AN EXAMINATION OF THE EXTENT AND ENDURANCE OF A TECHNOLOGY-BASED STAFF DEVELOPMENT PROGRAM ON THE EPISTEMOLOGICAL, ONTOLOGICAL, AND METHODOLOGICAL BELIEFS OF HIGH SCHOOL CHEMISTRY TEACHERS

A Dissertation

by

DEENA SAN HARPER

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

DOCTOR OF PHILOSOPHY

December 2008

Major Subject: Curriculum and Instruction

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ABSTRACT

An Examination of the Extent and Endurance of a Technology-Based Staff Development Program on the Epistemological, Ontological, and Methodological Beliefs of High School Chemistry Teachers. (December 2008)

Deena San Harper, B.S., East Texas State University;

M.Ed., Texas A& M University

Chair of Advisory Committee: Dr. Lynn M. Burlbaw

The purpose of this qualitative, narrative study was to examine the extent and endurance of influence a technology-based professional development program had on the epistemological, ontological, and methodological beliefs of selected high school chemistry teachers. Three participants of a technology-based professional development program were interviewed with additional insight provided by this author, who was a participant in the program.

Evidence of an epistemological, ontological, and methodological change in the participants was indicated by their self-proclaimed change in attitudes concerning the use of inquiry-based learning and information technology in the classroom. The participants understood and related the importance of incorporating inquiry-based learning and information technology into their classroom methodology and provided examples of their applications.

Findings of this study reveled that the participants acknowledged the effectiveness of inquiry-based learning and information technology teaching strategies, but did not fully implement either strategy citing time constraints, lack of resources, and statewide accountability testing. A surprising finding was that the participants did not use the technology-based instructional strategies to prepare students for the TAKS test.

DEDICATION

I dedicate this dissertation to the honorable profession of teaching and all its practitioners who are curious about the art and science of teaching.

ACKNOWLEDGMENTS

"From the outside looking in, you can't understand it. From the inside looking out, you can't explain it" is an Aggie "truism" in reference to traditions at Texas A&M, but I found it apropos when explaining the dissertation process to family and friends. The completion of this dissertation is the result of numerous influences and support from home and Texas A&M, and it is the culmination of many years of dedicated work interspersed with some "introspective navel gazing."

To Dr. Lynn Burlbaw: thank you for believing in me and facilitating a focus for a dream of mine. It only took me seven years to get it done, but I did it, and you were ever so patient and kind. To Drs. Lynn Burlbaw, Robert Beck Clark, Larry Peck, Vickie Williamson, John Morris, Jane Schielack, Patrick Slattery, Kris Sloan, Linda Skrla, Jenny Sandlin, Robert Hall, Larry Kelly and so many others at A&M: your professionalism, work ethic, and personal standards were the template for my own professional development.

To Pam, a great friend and life line for the past seven years while we both pursued our goals: now we are truly a 'paradox'. To my two sisters, Carrie Pierce and Amy Eppler and their families, who have always been my biggest fans: thank you for being patient with me. An extra special thank you to Amy for all the "hand-holding" she provided. To my Mom and Dad, Mary and Roy Brock, who instilled a love of learning and an insatiable curiosity about 'stuff,' thank you for having faith in my dreams. To my sons, Nathanael and Andrew, who inspired me to be the best mom, person, and teacher that I could be:

thank you for listening and cheering me up when I did not think I could ever get this done. And most importantly, to my husband, Michael, with him I could be on my worst behavior, which occurred often during this process, yet I knew he would love me and keep me grounded through it all: thank you for understanding why I had to keep going and for giving me the freedom to pursue my dream. Now, we can play!

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CHAPTER I

INTRODUCTION

In this chapter, I introduce the background influence and direction for my research. First, I present The No Child Left Behind Act of 2001 (NCLB). Second, I discuss the Information Technology in Science Center, which provided a technology-based professional development experience for a selected group of high school chemistry teachers, including this author, and the perceived parallels between the program and the NCLB. Third, I state my purpose for this study, the personal motivation, and present the model for the research. Fourth, the research questions are presented . Finally, the assumptions, limitations, delimitations, definitions for the terms used for the research, and the organization of the dissertation are listed.

The No Child Left Behind Act of 2001

In the No Child Left Behind Act of 2001, the measure of student achievement is a primary focus. The NCLB makes a direct link between student achievement and the qualifications of teachers in classrooms, and mandates for highly qualified teachers to instruct all students. The U.S. government states that educational agencies and schools are accountable for student success and that adequate yearly progress as determined by measurable objectives must be met (NCLB, 2001, p. 81).

