necessary materials, as well as concerns about large class sizes.

Objective Two

Objective two was to describe the NATAA workshop respondents' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a trainer-led professional development workshop. The Inquiry-based Teaching Techniques (ITT) instruments asked respondents respond to items on two subscales assessing the frequency of IBI teacher practices and student practices.

The initial subscale assessed by the ITT examined the respondents' perceptions of the extent to which they use different teaching methods and activities in general for all of their classes. Though the percentages changed at each data collection point, the teaching methods that respondents reported utilizing the least were using a textbook as the primary method for studying agriscience and asking a question or conducting an activity that calls for a single correct answer. At all data collection points, a majority of respondents reported asking questions that encourage observation, investigation, and scientific thinking, as well as providing students with a wide variety of resource materials for scientific investigation more than once a week. Respondents were provided the same subscale and asked to complete it with one specific class in mind. These responses mirrored the respondents' responses of the subscale when applied to all courses in general.

The second subscale of the ITT assessed the respondents' perceptions of the frequency of student activities during their classroom instruction. In January, a majority of responses indicated that respondents perceived using the student activities between once per day and once per month. In May, all of the respondents reported using each student activity at some point during the year; however the most frequently selected response in May were one time per day. In September, nearly all responses indicated respondents were requiring students to use the items on the scale at least once a month. The only activity teachers reported never having a student do in their classroom was memorize scientific facts or information separately from activities. While in December, the most frequently selected answer for this subscale was once per week.

Objective Three

Objective three was to describe the NATAA workshop respondents' utilization of NATAA follow-up support after a Trainer-led professional development workshop. Only three respondents (1 control group, 2 treatment group) contacted the ask-an-expert email throughout the duration of the study. Each email was introductory in nature, allowing respondents to confirm they had the correct email address if they needed support. This level of participation was corroborated through the survey instruments as none of the respondents reported utilizing the ask-an-expert email for support. A majority of respondents reported seeking support for implementing the content of the NATAA workshop and indicated the person they sought support from did not attend the NATAA workshop with them. When asked if there were other support structures that could be developed to help teachers implement NATAA workshop content, the respondents were split between wanting supports and not wanting supports.

Objective Four

Objective four sought to determine the effects of follow-up on NATAA workshop participants' perceptions of science integration in agriculture and IBI. Analysis could not be completed because participants did not utilize the experimental email follow-up support.

Objective Five

Objective five was to determine the relationship between NATAA workshop participants' perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model (teacher variables, professional development program variables, school culture and other professional development). The dependent variables within this study, agriscience Integration (ISS scale) and IBI (ITT scale), were found to have moderate positive relationships at three of the data collection points (Jan. r = .35, Sept. r = .45, Dec. r = .43), and low positive relationship (r = .21) in May.

Additionally in September and December, a positive substantial correlation existed between the ISS and the Core Facet of Coherence (Sept. r = .59, Dec. r = .68). In December, an additional positive substantial correlation was found between the ISS and respondents who reported they had conducted scientific research (r = .65).

In January, a positive moderate correlation was found between the ISS and the number of years respondents reported being a teacher (r = .32). In May, there was also a positive moderate correlation between the ITT and respondents who had integrated science into the curriculum (*r* = .40) and those who were content with their levels of science integration (*r* = .31).

In September, three moderate correlations were found between the ISS and independent variables. A positive moderate correlation was found between the ISS and the core facet of active participation (*r* = .40) as well as for respondents who had sought support for science integration (*r* = .33). A negative moderate correlation was found between the ITT and the overall school culture survey (*r* = -.52). The ITT was found to be moderately negatively associated with the constructs of the core facet element of time (*r* = -.35), the collaborative leadership element of school culture (*r* = -.45), and respondents who sought support for science integration (*r* = -.39). A positive moderate association existed between the ITT and the core facet of active participation (*r* = .35).

In December, the ITT was found to be moderately positively associated with teachers who reported they integrated science into their curriculum (*r* = .30), formed collaborative relationships (*r* = .40), and conducted scientific research (*r* = .34). The ITT was found to be moderately negatively associated with teachers' perceptions of school culture: overall school culture (*r* = -.42), teacher collaboration in school culture (*r* = -.31), professional development in school culture (*r* =-.33), unity of purpose in school culture (*r* = -.33), and learning partnerships in school culture (*r* = -.31). Additional positive and negative correlations of low magnitudes were found in great variation among the dependent and interdependent variables at each data collection point.

Objective Six

Objective six was to predict teacher perceptions of science integration in agriculture and IBI based on the elements of the high-quality teacher professional development model.

First, regression analyses were conducted in relation to the teachers integrated science scores (ISS). Five models were discovered which provided significant predictors to science integration in agriculture as a dependent variable. In January, the regression model included only the ITT (R^2_{adj} = .346, p < .05), which was found to be a significant predictor. In September, model one included the ITT and SCS (R^2_{adj} = .875, p < .01) as significant predictors, while model two included ITT, SCS, core facet of coherence and core facet of active participation (R^2_{adj} = .940, p < .01) as significant predictors of the ISS. In December, the portion of the ISS due to model three, which included the ITT, SCS, and the core facet of coherence (R^2_{adj} = .652, p < .01) and the portion of ISS due to model four, which included the ITT, SCS, core facet of coherence, and the TAP (R^2_{adj} = .674, p < .01), was also found to be a significant predictor.

Additional multiple regression analysis were conducted with the ITT as the dependent variable. Only three models were found to be significant predictors of the ITT throughout the duration of the study. In January, the ISS was found to be a significant predictor of the ITT (R^2_{adj} = .346, p < .05). Additionally, in September, a model using the ISS and SCS (R^2_{adj} = .828, p < .01), and a second model which included the ISS, SCS, core facet of coherence, and core facet of active participation (R^2_{adj} = .877, p < .05) were found to be a significant predictors of the ITT.

Conclusions

The findings are limited to the population of this study. With this limitation in mind, and based on the findings of this study, several conclusions can be drawn.

1. Respondents of this study have favorable attitudes towards integrating science into their programs. Respondents indicate that integrating science into agriculture courses makes science concepts easier to understand for students and better prepares students in science. Additionally, respondents report that science integration is appropriate at all levels of an agriculture program. These are supported

by the grand means (3.74, 3.79, 3.66, 3.82), which are interpreted on a five point Likert scale.

2. Respondents in this study are more comfortable teaching biological science concepts than physical science concepts in agricultural programs.

3. Agriculture teachers recognize the need to have preservice teachers gain experiences, during early field experiences and student teaching internships, in agriculture programs that integrate science.

4. Respondents in the study indicate that when science integration in agriculture occurs, there is an increase in total program enrollment as well as an increase in enrollment of high achieving students, though some respondents indicate an enrollment decrease of low-achieving students.

5. Respondents feel that science integration into agriculture programs is positive, and indicated the biggest challenges to integrating science into programs are the amount of planning time and support needed while integrating science as well as a lack of funding.

6. All respondents indicate utilizing the teaching methods exemplified by IBI. The teaching methods respondents indicate that they used least frequently are not methods associated with IBI teaching practice.

7. A majority of respondents indicate they had sought support as they integrated science and implemented IBI, though no respondents utilized the experimental ask-the-expert email support. Additionally, the majority of respondents did not seek support from someone who attended the NATAA workshop with them.

8. As respondents' perceptions of science integration in agriculture become more positive, implementation of IBI increased.

9. As respondents' perceptions of science integration in agriculture becomes more positive, their perception of the NATAA workshops' coherence with their individual beliefs, as well as state and national policy, increases. Likewise, as respondents' perceptions of active participation within the workshop increase, so their perceptions of science integration in agriculture becomes more positive. Respondents who participated in scientific research and respondents who had sought support in integrating agriscience have increased perceptions of science integration in agriculture. Additional low and moderate correlations are identified, however they varies greatly between data collection point. As the number of years respondents had been teaching increases, so do their perceptions of science integration in agriculture.

10. Respondents who had integrated science into the curriculum and those who were content with their levels of teaching implement IBI methods more frequently. Additionally, as the frequency with which respondents utilized IBI techniques increases, the respondents' perceptions of active participation within the workshop

increase. However, as respondents' perceptions of IBI increase, their perceptions of school culture decrease. An examination of the subscales of school culture in relation to teachers' use of IBI indicate that as respondents utilized IBI more frequently, respondents' perceptions of teacher collaboration, professional development, unity of purpose and learning partnerships in school culture decrease.

11. A variety of models were found to be significant predictors of respondents' perceptions of science integration in agriculture. Those models include a variety of independent variables, such as the ITT, overall school culture scores, core facet of coherence, core facet of active participation, and teacher attitudes towards professional development. The respondents' ITT scores provide a range of effect size (.21 to .77) in each of the significant models. Additionally, at one data collection point, overall school culture provided the strongest effect (.70 to .81) on the significant models. At a second data collection point the core facet of coherence had the strongest effect (.62 to .63).

12. Three models were found to be significant predictors of respondents' implementation of IBI. Those models include a variety of independent variables, such as the ISS, overall school culture cores, the core facet of coherence, and the core facet of active participation.

Implications from Findings

Objective One: Describe the NATAA workshop participants' immediate and long-term perceptions of science integration in agriculture following a trainer-led professional development workshop

Conclusion: Respondents of this study have favorable attitudes towards integrating science into their programs. Respondents indicate that integrating science into agriculture courses makes science concepts easier to understand for students and better prepares students in science. Additionally, respondents report that science integration is appropriate at all levels of an agriculture program. These are supported by the grand means (3.74, 3.79, 3.66, 3.82), which are interpreted on a five point Likert scale.This conclusion implies that integrating science into agriculture programs will produce more science-literate students who are better prepared to compete in today's society, which concurs with previous literature (Thompson & Balschweid, 1999; Layfield et al., 2001, Myers & Washburn, 2008; Myers, Thoron, & Thompson, 2009). Additional findings from this study found that respondents felt students would be better prepared in science after completing a course in agriculture that integrated science, and those students may learn more about agriculture when science is an integral part of their instruction. Science integration in agriculture may also help students make connections between science and agriculture concepts.