This dissertation follows the style of *Science Education.*

Title II of NCLB explains the law's stance on teacher and principal preparation, training, and recruiting (NCLB, 2001, p.196) and establishes funding for the mandates. Specific strategies, such as training in technology (p.199, p. 202), encouragement of collaborative efforts among education professionals (p. 207), and improvement of teacher content knowledge (p. 201) are listed as topics for professional development. The law also stresses that teachers need professional development in learning styles and strategies for teaching students with disabilities, special needs, and limited English proficiency. In addition, the law specifies the need for professional development for dealing with various student behaviors, acquiring knowledge of appropriate student interventions, encouraging parental involvement, and training teachers to use action research in improving student learning and teacher practice (NCLB, 2001, p. 206).

A Technology-Based Professional Development Program

Texas A&M sponsored a technology-based professional development program that was funded by the National Science Foundation. The program was the Information Technology in Science (ITS) Center for Teaching and Learning (ITS, 2004a).

The program provided a stipend of $3000 for each summer of participation, 12 hours of graduate course work, and the opportunity to apply for an additional $1000 stipend for each academic year of continued participation. Participants who chose to pursue a degree could apply for additional tuition and fee reimbursement as long as the course work related to their degree. Those participants pursuing a doctoral degree could apply for $500 for dissertation or record of study support and were eligible to apply for a 2 year graduate assistantship at Texas A&M (ITS, 2004b).

The three goals established for the ITS Center were:

- To produce education specialists through a program of study which focused on the interaction between scientists, mathematicians, education researchers, and education practitioners.
- To create new knowledge through research involving the impact of information technology on learning and teaching science and mathematics.
- To develop and disseminate quality professional growth experiences, structured around the impact of information technology on learning and teaching science and mathematics (ITS, 2004a).

Perceived Parallels

The NCLB Act is pervasive throughout the educational culture. As I conducted my review of literature, I discovered what I perceived as parallels between the strategies specified in the NCLB Act (2001) and the goals of the ITS program. In the NCLB, the strategies that involved the encouragement of collaborative efforts among education professionals (p. 207) with an added benefit of creating teacher leaders (p. 203) parallel with the first ITS goal of producing education specialists. The NCLB strategy that specified the improvement of teacher content knowledge (p. 201) parallel with the second ITS goal of creating new knowledge focused on the impact of information technology on learning and teaching science and mathematics. Finally, the NCLB strategy to train teachers to integrate technology into the classroom via curriculum and instruction (p.202) parallel the last ITS goal to develop and disseminate quality professional growth experiences centered on information technology. Additional literature review led me to one other parallel.

Within the realm of educational research, I found literature, which referred to epistemology, ontology, and methodology. The definitions for epistemology and ontology ranged from simple definitions, for example, the study of knowledge and the study of being (Guralnik, 1979), respectively, to more complex philosophical stances and the definitions and concepts of each are interwoven. I devised definitions for this dissertation as I perceived a parallel between the ITS goals and the literature.

The first ITS goal which provided interaction between scientists and teachers I viewed as a means to change the teachers' beliefs about science, science learning, and technology, or the teachers' epistemology. The second goal, to create new knowledge through research, was a means to change the teachers' understanding of the nature of science and science teaching, or their ontology. The third goal, where teachers participated in professional growth experiences, was designed to change the teachers' instructional practices or methodology. Possible changes to the teachers' epistemology, ontology, and methodology inspired this research.

Purpose

For the purpose of this dissertation, I examine the extent and endurance of the influence the ITS professional development program had on the epistemological, ontological, and methodological beliefs of three selected high school chemistry teachers in the 2001-2003 program Cohort. “Experience is a form of human achievement” (Eisner, 1998). If the experiences of the participants can be obtained, analyzed, and evaluated, a certain cohesiveness of professional growth may be discovered (Hashweh, 1996). My own personal professional growth as a participant in the ITS program was a motivational factor for this research.

Each of my participants had a story to tell, a path they followed to get to the point where they became participants in the ITS program, the story they shared with me for this study. The teachers’ stories, as reflections of their process of becoming ITS participants from recruitment to certificate holders from the program, contained information that reflected their beliefs about science, the teaching of science, and how those beliefs were the basis for their practice in the classroom. Their backgrounds were varied, as were their motivations, beliefs, and understandings. This information provides the basis for this study.

Personal Motivation

I also participated in the ITS program. My own personal experience with the ITS program was very significant, to the point of life altering, and I was curious to discover if the other participants in the Chemistry Cohort I of the ITS program had similar experiences.

After my participation in the program, my ontology changed from a scientist who happened to teach to a scholar of the art and science of teaching the sciences. Two months *into my teaching career, I attended my first Conference for the Advancement of Science Teaching (CAST). During that conference, I attended many different sessions and listened to ideas about making science fun and exciting for the students. If there were any sessions on pedagogy, I did not attend them. I wanted the sessions focused on either hands-on activities, which were demonstrations for the teacher to perform, or laboratory activities for students. As a result, I was armed with all these great things to do, but I did not really know why I was doing them. My ontology during this time was based on survival in the classroom and my epistemology was what I garnered by attending the conference sessions. Back at school, when we did the demonstrations and the labs in class, we had fun but the learning was hit or miss.*

I never looked at the research about learning or teaching, precisely as Noddings (1998) noted, "We generally assume that the material we teach, if not actually verified as true, is at least accepted by a scholarly community as not false" (pg 111). I was not cognizant of research-based educational practices or that there was any research that was education-oriented until I started working on my M.Ed. I had been teaching for about thirteen years, I had developed some great techniques, and an instinct for what was working and not working. However, the self-educating process had taken a lot of on-the-job training and many lost learning opportunities for my students.

Some of the research I read resonated with my existing beliefs and ideas about teaching, and some of the research challenged my beliefs and ideas. I began to make connections between my classroom practice and the research that I was reading. I was *becoming a stronger teacher because of the research papers I had to read and the papers I had to write. The satisfaction I gained from reading the research was that most of my instincts were confirmed by the research and that was validating to me as a teacher.*

I had just finished work on my M.Ed. when I began the ITS program because I wanted to know more about technology. The rigors of the ITS program humbled me with the amount of research we were required to read from leading scholars in the fields of education, research, science, and information technology. All of it began to come together for me. "It" being the concept of what it meant to be a teacher. At times, I cringed because I was so ashamed of my arrogance toward the teaching profession. I learned so much about myself and learned how I could become a better teacher for my students.

The course work for my PhD, from the history of education all the way through to the philosophical theories of education, just made the East Texas adage, "the more I learns the less I knows" even more pertinent. When I read A History of the Western Educational Experience by Gutek (1995), I was instilled with an enormous pride in my legacy as a teacher. Finding my philosophical framework helped me find others who thought about education in the same ways as I. An appreciation and understanding of what it meant to be a teacher, to reach students, and to help them create and own their knowledge had unfolded before me. My thinking, my beliefs, and my way of approaching teaching had changed profoundly, and I wanted to know if any of my ITS Cohort colleagues had experienced the same changes and what their thoughts were about the experience.

Research Model

In this study, I listened to the participants for evidence of a change in their beliefs about science, science learning, and technology and for cases where the changes were attributed to their ITS experience. I wanted to know if they were using information technology as presented by the ITS program to explain science concepts. With those criteria in mind, I determined if they demonstrated or recognized an epistemological change. I also listened to the participants for an indication of a change in perception of their outlook on the nature of science and science teaching. This criterion was used to determine an effect on their ontology. If a change in the participants epistemology and ontology was evident, then I would expect a methodological change that they would attribute to their ITS participation.

Research Questions

To discover if an epistemological and ontological change would initiate a methodological change and to discover how influential the ITS experience was on my Cohort colleagues, I formulated the following research questions:

1. How did the teachers' background and experience of participating in ITS effect their epistemological, ontological, and methodological practices?
2. How have teachers who made changes in their epistemological, ontological, and methodological practices as a result of the ITS program sustained those changes in the face of institutional and social pressures?

This research uses teachers' interview responses to determine if through their statements, they demonstrate an epistemological, ontological, and methodological transformation due to the ITS professional development experience.

Assumptions, Limitations, and Delimitations

Assumptions

This study assumes that the teachers who participated in the interviews provided accurate and truthful answers to the best of their abilities. A second assumption is that the teachers who participated in the ITS program training, which occurred from 2001-2003, could trace their reported teaching practices to their participation in the ITS program. A third assumption is that once the ontological change occurred, the participant cannot revert to their previous ontology, but institutional and social pressures may continue to alter their ontology (Kuhn, 1996).

Limitations

This study was limited by the data collection method which relied on participants' interview responses about their personal perspectives of the effects the ITS program. Another limitation was the small number of Cohort I Chemistry participants who were teaching in the public school system during the period of this study.

Delimitations

This study was not designed to measure student achievement, nor does this study determine which professional development methods are most effective.

Definitions

The definitions of terms used in this dissertation are as follows:

- Epistemology: A belief system a teacher has about knowledge and knowing (Schommer-Aikins, 2004; Brownlee & Berthelsen, 2006; Niessen, Abma, Widdershoven, van der Vleuten, 2008).
- Information Technology (IT): The study of learning theories and the subsequent use of technological resources by teachers to facilitate learning and to solve educational challenges in the classroom (Medland, 2007; Mihalca & Miclea, 2007; Association for Educational Communications and Technology (AECT) Definition and Terminology Committee, 2004).
- Methodology: Instructional practices teachers use with learners to promote understanding and comprehension of content.
- Ontology: The teacher's reality, or nature of knowledge, which is formed from previous experiences and, for this paper, concerns the nature of science and science education (Niessen et al, 2008; Dall'Alba & Barnacle, 2007; Duncan, Cloutier, & Bailey, 2007).