Conclusion: Respondents in this study are more comfortable teaching biological science concepts than physical science concepts in agricultural programs. This conclusion indicates that teachers may have higher levels of self-efficacy in biological sciences and may have been better prepared to teach biological science then physical sciences. This conclusion aligns with previous literature, which found that teachers emphasized a greater understanding of biological sciences than physical sciences (Thompson & Balschweid, 1999). If science integration is going to continue to emphasize in agricultural education programs it may be essential to conduct professional development that demonstrates the use of biological sciences and especially physical sciences in agriculture. These professional development opportunities will help teachers to develop similar levels of comfort both science constructs. However, all respondents did not agree it was essential to require additional science coursework in preservice preparation programs. They did indicate it was important for preservice teachers to be provided with instruction on how to integrate the science principles and concepts into agriculture courses. This may imply that the teachers think that the preservice teachers have the content knowledge, but need to know how to utilize it in the classroom setting. Teacher education programs should develop resources to focus on an integrated track for preservice teacher preparation, as well as continue to provide inservice professional development for science integration.

Conclusion: Agriculture teachers recognize the need to have preservice teachers gain experiences, during early field experiences and student teaching internships, in agriculture programs that integrate science. This indicates that respondents see the need for preservice agriculture teacher preparation programs to provide preservice teachers with examples of agricultural teaching in secondary agriculture programs that strongly integrate science. It is essential that teacher preparation programs identify agriculture programs that integrate science into their programs at high levels and utilize these programs when placing preservice teachers for early field experiences and student teaching internships. Providing preservice teachers with exemplary practicing teachers that integrate science will provide preservice teachers with examples of science integration in agricultural contexts, but also provide the opportunity to practice integrating science into agricultural curriculum under the guidance of an experienced teacher.

Conclusion: Respondents feel that science integration into agriculture programs is positive, and indicated the biggest challenges to integrating science into programs are the amount of planning time and support needed while integrating science as well as a lack of funding. This implies that teachers who have already started to integrate science may have experienced an increase in total program enrollment because of science integration, as well as an increase in enrollment from high achieving students. However, integration of science may change low achieving students' perceptions about agriculture programs that integrate science, causing a decrease in enrollment of low achieving students.

Conclusion: Respondents feel that science integration into agriculture programs is positive, and indicated the biggest challenges to integrating science into programs are the amount of planning time and support needed while integrating science as well as a lack of funding. These findings are similar to previous findings that indicated insufficient time and planning support was the biggest barrier to integrating science into agricultural education curriculum (Balschweid & Thompson, 2002; Warnick & Thompson, 2007; Myers, Thoron, & Thompson, 2009). This implies that there is a need for increased planning time for teachers as they implement science integration and that systems must be developed that will support teachers as they create changes in their classroom practices. Additionally, avenues of financial support that can provide agricultural teachers with the classroom supplies and professional development to implement science integration in agriculture must be developed.

Objective Two: Describe the NATAA workshop participants' immediate and long-term perceptions of inquiry-based instruction (IBI) implementation following a trainer-led professional development workshop

Conclusion: All respondents indicate utilizing the teaching methods exemplified by IBI. The teaching methods respondents indicate that they used least frequently are not methods associated with IBI teaching practice, such as using a textbook as the primary means of studying agriscience and asking students questions or providing activities that have one correct answer. Though the frequency of teachers' use of IBI techniques changed based on the specific data collection points, these findings indicate that the frequency was slightly lower than frequencies reported by NATAA teacher trainers in previous studies (Myers, Thoron, & Thompson, 2009). This may indicate that the professional development provided for the NATAA trainers supports implementation of IBI techniques more adequately then the NATAA workshops provided by the trainers. It may also indicate predisposed differences between NATAA trainers and the respondents of this study related to motivation levels, attitudes, and abilities to integrate science and agriculture.

Objective Three: Describe the NATAA workshop participants' utilization of NATAA follow-up support after a trainer-led professional development workshop

Conclusion: A majority of respondents indicate they had sought support as they integrated science and implemented IBI, though no respondents utilized the experimental ask-the-expert email support. Additionally, the majority of respondents did not seek support from someone who attended the NATAA workshop with them. This finding suggests that teachers may seek support for science integration and IBI implementation through personal contacts. It may also indicate that email supports are not deemed useful by secondary teachers or that teachers forget the online resources provided by professional development programs that may provide support for implementing professional development content.

Objective Five: Determine the relationship between NATAA workshop participants' perceptions of science integration in agriculture and IBI and selected elements of the high-quality teacher professional development model

Conclusion: As respondents' perceptions of science integration in agriculture became more positive, teachers' implementation of IBI increased. This moderate, or low, positive relationship indicates that positive perceptions of science integration in agriculture and implementation of IBI are closely related. It may indicate that teachers with positive perceptions of science integration are more willing to implement science teaching techniques such as IBI. It may also indicate that as teachers implement IBI, their perceptions of science integration into agricultural education become more positive. These close relationships provide a foundation for how to increase teachers' use of IBI and support for science integration in to agricultural education programs.

Conclusion: As respondents' perceptions of science integration in agriculture became more positive, their perception of the NATAA workshops coherence with their individual beliefs, as well as state and national policy increased. Likewise, as respondents' perceptions of active participation within the workshop increased, so did their perceptions of science integration in agriculture. Also, respondents who participated in scientific research and respondents who had sought support in integrating agriscience had more positive perceptions of science integration in agriculture. Additional low and moderate correlations were identified, however they varied greatly between data collection points.

The great variety in the correlations between elements of high-quality teacher professional development and teachers' perceptions of science integration in agriculture provides support for further research examining the relationship between the variables. As teachers' perceptions of the NATAA workshops implementation of core facets such as coherence and active participation increased so did their perceptions of science integration in agriculture. This implies that when teachers deem professional development to be coherent with their individual beliefs, as well as the current state and national policies, they have more positive perceptions of science integration in agriculture. This may also indicate that they selected to attend the professional development because it aligned with their previous beliefs about science integration in agriculture. The findings also support active respondents' important role in teacher professional development.

There was not a significant relationship found between the core facet of collective participation and the teachers' perceptions of science integration in agriculture. A majority of respondents indicated that there were no other teachers from their school or school district who participated in the NATAA workshop with them, however there were agriculture teachers from their state within the NATAA workshop. This may indicate that there was not a sense of collaboration created within the workshops due to the distance between respondents.

Additionally these findings indicated that respondents who conducted scientific research had more favorable perceptions of science integration in agriculture, and indicated that getting secondary teachers involved with research influenced their perceptions of science in agriculture. Also, those teachers who sought support for integrating science had more positive perceptions of science integration into agriculture course. This indicates that support does play an important factor in teachers' implementation of science integration. Though the experimental supports provided in this study were not successful in creating changes in teachers' perceptions, it is essential to explore other options of support, especially those that are founded in teacher networking and building teachers' personal relationships.

Conclusion: Respondents who had integrated science into the curriculum and those who were content with their levels of teaching had implemented IBI methods more frequently. Additionally, as IBI implementation increased, the respondents' perceptions of active participation within the workshop increased. However as respondents' perceptions of IBI increased, their perceptions of school culture decreased. An examination of the subscales of school culture in relation to teachers' use of IBI indicated that as respondents utilized IBI more frequently, respondents' perceptions of teacher collaboration, professional development, unity of purpose and learning partnerships in school culture decreased. This indicates that the implementation of IBI and the school culture, as well as the individual subscales, may be closely related and may have negatively impacted each other.

The variation in the remaining relationships between ISS and ITT and the independent variables indicates that there is great change over time in teachers' perceptions of science integration in agriculture and implementation of IBI. Though additional low positive and negative correlations were found, it is important to recognize the element of time in each of these correlations.

Objective Six: Determine the predictive variation of teacher perceptions of science integration in agriculture and IBI based on elements of the high-quality teacher professional development model

Conclusion: A variety of models were found to be significant predictors of respondents' perceptions of science integration in agriculture. Those models included a variety of independent variables, the ITT, overall school culture scores, core facet of coherence, core facet of active participation, and teacher attitudes towards professional development. The respondents' ITT scores provided a range of effect size (.21 to .77) in each of the significant models. Additionally, at one data collection point, overall school culture provided the strongest effect (.70 to .81) on the significant models. At a second data collection point the core facet of coherence had the strongest effect (.62 to .63).

The regression models supported the relationships identified in objective five. When combined, ITT, SCS, and the core facets of coherence and active participation accounted for 94% of the variation in teachers' perceptions of science integration in September. In December, the combination of ITT, SCS, and the core facet of coherence account for 65% of the variation in teachers' perceptions of science integration. Each of these suggests that not only is there a relationship between teachers' perceptions of science integration but that they can be used to predict the frequency with which teachers implement IBI, their perceptions of their school culture, and the level of coherence of professional development with their individual beliefs to predict how they perceive science integration. This implies that manipulating these variables professional development can have a great impact on teachers' knowledge and practice related to science integration into agriculture programs.

Conclusion: Three models were found to be significant predictors of respondents' implementation of IBI. Those models included a variety of independent variables, such as the ISS, overall school culture cores, the core facet of coherence, and the core facet of active participation. In September, a combination of teachers' perceptions of ISS, SCS, and core facets of coherence and active participation accounted for 88% of the variation in the frequency of which they utilize IBI techniques. This implies that by manipulating these variables, professional development can create an increase in the frequency with which agriculture teachers utilize IBI practices.

Though both of these conclusions are significant it is important to recognize that the high effect sizes may not be a realistic representation of the variation in respondents' perceptions of science integration into agricultural education and their implementation of IBI teaching techniques. Other variables related to the teachers formative experiences, teaching experience, motivation as well as personal attitudes, values and beliefs may also influence their perceptions. Until further research is conducted to evaluate and support these high, the strength of these effect sizes should be referenced with caution.

Discussion

This study offers findings that indicate secondary agriculture teachers understand the importance of integrating science into agriculture coursework and utilizing inquiry-based instruction techniques. This study's findings also indicate that elements of the high-quality teacher professional development model impacts teachers' perceptions of science integration in agriculture and implementation of IBI. Additionally, it supports the use of the train-the-trainer form for professional development. However, the respondents' perceptions of science integration in agriculture and IBI may be influenced by numerous factors beyond the scope of professional development model.

Relationship between Science integration in agriculture and Implementation of IBI

Previously conducted studies assessed teachers' perceptions of science integration into agricultural curriculum and teachers' implementation of IBI techniques (Thompson & Balschweid, 2000; Layfield et al., 2001, Myers & Washburn, 2008; Myers, Thoron, & Thompson, 2009). However, no previous literature exists that examines the relationship between the two. This study explored that relationship and found that a moderate to low positive correlation exists between teachers' perceptions of science integration and the frequency of which they use IBI techniques. Though these findings are significant, it is essential that additional research be conducted to more deeply understand the relationship and how teacher educators can utilize that relationship to improve teachers' classroom practices. IBI is a teaching method that has been shown to advance student achievement, scientific reasoning, and argumentation (Thoron, 2010), and if influencing teachers' positive perceptions of science integration can increase the frequency with which teachers utilize IBI, it would in turn influence student learning outcomes.

High-Quality Teacher Professional Development

The core facets of high quality teacher professional development (duration, collaboration, coherence, active participation, content and form) have gained consensus, yet little is known about their implementation as well as their impacts on teacher knowledge and practice. This study differs from previous studies based on the following: 1) it moved beyond teachers' perceptions of the professional development to explore the relationships between the professional development and teachers' implementation of the professional development content, and 2) it used a quasi-experimental design to explore the core facet of duration by creating a follow up support.

Though gathering teachers' perceptions of a professional development experience is the first level of evaluating professional development, it is essential to move beyond that and evaluate the respondents learning and development of knowledge and skill (Gusky, 2000). Through the examination of teachers' perceptions of science integration and IBI over the course of the year, this study moved the research to that higher level of evaluation. The examination of the teachers' perceptions of their teaching practice and the impact of their practices is a starting point for examining their actual teaching practice. The relationships and predictive variability identified in this study should be utilized to guide future research on teacher professional development.

A common criticism of teacher professional development experiences is that they are too short and do not offer follow-up support for teachers as they implement the professional development content in their own classrooms (Penuel, Fishman, Yamaguchi, & Gallagher, 2007). This study implemented experimental email reminders as well as a ask-the-expert email system which teachers who attended the NATAA professional development could send questions to as they implementing IBI and science integration within their classrooms. The hope was to expand the duration of the professional development experience to support teachers for a year following the workshop. However, the respondents reported they felt the duration of the NATAA workshop (60 to 90 minutes) provided them with the knowledge and skill necessary to implement the specific content of the workshop in their own classrooms. Additionally, no respondents utilized the ask-the-expert email to support their implementation. This indicates that email follow-up support may not be deemed useful by teachers or teachers may not remember to use it at the appropriate times. Additionally, it may indicate that respondents utilize peers for support instead of professional development supports.

Designing Studies Accessing Teachers over Time

The procedures of this study called for surveying teachers over the course of a year, which did not align with the school year, and created challenges in contacting all members of the population for the duration of the study. The researcher expected to be able to reach the population because the participants had provided the contact information within a month of the beginning of the study. However, the contact information provided by numerous teachers was incorrect and attempts to use the provided information to locate correct information was unsuccessful. There is a need for more accurate database for teacher contact information.

Teachers were made aware of the expectations and duration of the study through initial contact before any surveys were distributed. Many teachers asked to be removed from the study after that initial contact. Those that remained in the study did not complete surveys on a consistent basis or did not complete surveys at all. Out of 178 participants, only 21 responded to surveys at all four data collection points. While the methods of this study aligned with suggested research practices, this study was challenged to have a higher level of consistent participation from the participants. Research that utilizes surveys to gather information from teachers requires a balance between rigorous research methods and methods which are practical in given situations. Understanding teachers' dispositions about completing surveys can help researchers design studies that align with teachers' abilities and desires to participate in survey research.

Recommendations for Future Research

Numerous follow-up studies could help the profession understand the impacts of high-quality teacher professional development on secondary agricultural teachers' perceptions and practices. Additionally, research should be conducted examining science integration in agriculture and implementation of IBI techniques.

Recommendations Related to Teacher Professional Development

This study provides evidence of the relationships between elements of high-quality teacher professional development and teachers' perceptions of specific teaching practices. Based upon the findings of this study related to teacher professional development, the following recommendations for further research were made:

1. More studies are needed in agricultural education, as well as teacher education in general, investigating the best methods of teacher professional development. Replication of this study involving different groups of teachers and different professional development will add to the body of knowledge for the profession.

2. The interaction between high-quality teacher professional developments' coherence and teachers' perceptions of professional development should be further explored utilizing a pre-post research method to control for teachers' pervious perceptions.

3. Replication of this study comparing the train-the-trainer form of professional development with other forms of professional development is essential to providing insight as to how the core facets of professional development can influence teacher practice.

4. Increased evaluation is needed to assess the effectiveness of train-the-trainers form of professional development, and should especially be focused on the second generation of workshops on developing teachers' knowledge and abilities.

5. Though previous literature suggests that short, one-shot workshops do not provide the duration needed to impact teaching practice, the respondents in this study indicated that the NATAA workshops, which ranged for 60 to 90 minutes provided enough time for them to understand the content and implement it in their classrooms. More research must be conducted to examine the core facet of duration in relation to the content foci of professional development experiences.

6. This study was conducted over the course of a year. Other studies that investigate the effects professional development over extended periods of time should be conducted. It is also important to develop methods for increasing teacher participation at all data collection points.

7. Further investigation is warranted to determine methods of follow-up support for teachers as they implement what they learn in professional development programs.

8. This study reported correlations between teachers' perceptions of science integration in agriculture and implementation of IBI in relation to various independent variables. Given the variation in the magnitudes of the relationships, it is important to investigate these independent variables in multiples studies, as well as explore the effects on other dependent variables.

9. This study only gathered data on respondents' perceptions of the core facets of professional development. Further research should be conducted that determines the actual implementation of the core facets within a professional development experience and the impact they have on teacher knowledge and practice.

10. This study did not take into account teachers' motivations for attending the professional development or their self-efficacy in relation to the professional development content. Future research should be conducted to assess the impact these factors have on effects of the professional development.

11. The professional development programs that are utilized in research studies should be better explained how the core facets of high-quality teacher professional development impacts the research can be better understood. Additionally this will allow for professional development designers to utilize the core facets most effectively in impacting teacher knowledge and practice.

12. Specifically the core facet of collaboration should be further examined in professional development programs for secondary agricultural teachers. Because most agriculture teachers do not attend professional development with teachers from the same school or school district, it is important to develop ways for secondary agriculture teachers to develop collaborative relationships when implementing professional development content in their classrooms.

Recommendations Related to Science Integration in Agriculture and Inquiry-Based Instruction

This study provides evidence supporting science integration in agriculture and the use of IBI in secondary agriculture classroooms. Based upon the findings of this study related to science integration in agriculture and implementation of IBI, the following recommendations for further research were made:

1. The relationship between teachers' perceptions of science integration in agriculture and the frequency with which they utilize IBI techniques in their classrooms should be further explored. Numerous studies have found that secondary agriculture teachers deem science integration into agriculture courses important to students and program development, as well as the impact that IBI techniques can have on student learning. However, the relationship between the two has not yet been fully explored.

2. Increased evaluation is needed to assess the effectiveness of the NATAA professional development series, especially focused on the second generation of workshops, on developing agriculture teachers' knowledge and abilities related to science integration and IBI.

3. The relationship between school culture and teachers' implementation of IBI techniques should be further explored.

4. Further studies should move beyond gathering teacher perceptions of total program enrollment based on science integration and should focus on the impact that

integrating science has on the number and ability level of student enrolling in agriculture programs over time.

5. More experimental studies that examine science integration and implementation of IBI are needed. Teacher self-efficacy, motivation, perceptions of agriscience and IBI should be grouping variables examined in future studies to provide for their role in how science and IBI are utilized in secondary agricultural programs.

6. Studies that utilize a time series or examine science integration and IBI over an extended period of time should be implemented to further understand how agriculture teachers adapt to these teaching practices.

Recommendations for Teacher Professional Development

This study found that elements of high-quality teacher professional development can positively relate to and predict teachers' perceptions of professional development content. These findings and implications yield several recommendations for individuals responsible for teacher professional development activities.

1. When planning teacher professional development experiences, the core facets of professional development should be considered. The coherence of the professional development with respondents' individual beliefs and experiences may play a vital role in their implementation of the professional development program content. Additionally, active participation at professional development programs is important.

2. The train-the-trainer model of professional development must develop a support structure for participants who attend workshops presented by the trainers. Though the email reminders and ask-the-expert support in the study did not work, it is essential that support be offered to teachers.

3. Though previous literature suggests that short one-shot workshops do not provide the duration needed to impact teaching practice, the participants in this study indicated that the NATAA workshops, which ranged for 60 to 90 minutes, provided enough time for them to understand the content and implement it in their classrooms. Professional development programs should examine the time needed in relation to the content of the professional development.