Organization

This dissertation is organized in five chapters. Chapter I contains the introduction and a brief synopsis of the objective of the research, the rationale, the research question, limitations, delimitations, and definitions. Chapter II contains the review of literature with the background information necessary to understand the significance and influence of professional development on teachers who chose to participate in prolonged professional development, and of any possible effects, a change in beliefs may have on teaching behaviors. Chapter III contains the methodology, which explains the theory behind the methodology and how the research was conducted. This section also includes a description of the participants, treatment, the data collected, the data collection process, and the analytical processes. Chapter IV contains a report of the data collected and the findings and Chapter V contains the conclusion of the research and recommendations for further research.

CHAPTER II

REVIEW OF THE LITERATURE

In this chapter, I review literature, which is pertinent to the epistemological, ontological, and methodological components of professional development in education and the effect of professional development on teachers. First, a presentation and analysis of literature found on epistemology, ontology, and methodology; second, a presentation and analysis of professional development literature, governmental, research-based, and philosophical; and finally, the theoretical basis of the ITS model.

Epistemology, Ontology, and Methodology

In *The Paradigm Dialog*, Guba (1990) presented a need to establish a paradigm as a guide for disciplined inquiry. Eisner (1998) noted that epistemological questions are important to the development of a research methodology. Answers to epistemological, ontological, and methodological questions are the criteria in determining an inquiry paradigm. When we address the nature of the relationship between what is personally known and universal knowledge, when we seek the nature of reality, and when we determine how we should find out about knowledge then we have addressed the very basic versions of epistemology, ontology, and methodology.

In short, epistemology and ontology are a part of a teacher's belief system, while methodology is the manifestation of that belief system. Because the three concepts are intertwined, I have combined epistemology, ontology, and methodology together in this section of the review of literature.

Epistemology

Epistemology is a belief a person has concerning their reality or ontology (Schommer-Aikins, 2004). Noddings (1998) writes that teachers are not usually concerned about epistemology and its relationship to education. She states that teachers should be aware of the "truth" of what they teach, teachers need to be cognizant of educational research and the "knowledge" they can gain from the research, and teachers should be able to determine "whether the knowledge long reserved for a few students should or can be made accessible to all" (p. 111).

Whitworth (2006) views epistemology as what is learned about the reality (p. 153) and explains there are "epistemological consequences of a particular ontology" (p. 156). Carlo (1967) acknowledges that epistemology can have a variety of meanings, but embraces "the nature and the validity of knowledge" (p. 86) as a definition. Intuitive knowledge, according to Chi and Slotta (1993; Slotta & Chi, 2006), is derived from a person's experience of reality, or their epistemology.

Hashweh (1996) stated that studying a teacher's beliefs might well allow us to understand the teacher's behavior, and epistemological beliefs "are stable traits that strongly influence teaching" (p. 61) regardless of whether those beliefs were constructivist or empirical in nature. Hashweh's research examined the effectiveness of teachers who held a constructivist view of science teaching and he determined that teachers who used multiple strategies, introduced new concepts, addressed student misconceptions, and helped the students construct new knowledge were the most successful. Howard, McGee, Schwartz, & Purcell (2000) pointed out that "epistemology may be a less stable trait than was previously supposed" (p. 459) in the face of a constructivist intervention. Howard, et al. was able to change the epistemology of participants with a four-week program using a constructivist approach. The training course in the Howard research study consisted of teacher-to-teacher encounters, opportunities for reflection, challenges to existing beliefs help by the teachers, and support of the construction of new beliefs (p. 461). Both Hashweh and Howard, et al. determined that a constructivist approach to science teaching, in the form of an intervention, elicited a change in epistemology.

In epistemological research, Schommer-Aikins (2004) proposed that epistemology is considered "personal epistemology" (p.19), and in order to separate it from the epistemology of philosophy she referred to as a "belief system" (Schommer, 1990, p.498). Her research was quantitative and analyzed the components as individual aspects of an epistemological belief system. She introduced a belief system which allowed her to conduct her research on epistemology using quantitative methods (a Likert-type scale) when previously qualitative methods were used. She acknowledged that quantifying epistemological beliefs is difficult (p. 22).

Niessen et al (2008), recognized that the teacher's epistemological experience is worthy of researchers' interest and cited a variety of qualitative methodologies which provide the researcher with rich and thick descriptions. The suggestion is that the qualitative methodologies keep the study of the teacher's epistemological beliefs in context with the teaching experience, as opposed to the use of Likert-type questionnaires composed of items that are out of context with the teacher's actual experience. Regardless of the methodology of the research, epistemological beliefs are not readily identified by the observed, but the observer (Schommer-Aikens, 2004) can identify them.