4. Professional development opportunities focused on content knowledge development should utilize experts from the field to assist teachers in building their knowledge.

Recommendations for Agricultural Education

This study found that secondary agriculture teachers' perceptions of science integration in agriculture and implementing IBI were positive. Teachers integrating agriculture and science and implementing IBI can be assisted through

recommendations for preservice education and professional development programs.

1. Based on the findings of this study, science integration and IBI should be utilized in secondary agriculture classrooms, though it may take time for teachers and students to adjust to the new teaching practices.

2. Additional professional development opportunities should be developed at the state and national level to increase the number of agricultural teachers who develop positive perceptions of science integration and utilize IBI techniques more frequently. As NATAA workshops occur at national conferences, a portion of agriculture teachers are not able to attend the NATAA professional development opportunities with this content focus.

3. Teacher education programs should develop coursework that demonstrates the use of agricultural contexts to integrate science. This instruction should include developing content knowledge in biological and physical sciences as well as the pedagogical knowledge needed to integrate these concepts and principles into an agricultural context.

4. Inquiry-based instructional techniques should be introduced to preservice teachers in teaching methods course. Though IBI techniques take time for teachers to develop a comfort level with its implementation, the techniques can be implemented slowly over time.

5. Mentoring programs should be developed that allow agriculture teachers with experience and practice with science integration and IBI to provide feedback, support and clarity for teachers beginning the process of integration and implementation.

6. Preservice teachers should be provided with early field experiences and student teaching experiences with teachers who have high levels of science integration in agricultural courses.

7. Teacher preparation programs should develop resources, materials, and funding initiatives for preservice and inservice teacher professional development that supports science integration and the implementation of IBI.

8. Agriculture teachers should be provided the opportunity to engage with content area experts in areas of scientific research and during professional development experiences to increase scientific content knowledge.

Summary

This chapter presented a summary of the study’s objectives and presented conclusions stemming from the findings. Chapter 5 also provided recommendations for further research, teacher professional development and agricultural education.

The study’s findings indicated that science integration in agriculture and the use of inquiry-based instruction are perceived by teachers to have a positive impact on student learning. Additionally, the findings indicate complex relationships between elements of high-quality teacher professional development, teachers’ perceptions of science integration in agriculture, and the frequency with which they implement IBI in their classrooms. These findings, combined with previous research, provided recommendations for preservice and inservice professional development for teachers, school-based agricultural education, and research seeking to further expand on the effects of professional development on teaching practice.

APPENDIX A
RESOURCE REMINDER

Subject: NATAA workshop follow-up: Do you have questions

Dear ___________________,

This email to remind you of the support service provided following your participation at the __________ convention to help you implement what you learned in your own classroom.

Feel free to contact AskAnExpert.NATAA@gmail.com any time with questions, concerns or issues that may arise as you try to put what you learned at the NATAA workshop to use in your classroom.

Your questions will be answered in a timely manner by a past NATAA Ambassador with years of experience integrative science concepts and using inquiry in their own classroom.

Hope to hear from you soon!

The Expert behind Ask an Expert

APPENDIX B
CONTENT REMINDERS

July Content Reminder

Dear ____________,

Last fall you participated in a NATAA workshop at the ___________ Convention. It was focused on science integration and implementing inquiry-based instruction in agricultural classrooms. Because of your participation you are receiving this email to support you as you try to implement these concepts in your classroom.

Also don't forget about AskAnExpert.NATAA@gmail.com! It's a free resource you can contact any time with questions, concerns or issues that may arise as you try to put what you learned at the NATAA workshop to use in your classroom. Your questions will be answered in a timely manner by a past NATAA Ambassador with years of experience integrative science concepts and using inquiry in their own classroom.

As you gear up for a new year and beginning planning your classes for the fall here is some helpful information about inquiry-based instruction.

Frequently-Asked-Questions

Question: What is inquiry-based instruction?
Inquiry-based instruction is any instruction that requires students to gain knowledge through the process of inquiry. This is when students seeks information or knowledge by actively engaging in the questioning process. There are 5 essential features of classroom inquiry (Inquiry in the National Science Education Standards, 2000):

1. Learners are engaged by scientifically oriented questions.
2. Learners give priority to evidence, which allows them to develop and evaluate explanations that address scientifically oriented questions.
3. Learners formulate explanations from evidence to address scientifically oriented questions.
4. Learners evaluate their explanations in light of alternative explanations, particularly those reflecting scientific understanding.
5. Learners communicate and justify their proposed explanations.

Question: Should I try to teach everything using inquiry-based instruction?
It's up to you to determine the best methods for your classroom, however keep in mind that teaching agriculture requires a variety of approaches and strategies. Teaching everything using inquiry would probably be ineffective, and become boring for the students.

However, you can change what essential features of inquiry you utilize during different lessons. Check out the chart at the bottom of the email for more information. The chart takes the 5 essential features and puts them on a scale of more student-centered to less student-centered. It shows how you can use some elements of inquiry without using all element of inquiry.

Hope this helped, Happy Planning!

- The Expert
AskAnExpert.NATAA@gmail.com

Essential Features of Classroom Inquiry & Their Variations

Feature of Inquiry	Less ← Student Self-Direction → More More ← Direction from Teacher → Less			
Learner engages in scientifically oriented questions	Learner engages in questions provided by teacher, materials or other source	Learner sharpens or clarifies questions provided by teacher, materials or other source	Learner selects among questions poses new questions	Learner poses a question
Learner gives priority to **evidence** in responding to questions	Learner is given data and told how to analyze	Learner is given data and asked to analyze	Learner is directed to collect certain data	Learner determines what constitutes evidence and collects it
Learner formulates **explanations** form evidence	Learner is provided with evidence	Learner is given possible ways to use evidence to formulate explanation	Learner is guided in process of formulating explanations from evidence	Learner formulates explanation after summarizing evidence
Learner connects explanations to scientific knowledge	Learner is given all connections	Learner is given possible connections	Learner is directed towards areas and sources of scientific knowledge	Learner independently examines other resources and forms links to explanations
Leaner communicates and justifies explanations	Learner is given steps and procedures for communication	Learner is provided Broad guidelines to use to Sharpen communication	Learner coached in development of communication	Learner forms reasonable and logical argument to communicate explanations

Adopted from the: National Research Council, 2000. Inquiry and the National Science Education Standards: A guide for Teaching and Learning. Washington, DC: National Academy Press.

APPENDIX C
INTEGRATIVE SCIENCE SURVEY

Section I: Perception toward integration of science

Directions: Using the scale below, please indicate the degree to which you agree or disagree with the following statements by circling the appropriate number. Please answer each question.

1 = Strongly Disagree
2 = Disagree
3 = Neither agree or disagree
4 = Agree
5 = Strongly Agree
x = Not Applicable

Example:

	SD	D	N	A	SA	NA
I enjoy teaching agriscience	1	2	3	4	5	x

		SD	D	N	A	SA	NA
1.	Students learn more about agriculture when science concepts are an integral part of their instruction.	1	2	3	4	5	x
2.	Students are more motivated to learn when science is integrated into the agricultural education program.	1	2	3	4	5	x
3.	Agriculture concepts are easier for students to understand when science is integrated into the agricultural education program.	1	2	3	4	5	x
4.	Science concepts are easier for students to understand when science is integrated into the agricultural education program.	1	2	3	4	5	x
5.	Integrating science into the agricultural education program requires more preparation time than teaching a more traditional agriculture curriculum.	1	2	3	4	5	x
6.	Less effort is required to integrate science in advanced courses as compared to introductory courses.	1	2	3	4	5	x
7.	Integrating science into agriculture classes increases the ability to teach students to solve problems.	1	2	3	4	5	x
8.	Integrating science into the agricultural education curriculum more effectively meets the needs of special population students (i.e. learning disabled).	1	2	3	4	5	x
9.	It is more appropriate to integrate science in advanced courses than into introductory courses.	1	2	3	4	5	X

10.	Students are more aware of the connection between scientific principles and agriculture when science concepts are an integral part of their instruction in agricultural education.	1	2	3	4	5	X
11.	Students are better prepared in science after they completed a course in agricultural education that integrates science.	1	2	3	4	5	X

Section II: Preparation to integrate science

Directions: Using the scale below, please indicate the degree to which you agree or disagree with the following statements by circling the appropriate number. Please answer each question.

		SD	D	N	A	SA	NA
1.	I feel prepared to teach integrated biological science concepts.	1	2	3	4	5	x
2.	I feel prepared to teach integrated physical science concepts.	1	2	3	4	5	x
3.	Teacher preparation programs in agriculture should require students to take more science courses (biology, chemistry, physics, etc.).	1	2	3	4	5	x
4.	Teacher preparation programs in agriculture should provide instruction for undergraduates on how to integrate science concepts/principles in agriculture.	1	2	3	4	5	x
5.	When placing student teachers, teacher preparation programs should expect cooperating teachers to model science integration.	1	2	3	4	5	x
6.	Teacher preparation programs should require that students conduct their early field experience program prior to student teaching with a teacher who integrates science into the agricultural education program.	1	2	3	4	5	x

Section III: Support for integration

Directions: Using the scale below, please circle the appropriate number to indicate how you feel integrating science into your agricultural education program would (or does) increase or decrease the support you receive from the following groups by circling the appropriate number.

1 = Greatly Decrease	Example:						
2 = Decrease		GD	D	N	I	GI	NA
3 = No Change	Local administrators	1	2	3	4	5	x

4 = Increase
5 = Greatly Increase
x = Not Applicable

Section IV: Impact of integration on recruitment

	How would/does integrating science into the agricultural education program affect enrollment of the following student groups:	GD	D	N	I	GI	NA
1.	High achieving students	1	2	3	4	5	x
2.	Average achieving students	1	2	3	4	5	x
3.	Low achieving students	1	2	3	4	5	x
4.	Minority students	1	2	3	4	5	x
5.	Social diversity (athletes, “popular” students, etc)	1	2	3	4	5	x
6.	Total program enrollment	1	2	3	4	5	x

Section VII: Barriers to integration

Directions: Using the scale below, please indicate the degree to which you agree or disagree with the following items being barriers to integrating science into your curriculum. Please answer each question.