Ontology

Eco (2005), in *The Mysterious Flame of Queen Loana,* claims, "My ontology is out of joint. I have the supreme power to create my own gods, and my own mothers" (p. 421) meaning that his ontology is an image of reality (Whitworth, 2006). Chi and Slotta (1993; Slotta & Chi, 2006) described ontology as providing a "level of coherence to intuitive knowledge" (Chi and Slotta, 1993, p.255).

Carlo (1967) states that "man's particular environment can make him more interested in practical or speculative knowledge at different historical periods" (p. 26) leading to a change in ontology. Aronowitz and Giroux (1991) reference the ontological change from one view of evolution to another as an indication of the epistemological change of the 1960s (p. 150), which is reminiscent of Kuhn's (1996) concept of the paradigm shift as it applies to changes in scientific thought.

The context wherein a teacher understands scientific concepts is the ontology of that teacher. If the contextual understanding of scientific concepts change, then the ontology of the teacher has changed (Slotta & Chi, 2006; Duncan et al, 2007).

Methodology

Methodology refers to instructional practices that a teacher can use with learners. Methodology, from the learners' or a researchers' perspective, is a way to acquire the knowing of the reality, or the epistemology of the ontology. Moreover, epistemological change for a teacher effects the teacher's methodology, which is the key to this dissertation's research model (Hashweh, 1996; Howard, et al., 2000; Brownlee, 2003; Brownlee & Berthelsen, 2006).

The National Research Council (1996), in the *National Science Education Standards* publication, recommend inquiry-based teaching methods and the use of technology to gather data as instructional practices for science teachers (p. 144, 176). The ITS program introduced the use of modeling, visualization materials, and the use of technology to manage data to the Cohort participants with the intent that the participants would use the instructional strategies with their students (Williamson & José, 2008; ITS, 2004d)

Professional Development in Education

In this section, I review the literature concerned with professional development from both government mandates and a philosophical standpoint. Because of the influence teachers have on students, the influence teachers have on the schools, and the influence teachers have on the community, the study of teachers fuels many research endeavors. One of those endeavors is the study of professional development and its impact on teachers (Gall, Borg, & Gall, 1996).

Government Mandates

Government mandates establish the requirements for professional development whereas research-based and philosophical ideals guide the planning and implementation of professional development experiences.

Title II of the No Child Left Behind Act of 2001, contains directives to prepare, train, and recruit highly qualified teachers and principals (p.196). The NCLB standards for a highly qualified teacher state two criteria: one, the teacher has obtained full state certification and two, the teacher holds a licensed to teach in that state. For secondary teachers, they must have passed the state exam for their assigned content area and show that they have a high level of competency for that content area. A high level of competency is indicated by having an undergraduate degree in that field, a graduate degree, enough college hours that would qualify for an undergraduate degree in that field, or an advanced certification in that subject. Competency is defined as compliance with state standards. The NCLB did not specify how compliance to the directives is to be evaluated (p. 535).

The common factor between a highly qualified new teacher and a highly qualified experienced teacher is a certain level of competency in their content area, which can be achieved by professional development. The NCLB insures that grant money will be available to various educational agencies in order that they may follow the directive while also holding them accountable via adequate yearly progress (p. 81). One of the specified professional development topics is training in the use of technology to improve teaching and learning (p. 208). The NCLB established mandates for professional development, but they have not mandated the methods by which the professional development can be presented.

The NCLB stated in Part A, Subpart 1 section 1111 (p. 20, 21) that each state shall have an accountability system that is based on academic standards, academic assessments, and other academic indicators which ultimately demonstrate adequate yearly progress for the achievement of all public elementary and secondary school students. Data analyzed by the National Science Teachers Association (2006) linked gains in student achievement with implementation of standards-based education.

While there are data to make a link between student achievement and implementation of standards-based education, data are lacking in making a connection between efforts to improve teacher quality and student achievement. In Olson's (2006) examination of *Education Weeks'* 10th edition of Quality Counts annual report (Editorial Projects in Education, 2006) on how the nation's schools are doing, she identified twenty-four specific indicators for four core areas: standards, assessments, accountability, and efforts to improve teacher quality. The report "revealed that the implementation of policies related to teacher quality was negatively related to achievement gains in both reading and math" (p. 4). The indicators, which are measured by the Quality Counts report, were statistically manipulated in order to find a connection between student achievement and efforts to improve teacher quality. When the teacher quality indicators were removed and only "the relationship between state implementation of standards, assessments, and accountability systems" (p. 4) were considered, there was a stronger correlation in gains for reading and math. The report concluded the difficulty in assessing teacher quality when there are so many variables in the interpretation of teacher quality.