1 = Strongly Disagree
2 = Disagree
3 = Neither agree or disagree
4 = Agree
5 = Strongly Agree
x = Not Applicable

Example:

	SD	D	N	A	SA	NA
Lack of experience in science integration	1	2	3	4	5	x

		SD	D	N	A	SA	NA
1.	Reluctance to give up the role of primary source of classroom information	1	2	3	4	5	x
2.	Lack of experience in science integration	1	2	3	4	5	x
3.	Lack of parent and community support for science integration	1	2	3	4	5	x
4.	Have tried it and it was unsuccessful	1	2	3	4	5	x
5.	Lack of support from local science teacher(s)	1	2	3	4	5	x
6.	Concerns about discipline	1	2	3	4	5	x

7.	Concerns about large class size	1	2	3	4	5	x
8.	Insufficient time and support to plan for implementation	1	2	3	4	5	x
9.	Lack of integrated science curriculum in courses I teach	1	2	3	4	5	X
10.	Disagreement with the notion that science integration is necessary	1	2	3	4	5	X
11.	Reluctance to diminish emphasis on agricultural production	1	2	3	4	5	X
12.	Doubts about students' capacity to handle material	1	2	3	4	5	X
13.	Lack of administrative support for science integration	1	2	3	4	5	X
14.	Insufficient funding	1	2	3	4	5	X
15.	Insufficient background in science content	1	2	3	4	5	X
16.	Don't have the necessary materials	1	2	3	4	5	X
17.	Lack of agriscience jobs in the local community	1	2	3	4	5	X

Section IX: Level of Integration

1. Have you integrated science into your agricultural education program? ❑ Yes ❑ No
If yes, how has it affected your program's enrollment?
❑ Increase ❑ Decrease ❑ No Affect

2. Are you content with the level to which you currently integrate science? ❑ Yes ❑ No

3. Which phrase best describes your future plans to integrate science into your curriculum?
    - ❑ I plan to <u>increase</u> the amount of science integration in my curriculum
    - ❑ I plan to <u>decrease</u> the amount of science integration in my curriculum
    - ❑ I plan <u>no change</u> in the amount of science integration in my curriculum

4. How many agriscience integration workshops have you attended? _____________

4a. What agency/organization sponsored the integration workshops?

5. Identify the most significant factor(s) that caused you or will cause you to integrate science into your program.

6. Have you formed collaborative relationships with an individual(s)/organization(s) that have assisted you with integration? ❑ Yes ❑ No

If yes, who have you collaboration with and in what ways?

APPENDIX D
INQUIRY-BASED TEACHING TECHNIQUES

Section V: Teacher Inquiry scale

Directions: Please answer the following questions about what happens during lessons in your classroom. Answer based on actual events in your classroom. Respond to all questions by clearly marking one of the answers.

	On average, to what extent do you:	Never	<1x per week	1x per week	2x per week	3x per week	4x per week	5x per week
1.	Use a textbook as the primary method for studying agriscience.	0	1	2	3	4	5	6
2.	Use open-ended questions that encourage observation, investigations, and scientific thinking.	0	1	2	3	4	5	6
3.	Identify agricultural situations/issues that can be investigated at varying levels of complexity.	0	1	2	3	4	5	6
4.	Encourage students to initiate further investigation.	0	1	2	3	4	5	6
5.	Ask a question or conduct an activity that calls for a single correct answer.	0	1	2	3	4	5	6
6.	Facilitate and encourage student dialogue about science.	0	1	2	3	4	5	6
7.	Encourage students to defend the adequacy or logic of statements and findings.	0	1	2	3	4	5	6
8.	Make readily available to students a wide variety of resource materials for scientific investigations.	0	1	2	3	4	5	6
9.	Encourage students to design and conduct experiments.	0	1	2	3	4	5	6

Section VI: Student Inquiry scale

Directions: Please answer the following questions about what happens during lessons in your classroom. Answer based on actual events in your classroom. Respond to all questions by clearly marking one of the answers.

	How often do you ask students	Never	1x per	1x per	1x per	1x per	1x per

	in your classroom to:		year	semeste r	month	week	day
1.	Memorize scientific facts or information separately from activities.	0	1	2	3	4	5
2.	Use data to construct a reasonable explanation.	0	1	2	3	4	5
3.	Seek and recognize patterns (trends in the data or observations).	0	1	2	3	4	5
4.	Follow a set series of steps to get the right answer to a question.	0	1	2	3	4	5
5.	Ask questions during investigations that lead to further ideas, questions, and investigations.	0	1	2	3	4	5
6.	Wait to act until the teacher gives instructions for the next step in the investigation.	0	1	2	3	4	5
7.	Choose appropriate tools for an investigation.	0	1	2	3	4	5
8.	Wait for the teacher's explanation before expressing an observation or conclusion.	0	1	2	3	4	5
9.	Offer explanations from previous experiences and from knowledge gained during investigations.	0	1	2	3	4	5
10.	Make connections to previously held ideas (or revise previous conceptions/assumptions).	0	1	2	3	4	5
11.	Communicate investigations and explanations (purposes, procedures, and/or results of investigations) to others.	0	1	2	3	4	5
12.	Use investigations to satisfy their own questions.	0	1	2	3	4	5
13.	Listen carefully to peers as they discuss scientific investigations.	0	1	2	3	4	5
14.	Use drawing, graphing, or charting to convey new information from an agriscience activity.	0	1	2	3	4	5

APPENDIX E
SCHOOL CULTURE SURVEY

School Culture Survey Factor and Items
1=Strongly Disagree 2=Disagree 3=Neutral 4=Agree 5=Strongly Agree

Collaborative Leadership
2. Leaders value teachers' ideas.
7. Leaders in this school trust the professional judgments of teachers.
11. Leaders take time to praise teachers that perform well.
14. Teachers are involved in the decision-making process.
18. Leaders in our school facilitate teachers working together.
20. Teachers are kept informed on current issues in the school.
22. My involvement in policy or decision making is taken seriously.
26. Teachers are rewarded for experimenting with new ideas and techniques.
28. Leaders support risk-taking and innovation in teaching.
32. Administrators protect instruction and planning time.
34. Teachers are encouraged to share ideas.

Teacher Collaboration
3. Teachers have opportunities for dialogue and planning across grades and subjects.
8. Teachers spend considerable time planning together.
15. Teachers take time to observe each other teaching.
23. Teachers are generally aware of what other teachers are teaching.
29. Teachers work together to develop and evaluate programs and projects.
33. Teaching practice disagreements are voiced openly and discussed.

Professional Development
1. Teachers utilize professional networks to obtain information and resources for classroom instruction.
9. Teachers regularly seek ideas from seminars, colleagues, and conferences.
16. Professional development is valued by the faculty.
24. Teachers maintain a current knowledge base about the learning process.
30. The faculty values school improvement.

Unity of Purpose
5. Teachers support the mission of the school.
12. The school mission provides a clear sense of direction for teachers.
19. Teachers understand the mission of the school.
27. The school mission statement reflects the values of the community.
31. Teaching performance reflects the mission of the school.

Collegial Support
4. Teachers trust each other.
10. Teachers are willing to help out whenever there is a problem.
17. Teachers' ideas are valued by other teachers.
25. Teachers work cooperatively in groups.

Learning Partnership
6. Teachers and parents have common expectations for student performance.
13. Parents trust teachers' professional judgments.
21. Teachers and parents communicate frequently about student performance.
35. Students generally accept responsibility for their schooling, for example they engage mentally in class and complete homework assignments.

APPENDIX F
TEACHER ATTITUDES TOWARDS PROFESSIONAL DEVELOPMENT

Directions: Using the scale below, please give your opinion about each statement below by circling the appropriate number which indicates the degree to which you agree or disagree with the following statements. Please answer each question.

1 = **S**trongly **D**isagree
2 = **D**isagree
3 = **N**either agree or disagree
4 = **A**gree
5 = **S**trongly **A**gree
x = **N**ot **A**pplicable

Example:

	SD	D	N	A	SA	NA
I enjoy teaching agriscience	1	2	3	4	5	x

		SD	D	N	A	SA	NA
1.	Professional development workshops often help teachers to develop new teaching techniques.	1	2	3	4	5	x
2.	If I did not have to attend inservice workshops I would not be able to improve my teaching.	1	2	3	4	5	x
3.	Professional development events are worth the time they take.	1	2	3	4	5	x
4.	I have been enriched by the teacher training events I have attended.	1	2	3	4	5	x
5.	Staff development initiatives have NOT had much impact on my teaching.	1	2	3	4	5	x

APPENDIX G

CORE FACETS OF PROFESSIONAL DEVELOPMENT QUESTIONS

Duration

1. Do you think that you had enough time to gain the knowledge and practice needed to implement the workshop content in your own classroom?   Y   N
    a. Why not?
2. What amount of time would you suggest for a workshop on a similar topic?

Coherence

Using the scale below, please indicate the degree to which you agree or disagree with the following statements by choosing the appropriate number. Please answer each question.

1=Strongly Disagree   2=Disagree   3=Neutral   4=Agree   5=Strongly Agree

The NATAA workshop was coherent with…

- My individual beliefs concerning science integration in agriculture
- My prior knowledge about science integration in agriculture
- My teaching practices related to science integration in agriculture
- The policies or practices in my school and/or my school district
- The policies or practices at the state or national level.
- My previous professional development experiences

Collective Participation

1. Did any people from the following places participate in the workshop with you?
    i. Your school   y   n
    ii. Your school district   y   n
    iii. Your state   y   n

Active Participation

Using the scale below, please indicate the degree to which you agree or disagree with the following statements by choosing the appropriate number. Please answer each question.

1=Strongly Disagree   2=Disagree   3=Neutral   4=Agree   5=Strongly Agree

I had the opportunity to…

- witness modeling of inquiry-based instructional strategies.
- ask questions and have them answered.
- discuss my concerns about implementation of workshop content in my own classrooms.
- participate in activities that enhanced my ability to teach the content area in my own classroom.
- discuss examples of students' work related to the workshop content.
- work with other agriculture teachers in planning for the implementation of the workshop content.
- discuss the student activity/experiment provided by the workshop.
- complete the student activity/experiment provided by the workshop.

APPENDIX H
IRB, INVITATION TO PARTICIPATE EMAIL, AND CONSENT EMAIL

UF | Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

DATE: October 18, 2012

TO: Jessica Blythe
PO Box 110540
Campus

FROM: Ira S. Fischler, PhD, Chair
University of Florida
Institutional Review Board 02

SUBJECT: **Approval of Protocol #2012-U-1050**

TITLE: Effective Professional Development for Inquiry Based Instruction in Secondary Agriculture Programs

SPONSOR: None

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants, and based on 45 CFR 46.117(c), An IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: *(1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject's wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.*

The IRB authorizes you to administer the informed consent process as specified in the protocol. If you wish to make any changes to this protocol, ***including the need to increase the number of participants authorized***, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

This approval is valid through **October 11, 2013.** If you have not completed the study by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. **Additionally, should you complete the study before the expiration date, please submit the study closure report to our office.** The form can be located at http://irb.ufl.edu/irb02/Continuing_Review.html. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dl

UF | Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

DATE: September 27, 2013

TO: Jessica Blythe
PO Box 110540
Campus

FROM: Ira S. Fischler, PhD; Chair ISF/dl
University of Florida
Institutional Review Board 02

SUBJECT: **Renewal of Protocol #2012-U-1050**

TITLE: *Effective Professional Development for Inquiry Based Instruction in Secondary Agriculture Programs*

SPONSOR: None

Your request to continue your research protocol involving human participants has been approved. Participants are not placed at more than minimal risk by the research. You are reminded that any changes, including the need to increase the number of participants authorized, must be approved by resubmission of the protocol to the Board.

Re-approval of this protocol extends for one year from the date of the review, the maximum duration permitted by the Office for Human Research Protection. This approval is valid through **October 11, 2014.** If this project will not be completed by this date, please telephone our office (392-0433) at least four weeks prior to this date so that we can discuss the renewal process with you. If you complete the project on or before the date please submit the closure report to our office. The report can be located at http://ib.ufl.edu/irb02/Continuing_Review.html.

It is important that you keep your Department Chair informed about the status of this research project. In addition, if your project is funded, you should send a copy of this project renewal notification to the Division of Sponsored Research, Awards Administration, P.O. Box 115500.

ISF:dl

Invitation Email

Dear ________________ ,

As a participant of 2012 NATAA convention workshop, you are invited to participate in a research study to examine how a teachers' teaching is impacted over the course of a year after attending a professional development workshop. It is a one year study looking at changes in teachers' perceptions of a teaching method after attending professional development training. The hope is to help teachers secure support for attendance and funding to travel to the NAAE and FFA conventions.

At four points throughout the following year (January, May, September and December) you will be asked to complete the short survey (10 - 20 minutes). At each point your participation is needed you will receive an email asking you to complete the survey by completing on the link. You will be asked to give your perceptions related to inquiry-based instruction and science integration into agriculture programs as well as your thoughts on teacher professional development.

Your identity and responses will be kept confidential to the extent allowed by law. Your participation is voluntary and you are free to withdraw at any time without giving a reason. There are no known risks or immediate benefits to you.

If you have any questions, or if you need further information, please contact me at jmblythe@ufl.edu opr Dr. Brian Myers at bmyers@ufl.edu. If you have any questions regarding your rights in this study you may contact the UFIRB Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone: (352) 392-0433 (Approved by UFIRB Protocol # 2012-U-1050). Thank you for your anticipated help in this effort. As a teacher, I know that you are very busy but your participation is important and greatly appreciated!

Jessica M. Blythe
Graduate Teaching and Research Assistant
Agricultural Education and Communication
University of Florida - 411 Rolfs Hall
Phone: 352-273-3425
jmblythe@ufl.edu

Consent Email

Dear _________________ ,

As a participant of 2012 NATAA convention workshop, you were invited to participate in a research study to examine how a teachers' teaching is impacted over the course of a year after attending a professional development workshop. It is a one year study looking at changes in teachers' perceptions of a teaching method after attending professional development training. The hope is to help teachers secure support for attendance and funding to travel to the NAAE and FFA conventions.

To complete the short survey (10 -15 minutes), please select the link below (you may need to copy the link and paste it into your web browser). Your identity and responses will be kept confidential to the extent allowed by law. Your participation is voluntary and you are free to withdraw at any time without giving a reason. There are no known risks or immediate benefits to you.

By clicking on the following links, I acknowledge that I accept the terms and conditions of this informed consent and understand that my participation in the study is strictly voluntary.

Individual Survey Link

If you have any questions, or if you need further information, please contact me at jmblythe@ufl.edu. If you have any questions regarding your rights in this study you may contact the UFIRB Office, Box 112250, University of Florida, Gainesville, FL 32611-2250; phone: (352) 392-0433 (Approved by UFIRB Protocol # 2012-U-1050). Thank you for your anticipated help in this effort. As a teacher, I know that you are very busy but your participation is important and greatly appreciated!

Thank you again for your time and effort!

Jessica M. Blythe
Ph.D. Candidate
Agricultural Education and Communication
University of Florida - 411 Rolfs Hall
Phone: 352-273-3425
jmblythe@ufl.edu

LIST OF REFERENCES

Ary, D., Jacobs, L. C., & Sorensen, C. (2010). *Introduction to research in education*. CA: Cengage Learning.

Ashdown, J., & Hummel-Rossi, B. (2005). The impact of program adoption on teachers' professional lives. In Beijaard, D., Meeiger, P. C., Morine-Dershimer, G. & Tillema, H.(Eds.), *Teacher professional development in changing conditions* (p.213-229). Netherlands: Springer.

Balschweid, M. A., & Thompson, G. W. (2002). Integrating science in agricultural education: Attitudes of Indiana agricultural science and business teachers. *Journal of Agricultural Education, 43*(2), 1-10. doi:10.5032/jae.2002.02001

Barrick, R. K., Ladewig, H. W., & Hedges, L. E. (1983). Development of a systematic approach to identifying technical in-service needs of teachers. *Journal of the American Association of Teacher Educators in Agriculture, 24*(1), 13-19. doi:10.5032/jaatea.1983.01013

Barrow, L. J. (2006). A brief history of inquiry: From Dewey to standards. *Journal of Science Teacher Education, 17*(3), 265-278.

Barth, R. S. (2002). The culture builder. *Educational Leadership, 59*(8), 6 - 11.

Birkenholds, R. J., & Harbstreit, S. R. (1986). Analysis of the inservice needs of beginning vocational agriculture teachers. *Journal of the American Association of Teacher Educators in Agriculture, 28*(1), 41-49. doi:10.5032/jaatea.1987.10041

Birman, B. F., Desimone, L., Porter, A. C., & Garet, M. S. (2000). Designing professional development that works. *Educational Leadership, 57*(8), 28-33.

Borko, H. (2004). Professional development and teacher learning: Mapping the terrain. *Educational Researcher, 33*(8), 3–15. doi:10.3102/0013189X033008003

Borko, H., Elliott, E., & Uchiyama, K. (2002). Professional development: Akey to Kentucky's educational reform effort. *Teaching and Teacher Education, 18,* 969-987.

Borko, H., Jacobs, J., & Koeliner , K. (2010). *Contemporary approaches to teacher professional development.*

Brooks, G. J., & Brooks, G. M. (1993). *In search of understanding: The case for constructivist classrooms.* Alexandria, VA: Association for Supervision and Curriculum.

Campbell, D. T., & Stanley, J. C. (1963). *Experimental and quasi-experimental designs for research.* Boston, MA: Houghton Mifflin.

Cohen, D. K., McLaughlin, M. W., & Talbert, J. E. (1993). *Teaching for understanding: Challenges for policy and practice.* San Francisco: Jossey-Bass.

Craft, A. (2000). *Continuing professional development : A practical guide for teachers and schools* (2nd ed.). New York: Routledge.

Crandall, D. P., Loucks-Horsley, S., Bauchner, J. E., Schmidt, W. B., Eiseman, J. W., Cox, P. L., & Taylor, J. A. (1982). *People, policies, and practices: Examining the chain of school improvement.* Andover, MA: The Network.

Croft , A., Coggshall, J. G., Dolan, M., Powers, E. & Killion, J. (2010). *Job-embedded professional development: What it is, who is responsible, and how to get it done well.* Retrieved from http://www.gtlcenter.org/sites/ /JEPDIssueBrief.pdf

Darling-Hammond, L. & Bransford, J. (2005). *Preparing teachers for a changing world*. San Francisco, CA: Jossey-Bass.

Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N. & Orphanos, S. (2009) *Professional learning in the learning profession; A status report on teacher development in the United States and abroad*. The National Staff Development Council. Retrieved from http://www.nsdc.org/news/NSDCstudy2009.pdf

Darling-Hammond, L. & McLaughlin, M. (2011). Policies that support professional development in an era of reform. *Phi Delta Kappon*, 92(6), 81-92.

Dede, C. (2006). *Online professional development for teachers: Emerging models and methods*. Cambridge, Mass: Harvard Education Press

Day, C., & Sachs, J. (2004). *International handbook on the continuing professional development of teachers.* London, Great Britain: Open University Press.