Research-based and Philosophical Ideals

A pedagogical and professional development program should, according to the National Research Council (NRC, 1996), require teachers to learn "science content through the perspective and methods of inquiry" (p.59); to integrate "knowledge of science, learning, pedagogy, and students" and to apply "that knowledge to science teaching" (p. 62); and to build "understanding and ability for lifelong learning" (p. 68). In addition, professional development programs "must be coherent and integrated" (p. 70).

A program which reflects the NRC's (1996) requirements that a teacher should engage in inquiry with students, strive to integrate current findings in effective pedagogical practice with successful means of teaching their content, and hold tantamount the students innate desire to learn is a blue-print of a professional development program considered "coherent and integrated" (p. 70). Additionally, concepts for the advancement of the nature of scientific endeavor should be fashioned into part of the professional development program. Those concepts would be to learn the importance and use of mental models, to learn how to help students develop critical thinking skills, to learn the history of the enterprise of science, to understand and appreciate the scientific attitude, and to be trained in the practice of science (NRC, 1996).

Professional development is driven by the needs of society (Huffman, Thomas, & Lawrenz, 2003; Eisner, 1998). As society changes, educational requirements change. The National Education Association (NEA), the National Science Foundation (NSF), and independent educational researchers conduct research that covers the gamut of content areas and educational strategies. Researchers use both quantitative and qualitative data, seeking an answer, which could be the magic potion, or the Rosetta stone, that could decipher the making of a highly qualified teacher.

Teachers are students also; they are life-long learners either by choice or by decree. Understanding the mind of these teachers (Eisner, 1998) will give us insight as to why they seek out professional development and how they implement what they have learned from their experience. According to Kahle & Kronebusch (2003), much of the teacher training in the form of professional development experience offered by independent contractors to school districts is not "content-based, sustained, or connected to grade appropriate learning" (p. 591).

When seeking out professional development, teachers tend to search for an expedient experience that will satisfy the district, state, or national requirements rather than seeking a professional development experience designed to enhance their epistemology or pedagogy (Guskey, 2000). Loucks-Horsley, Love, Stiles, Mundry, & Hewson (2003) identified four target areas that guide the development of effective professional development programs, which in turn would be a positive influence on teachers' epistemology or pedagogy. The first target area is to develop strategies to use in order to conquer achievement gaps among the diverse populations of students. The second area is to create the capacity in teachers to move their students beyond superficial knowledge of math and science. The third area is to change teachers' practice. The last area is to promote collaboration among teachers (p.23).

For teachers and providers of professional development for teachers, Guskey (2000) defines three characteristics of professional development. The first characteristic is that professional development is intentional; an intentional process means that the participants are aware of the goals, the goals are worthwhile, and the goals can be assessed (p.19). The second characteristic is ongoing; an ongoing professional development provides teachers an opportunity to continue their learning and reflect on what they have learned and how they have applied it to the classroom (p.19). The last characteristic of professional development is that it is a systemic process; a systemic process of professional development allows for consistence, continuity, and cohesion (p. 16).

In her evaluation of the Concerns-Based Adoption Model (CBAM) Loucks-Horsley (1996) suggested that paying attention to the implementation of a professional development treatment for several years after the treatment can identify late emerging concerns. Professional development changes the culture whether the culture is a particular school district or a group of teachers collaborating for a certain number of years (Loucks-Horsley et al., 2003, p.26). Guskey (2000) pointed out that if a professional development experience is to be thoroughly evaluated, information must be gathered over an extended period of time to search for “unanticipated outcomes” (p.9).

Kahle and Kronebusch (2003) compared what they considered an ideal program for science teacher education, K-12, to what actually exists in the nation. Through their review of literature, Kahle and Kronebusch concluded that a “content-based, sustained, connected to grade appropriate learning materials” (p. 591) type of professional development was the most beneficial. Unfortunately, few states and districts can afford to provide those types of programs. In an ideal situation, Kahle and Kronebusch reported that pedagogy and subject matter should be integrated, subject-specific content should encompass breadth as well as depth, and the inquiry approach should be employed for both teacher and learner. In addition, the teacher should be engaged in a "career-long process of learning through which science teachers in the ideal state will have regular, sustained opportunities to engage in inquiry, knowledge acquisition and integration, reflection, and collaboration" (p. 588).

Huffman, et al. (2003) focused on middle school science teachers. The purpose of their study was to determine the relationship between a particular type of professional development and student achievement. Huffman et al. examined teachers who were voluntary participants in professional development. The variables of this study were the type and the frequency of professional development and the degree of engagement of the participating teachers (p. 380). The researchers used two surveys to gather data for their study. The first survey measured the teacher's assessment of their own instructional methodology as compared to standards-based instructional methodology described in the *National Science Education Standards* (NRC, 1996). The data from the second survey was used to "help describe the type and duration of the professional development" in which teachers participated (Huffman et al., p. 381). Students' scores on state achievement tests were used as the dependent variable to study relationships between the teachers' professional development and their standards-based instruction. Analysis of the data revealed that professional development, which emphasized the examination of practice and the participation in curriculum development, had the largest impact on student achievement. The researchers believed these professional development practices were related to the “use of standards-based instructional practice,” (p. 382) and therefore contributed to student achievement.