Desimone, L. (2009). Improving impact studies of teachers' professional development: Toward better conceptualizations and measures. *Educational Researcher*, *38*(3), 181-199. doi:10.3102/0013189X0833114

Desimone, L. M., Porter, A. C., Garet, M. S., Yoon, K. S., & Birman, B. F. (2002). Effects of professional development on teachers' instruction: Results from a three-year longitudinal study. *Educational Evaluation and Policy Analysis, 24*(2), 81-112.

Dillman, D. A., Smyth, J. D., & Christian, L. M. (2009). *Internet, mail, and mixed-mode surveys: The tailored design method.* Hoboken.

Doerfert, D. L. (2011). *National research agenda: American Association for Agricultural Education's research priority areas for 2011-2015*. Lubbock, TX: Texas Tech University, Department of Agricultural Education and Communications.

Doolittle, P. E., & Camp, W. G. (1No9). Constructivism: The career and technical education perspective. *Journal of Vocational and Technical Education, 16*(1). Retrieved from http://scholar.lib.vt.edu/ejournals/JVTE/v16n1/doolittle.html

Dooley, L., Metcalf, T., & Martinez, A. (1999). a study of the adoption of computer technology by teachers. *Educational Technology & Society, 2*(4) 107-115.

Dunbar, T. F. (2002). *Development and use of an instrument to measure scientific inquiry and related factors* (Unpublished doctoral dissertation). University of New Mexico, Albuquerque, NM.

Dunkin, M. J., & Biddle, B. J. (1974). *The study of teaching*. Washington, DC: University Press of America, Inc.

Fennema, E., Carpenter, T. P., Franke, M. L., Levi, L., Jacobs, V. R., & Empson, S. B. (1996). A longitudinal study of learning to use children's thinking in mathematics instruction. *Journal for Research in Mathematics Education, 27*(4), 403-434.

Fosnot, C. T. (2005). *Constructivism : Theory, perspectives, and practice* (2nd ed.). New York: Teachers College Press.

Fosnot, C. T., & Perry, R. S. (2005). Constructivism: A psychological theory of learning. In Fosnot, C. T. (Eds), *Constructivism: Theory, perspectives and practice* (p. 8-38). New York, Teachers College Press.

Fowler, F. J (2014). *Survey research methods 5th Edition*. Thousand Oaks, CA: SAGE

Fraley, C. A. (2007). *School cultures and their correlations with student achievement: An analysis of schools that have improved.* (Doctoral Dissertation) retrieved from ProQuest

Fullan, M., & Hargraves, A. (1996). *What's worth fighting for in your school?* New York: Teachers College Press.

Garet, M. S., Porter, A. C., Desimone, L., Birman, B. F., & Yoon, K. S. (2001). What makes professional development effective? Analysis of a national sample of teachers. *American Educational Research Journal, 38*, 915–945. doi: 10.3102/00028312038004915

Good, J. A. (2007). *A modified train-the-trainer professional development program designed to deliver spreadsheet skills to elementary teachers and students.* (University of Delaware, Doctoral Dissertation). Retrieved from ProQuest Dissertations and Theses.

Greiman, B. (2010). Continuing Professional Development. In R. Torres, T. Kitchel, & A. Ball (Eds.), *Preparing and advancing teachers in agricultural education* (pp.181-200). Columbus, OH: Curriculum Materials Service at The Ohio State University.

Gruenert, S. (1998). *Development of a school culture survey* (Doctoral dissertation). Retrieved from ProQuest Dissertations and Theses database.

Gruenert, S. & Valentine, J. (1998). School culture survey. Columbia, MO: Middle Level Leadership Center,University of Missouri.

Gu, Q. (2007). *Teacher development.* New York, NY : Continuum

Gurney, B. (1989). *Constructivism and professional development: A stereoscopic view*. A paper presented at the 62nd Annual Meeting of the National Association for Research in Science Teaching. San Francisco, CA.

Guskey, T. R. (2000). *Evaluating Professional Development*. Thousand Oaks, CA: Corwin Press, Inc.

Guskey, T. R. (2002). *Professional development and teacher change. Teachers and Teaching: theory and practice, 8*(3/4). doi: 10.1080/1354060021000051 2

Guskey, T. R., & Sparks, D. (1991). *Complexities in evaluating the effects of staff development programs.* Paper presented at the Annual Meeting of the American Educational Research Association.

Guskey, T. R., & Sparks, D. (1996). Exploring the relationship between staff development and improvements in student learning. *Journal of Staff Development, 17*, 34-38.

Guskey, T. R., & Yoon, K. S. (2009). What works in professional development? *Phi Delta Kappan, 90*(7), 495-500.

Harkreader, S., & Weathersby, J. (1998). *Staff development and student achievement: Making the connection in Georgia schools.* Atlanta, GA: Council for School Performance. Available: http://archweb.gsu.edu/csp.

Harland, J., & Kinder , K. (2006). Teachers' continuing professional development: framing a model of outcomes. *Journal of In-service Education, 23*(1), 71-84. doi: 10.1080/13674589700200005

Harris, C. R. (2008). Career development event participation and professional development needs of Kansas agricultural education teachers. *Journal of Agricultural Education, 49*(2), 131-138. doi: 10.5032/jae.2008.02130

Herndon, B. C. (2007). *An analysis of the relationships between servant leadership, school culture, and student achievement* (Doctoral dissertation, University of Missouri--Columbia). Retrieved from ProQuest.

Huffman, D., Thomas, K., & Lawrenz, F. (2003). Relationship between professional development, teachers instructional practices and the achievement of students in science and mathematics. *School Science and Mathematics*, *103*(8), 378-387.

Ingersoll, R. M. (2003). Why Schools Have Difficulty Staffing Their Classrooms with Qualified Teachers?. *Educational Leadership, 60*(8), 30-33.

Joyce, J. A. (2007). *A modified train-the-trainer professional development program designed to deliver spreadsheet skills to elementary teachers and students.* (Doctoral dissertation, University of Delaware).

Jupp, V. (2006). *The SAGE dictionary of social and cultural research methods*. London: SAGE

Keiny, S. (1994). Constructivism and teachers' professional development. *Teaching and Teacher Education, 10*(2), 157-167.

Labaree, D. F. (2008). The winning ways of a losing strategy: Educationalizing social problems in the United States. *Educational Theory, 58*(4), 447-460.

Layfield, K. D., Minor, V. C., & Waldvogel, J. A. (2001). *Integrating science into agricultural education: A survey of South Carolina teachers' perceptions.* Preceedings of the 28th Annual National Agricultural Education Research Conference, New Orleans, LA.

Le Ferve, D., & Richardson, V. (2002). Staff development in early reading intervention programs: The facilitator. *Teaching and Teacher Education, 18,* 483-500. doi: 10.1016/So742-051X(02)00011-2

Lieberman, A., & Wood, D. (2003). *Inside the national writing project.* New York: Teachers College press.

Loucks-Horsley, S., & Matsumoto, C. (1999). Research on professional development for teachers of mathematics and science: the state of the scene. *School Science and mathematics*, 99(5), 258-271.

Loucks-Horsley, S., Stiles, K. E., Mundry, S., Love, N., & Hewson, P. W. (2010). *Designing professional development for teachers of science and mathematics.* Thousand Oaks, CA: Corwin Press.

Lydon, S., & King, C. (2009). Can a single, short continuing professional development workhop cause change in the classroom. *Professional Development in Education, 35*(1), 63-82. doi: 10.1080/13674580802264746

McLaughlin, M.W. (1993). What matters most in teachers' workplace context? In J.W. Little & M.W. McLaughlin (Eds.), *Teachers' work: Individuals, colleagues, and contexts* (pp. 79-103). New York: Teachers College Press.

Mewborn, D. S. (2003). Teaching, teachers, knowledge, and their professional development. In J. Kilpatrick, W. G. Martin, & D. Schifter, (Eds.). *A research companion to principals and standardsfor school mathematics* (pp. 45-52). Reston, VA: The National Council of Teachers of Mathematics.

Mitchell, B. D. (2008). *A quantitative study on positive school culture and student achievement on a criterion-referenced competency test* (Doctoral dissertation) University of Phoenix.

Mizell, H. (2010). *Why professional development matters*. Oxford, OH: Learning Forward.

Myers, B. E., Dyer, J. E., & Washburn, S. G. (2005). Problems facing beginning agriculture teachers. *Journal of Agricultural Education, 46*(3), 47- 55.

Myers, B. E., Thoron, A. C., & Thompson, G. W. (2009). Perceptions of the National Agriscience Teacher Ambassador Academy toward integrating science into school-based agricultural education curriculum. *Journal of Agricultural Education,* 50(4), 120-133. doi: 10.5032/jae.2009.04120

Myers, B. E., & Thompson, G. W. (2009). Integrating academics into agricultural programs: A Delphi study to determine perceptions of the national agriscience teacher ambassador academy participants. *Journal of Agricultural Education*, 50(2), 75-86. doi:10.5032/jae.2009.02075

Myers, B. E., & Washburn, S. G. (2008). Integrating science in the agriculture curriculum: Agriculture teacher perceptions of the opportunities, barriers, and impact on student enrollment. *Journal of Agricultural Education, 49*(2), 27-38. doi: 10.5032/jae.2008.02007

NAAE.org (2013). The National Association of Agricultural Educators: Dupont National Agriscience Teacher Ambassador Academy. www.naae.org/prodev/nataa.html

National Commission on Teaching and America's Future. (2010, June). *Team up for 21st century teaching and learning: what research and practice reveal about professional learning.* Person Foundation; Washington D.C.

National Research Council. (1988) *Understanding agriculture: New directions for education.* Washington, DC: National Academy Press.