Songer, Lee, and McDonald’s (2003) multiyear study implemented an inquiry-based, technology-rich curriculum in middle schools across the nation. The professional development design was guided by collaboration to construct new knowledge, classroom practice of the new constructs, reflective teaching practices, and adapting the successful practices in the classroom. In their study, they identified two groups of teachers: those who were from suburban areas, who sought out the professional development from the authors and were “experienced and comfortable with risk-taking and overcoming small or large obstacles common in new innovations” (p. 495), and those from urban areas who were required to participate in professional development because of district mandates. The findings of this study were that urban teachers, regardless of whether they are risk-takers, have institutional and social pressures that discourage them from seeking out innovative professional development programs.

The ITS Professional Development Model

The teachers who participated in this research were part of Cohort I of the Information Technology in Science (ITS) program. ITS was a professional development program which was prepared for Texas science teachers of grades 7-12.

The importance of teachers understanding the nature of science and establishing the community of scholars (Herron, 1977) is evident in ITS goals. The ITS mission was to establish precedence whereby scientists, educational researchers, and teachers, within the realm of the ITS program and with the use of information technology, “learn about:

- how science is done,
- how science is taught and learned;
- how science learning can be assessed;
- and how scholarly networks between scientists, educational researchers, teachers
- and students can be developed” (ITS, 2004a).

Long-term objectives for the ITS Center focused on:

- “Increased public understanding of science research
- Transfer of current science, mathematics, and engineering research into Grades 7-12 mathematics and science
- Long-term, research-based strategies for using information technology to enhance science and mathematics education at a variety of levels
- Establishment of multi-disciplinary environment in which researchers and practitioners in science and education work together to address complex science education issues (ITS, 2004c).

The participants were to provide a professional development experience for their colleagues at their respective schools. Additionally, the program encouraged participants to obtain their Masters or Doctorates.

According to the Science and Engineering Indicators for 2006 (National Science Board, 2006), there has been a shift in professional development for teachers from the basics of computer literacy to the use of computers to support educational goals, albeit the training was determined not to be sustained. Information technology training improves teacher performance by providing opportunities to integrate the use of information technology into their teaching (Coley, Cradler, & Engle, 1997).

The ITS program provided morning sessions to the participants which presented the concepts necessary for the participants to understand and utilize the technology-related information presented in the afternoon. Kant stated that a method is necessary in order to gain knowledge (Kant, 1956, p. 155). “Ideas of reason,” or knowledge of concepts, according to Kant, cannot be formulated solely from experience, but in order for an experience to be understood (appreciated), the concepts have to be present in the learner first (p. 141).

The ITS program fostered educational leadership by encouraging collaboration among the Cohort participants. Wallace and Wildy (1995), in identifying a new leadership paradigm, stated that science teachers, as leaders in the school environment, work in collaboration with their colleagues to seek solutions to improve the teaching and learning of science (p. 3).

The National Science Board (NSB), in its report on Science and Engineering Indicators for 2006 (NSB, 2006), indicated that there are numerous means to incorporate information technology into instruction, but the results of the integration depends on how well specific information technology supports the "teachers' instructional goals" (p. 43) (Coley, Cradler, & Engel, 1997). The call to teachers to utilize technology comes from many quarters including "media, accrediting organizations, professional associations, teachers, administrators, state, and federal departments of education, and parents" (King, 2002). The National Science Education Standards explains that the use of the term technology is not to be confused with instructional technology or information technology. The use of computers and other tools to conduct inquiry for a more comprehensive understanding of science is the goal of instructional technology, whereas technological advancements that come because of scientific research can be the motive to expand technological developments (National Research Council, 1996).

How teachers view technology is a good indication as to how they will use technology in the classroom. How teachers use technology in the classroom determines how effective technology will be in a high school class. Generally, teachers are the deciding factor of the effectiveness of technology in a classroom (Crippen, Archambault, Ford, & Levitt, 2004; Barton, 2005; King 2002; Voogt, Almekinders, Van Dan Akker, & Moonen, 2005). Some teachers are reticent about using technology for one major reason; the apparent conflict between how to use technology and how they teach their subject matter (Barton, 2005). Other conflicts encountered by teachers are logistical problems (obtaining or access to the technology), emphasis on standardized tests and the subsequent lack of time to explore information technology options in lesson plans, and lack of knowledge or experience with legal issues associated with technology, such as security, copyrights, and privacy (Office of Technology Assessment study as cited in Coley, Cradler, & Engel, 1997; Williamson, Brown, Peck, & Simpson, 2005, October). In a 2002 study of third grade teachers (NSB, 2006), NSB investigators found that more experienced teachers were providing information technology experiences for their students more frequently than less experienced teachers. They suggest that the experienced teacher had professional development and a higher level of computer literacy (p. 44). An equivalent study of high school teachers has not been found.