National Research Council. (1996). *National science education standards.* Washington, D.C.: National Academy Press.

National Research Council. (1998). *Agriculture's Role in K-12 Education*. Washington, D.C.: National Academy Press.

National Research Council. (2000). *Inquiry and the National Science Education Standards: A guide for teaching and learning.* Washington, D.C.: National Academy Press.

National Research Council. (2009). *America's lab report: Investigations in high school science.* Washington, DC: National Academies Press.

Osborne, E. W. (Ed.) (n.d.). *National research agenda: Agricultural education and communication*, 2007-2010. Gainesville, FL: University of Florida, Department of Agricultural Education and Communication.

Osborne, J., & Waters, E. (2001). Four assumptions of multiple regression that researchers should always test. *Practical Assessment, Research and Evaluation*, *8*(2).

Pals, D. A., & Crawford, H. R. (1980). Roles and responsibilities of selected agencies and groups in providing in-service education for vocational agriculture instructors in Iowa. J*ournal of the American Association of Teacher Educators in Agriculture, 21*(1), 26-33. doi:10.503/jaatea.1980.01026

Patton, K., Parker, M., & Neutzling, M. M. (2012). Tennis shoes required: The role of the facilitator in professional development. *Research Quarterly for Exercise & Sport, 83*(4), 522-532. Doi: 10.1080/02701367.2012.10599141

Penuel, W. R., Fishman, B. J., Yamaguchi, R., & Gallagher, L. P. (2007). What makes professional development effective? Strategies that foster curriculum implementation. *American Educational Research Journa*l, *44*(4), 921-958). doi: 10.3102/0002831207308221

Pollnow, M. (2012). *Implementing a K--12 train the trainer professional development model through the school improvement grant.* (Doctoral Dissertation. Arizona State University). Retrieved from ProQuest Dissertations and Theses.

Porter, A. C., Garet, M. S., Desimone, L., Yoon, K. S., & Birman, B. F. (2000). Does professional development change teaching practice? Results from a three-year study. *American Institutes for Research in the Behavior Science*, Washington DC.

Ramsdell, R., Rose, R. and Kedera, M. (2006). PBS Teacherline and concord consortium's seeing math secondary: Scaling up a national professional development program. In Dede, C. (Eds.) *Online professional development for teachers: emerging models and methods*, pp. 69-88. Cambridge, MA: Harvard Education Press.

Roberts, T. G., Kitchel, T. (2010). Designing professional knowledge curriculum and instruction. In R. M. Torres, T. Kitchel, & A. L. Ball (Eds.), *Preparing and advancing teachers in agricultural education* (pp. 100-111). Columbus, OH: Curriculum Materials Service.

Rosenholtz, S. J. (1991). *Teachers' workplace: The social organization of schools.* New York: Teachers College Press.

Rovengno, I., & Dolly, J. P. (2006). Constructivist perspectives on learning. In D. Kirk, D. Macdonald, & M. O'Sullivan (Eds.), *The handbook of physical education* (p. 242-261). London, Sage.

Rutherford, F. J., & Ahlgren, A. (1989). *Science for all Americans.* New York: Oxford University Press.

Shunk, D.H. (2008). *Learning Theories: An educational perspective* (6th edition). Boston, MA: Pearson Education, Inc.

Scribner, J. P. (1999). Professional development: untangling the influence of work context on teacher learning. *Educational Administration Quarterly*, 35, 238-266. doi:10.1177/0013161X99352004

Shields, P. M., Marsh, J. A., & Adelman, N. E. (1998). *Evaluation of NSF's Statewide Systemic Initiatives (SSI) Program: The SSIs' impacts on classroom practice*. Menlo Park, CA: SRI.

Shoulders, C. W., & Myers, B. E. (2011A). An analysis of National Agriscience Teacher Ambassadors' stages of concern regarding inquiry–based instruction. *Journal of Agricultural Education*, *52*(2) 58-70. doi:10.5032/jae.2011.02058

Sigel, I. E. (1978). Constructivism and teacher education. *The Elementary School Journal, 78*(5), 332-338.

Smith, C. Hofer, J. Gillespie, M., Solomon, M. & Rowe, K. (2003). *How teachers change: a study of professional development in adult education* (Report #25). Retrieved from National Center for the Study of Adult Learning and Literacy website: http://www.ncsall.net/index.html@id=29.html

Sullivan, L. J. (2010). *The influence of school culture, school goals, and teacher collaboration on teachers' attitudes toward their professional development plans* (Doctoral dissertation, George Mason University).

Supovitz, J. A., & Turner, H. M. (2000). The effects of professional development on science teaching practices and classroom culture. *Journal of Research in Science Teaching, 37*(9), 963-980.

St. John, M., Hirabayashi, J., & Stokes, L. (2004). *The National Writing Project: An evaluator's perspective on the case for federal investment.* Inverness, CA: Inverness Research Associates.

Torff, B., Sessions, D., & Byrnes, K. (2005). Assessment of teachers' attitudes about professional development. *Educational and Psychological Measurement, 65*(5), 820-830.

Thomas, G. (2010). Facilitator, teacher, or leader? Managing conflicting roles in outdoor education. *Journal of Experiential Education, 32*, 239–254.

Thompson, G. W., & Balschweid, M. M. (1999). Attitudes of Oregon agricultural science and technology teachers toward integrating science. *Journal of Agricultural Education, 40*(3), 21-29.

Thompson, G. W., & Schumacher, L. G. (1998). Selected characteristics of the national FFA organization's agriscience teacher of the year award winners and their agriscience programs. *Journal of Agricultural Education*, 39(2),50-60.

Thoron, A. C. (2010). *Effects of inquiry-based agriscience instruction on student argumentation skills, scientific reasoning, and student achievement* (Doctoral dissertation). University of Florida, Gainesville, FL.

Thoron, A. C., Myers, B. E., & Abrams, K. (2011). Inquiry-based instruction: how is it utilized, accepted, and assessed in schools with national agriscience teacher ambassadors? J*ournal of Agricultural Education*, *52*(1), 96-106. doi:10.5032/jae.2011.01096

U.S. Department of Education, National Center for Education Statistics. (1999).Teacher quality. A report on the preparation and qualifications of public school teachers (NCES 1999-080). Washington, DC.

Warnick, B. K., & Thompson, G. W. (2007). Barriers, support, and collaboration: a comparison of science and agriculture teachers' perceptions regarding integration of science into the agriculture education curriculum. *Journal of Agricultural Education*, *48*(1), 75-85. Doi: 10.5032/jae.2007.01075

Webster-Wright, A. (2000). Reframing professional development through understanding authentic professional learning. *Review of Educational Research, 79*, 702-739. doi: 10.3102/0034654308330970

Weiss, I. R., Montgomery, D. L., Ridgway. C. J., & Bond, S. L. (1998). *Local systemic change through teacher enhancement: Year three cross-site report.* Chapel Hill, NC: Horizon Research.

Weiss, I. R., & Pasley, J. D. (2004). What is high-quality instruction? *Educational Leadership, 61*(5), 224-228.

Weiss, I. R., Pasley, J. D., Smith, P. S., Banilower, E. R., & Heck, D. J. (2003). *Looking inside the classroom: A study of K-12 mathematics and science education in the United States.* Chapel Hill, NC: Horizon Research.

Wilson, S.M. & Berne, J. (1999). Teacher learning and the acquisition of professional knowledge: Am examination of research on contemporary professional development. *Review of Research in Education, 24*, 173-209. Retrieved from http://www.jstor.org/stable/1167270?origin=JSTOR-pdf

Yoon, K. S., Duncan, T., Lee, S. W., Scarloss, B., & Shapley, K. L. (2007). *Reviewing the evidence on how teacher professional development affects student achievement.* National Center for Educational Evaluation and Regional Assistance, Institute of Education Sciences, US Department of Education.

BIOGRAPHICAL SKETCH

Jessica Marie Blythe was born and raised in Connecticut. Her interest in agriculture was instilled in her by her family at a young age. Playing in the garden, driving around the farm, and enjoying the natural areas around the state started a lifelong passion for agriculture and natural resources.

Her interest and experience in agricultural education continued when she was accepted to the Suffield Agriscience Center for high school and was an active member of the FFA chapter. In 2005, she earned her Bachelor of Science at the University of Connecticut in ornamental horticulture. To pursue her interests in agricultural education and becoming a secondary agriculture teacher, Jessica moved to Florida to complete a master's degree in Agricultural Education from the University of Florida.

Upon graduation in 2007, Jessica accepted a position as an agriculture teacher at Baker County High School in northern Florida. While at Baker County High school, she developed the horticulture pathway and taught four different courses. During her years as a secondary teacher, she strived to increase the relevance of content in students' lives and integrate academic content into agricultural contexts. In addition to her duties as an agriscience teacher, Ms. Blythe also served as the co-advisor to the FFA chapter and became an active member of the local community. Ms. Blythe was presented the National Association for Agricultural Educators Teacher Turn the Key award, and with her co-teacher was awarded Outstanding Middle/High School Program by the Florida Association for Agricultural Education. She was also an active member of the Florida Association for Agricultural Education and served as the Reporter as well as a member of the professional development committee.

After four years of teaching, in August of 2011, she returned to the graduate program at the University of Florida's Agricultural Education and Communication Department under the advisement of Dr. Brian E. Myers. Through her assistantship responsibilities, Ms. Blythe has provided professional development programs for agriscience teachers across the country and taught numerous undergraduate courses in the department, including supervising student teachers. She also served as a lead instructor for a college-wide undergraduate course, overseeing the learning of 250 students and 4 teaching assistants. Ms. Blythe has continually conducted meaningful research related to the integration of STEM in agricultural education and teacher professional development. It is her dream to continue her passion for agricultural education by preparing the next generation of secondary agriculture teachers and proving meaningful research that can enhance student learning across the nation.