Initially, technology in the classroom consisted of computers capable of simple record keeping and drill and practice routines. As the computers became more powerful, data analysis became more sophisticated and computer simulations came into use (Hurwitz & Abegg, 1999). The advances in computer technology continue and the selections of educational options are numerous. Within those choices are a multitude of varieties and combinations. A list of just a few of the technological advances of hardware, software, or applications are as follows: computer visualizations, concept maps, learning logs (Hurwitz & Abegg, 1999), data loggers (Barton, 2005), wireless computers, data collection and analysis software, (Crippen, et al, 2004), collaborative design patterns (DiGiano, Yarnall, Patton, Roschelle, Tatar, & Manley, 2003), PowerPoint presentations, virtual labs, web-based classes, and hypermedia (Chrisman & Harvey, 1998). These tools are useless if the teacher does not know how to, or does not want to, integrate them into the curriculum.

The Texas Regional Collaboration for Excellence in Science Teaching (Barufaldi, Ibeily, & Norman, 1997) determined that a paradigm shift in science education was necessary in order to meet the needs of a changing world. In order for the change to occur, teachers, the agents for change, will need to be “empowered to feel comfortable at taking risks; at acquiring new knowledge, skills, and competencies; at trying alternative methods of teaching; and at developing and adopting a new paradigm of science education” (p.3). For example, the wireless internet in tandem with the curriculum carts, which contain the wireless computer, data collection probes, and software to interface with the probes and computers (Crippen, et al, 2004; DiGiano, et al, 2003), are an exciting real-world experience and a challenge to teachers. The new learning that the probes facilitate encourages students to think critically. They collect data like scientists in the field, authentic learning, and collaboration is encouraged. The challenge for the teacher comes from the introduction of probes, which change laboratory methods that have been in practice for years. The teacher must learn a new method to collect and analyze data in order to prepare for the information technology classroom. DiGiano, et al (2003) points out that the wireless classroom allows for mobility in the classroom, throughout the school, and in the field. Students would be able to exchange data for additional analysis purposes. DiGiano, et al (2003) also discusses collaborative design patterns. These programs encourage collaborative learning. Students can use inquiry learning as they go through the program, and then they collaborate with another student in order to experience that science is a collaborative enterprise. Science is everywhere and could be taught as a process with the aid of a wireless classroom that would allow teachers and students to leave the classroom.

The value of educational technology is not in doubt. The students make connections between theoretical practice and the actual practice while using the wireless computer and conducting lab experiments. They are constructing new knowledge and making connections to the old. They are learning critical thinking skills along with skills they could use in college or in the field.

A teacher in the classroom may not have the time or the inclination to do all the preparatory work needed to make a web page. A teacher may not have the time or knowledge to learn how to use the data probes, the wireless technology, or the software on their own. In order for technology to be used effectively in the classroom, there must be transformative (King, 2002) professional development that is content specific, with sufficient time, in order to work with others in the same content area.

Tsai (2001) acknowledged the lack of research concerning teachers who have participated in an information technology related program and their reflections on their epistemological, ontological, and methodology views. Tsai's study examined one teacher's scientific epistemological views (SEVs) after the implementation of a science, technology, and society (STS) instruction to her students. The teacher's exposure to STS training was from workshops she attended and materials supplied to her by the author of the study. The type of professional development, which were the workshops, the teacher had before implementing STS to her students was classified as training and individually guided activities were materials and directions received from Tsai who also provided journals for the study (Tsai, 2001). Although Tsai did not study a teacher who participated in a long-term professional development, Tsai suggested that a long-term application of professional development would effect a change in a teacher's epistemology.

Summary

In this chapter, I reviewed the literature, which explored the interaction and importance of a teacher's epistemology, ontology, and methodology. Second, I presented and analyzed literature found on governmental, research-based, and philosophical influences on professional development for teachers. Finally, I presented and analyzed literature on the theoretical basis of the technology-based professional development model of ITS. Knowing what I have in the literature has prepared the field for my research study. The epistemology, ontology, and methodology, in the face of professional development and government mandates could have changed. The teachers' epistemology, ontology, and methodology intertwine and to unpack the changes, I must look at all of them together and separate.

CHAPTER III

METHODOLOGY

Chapter III contains a description of the ITS program, the theoretical basis of this study, a description of the participants and the selection process, the data collection and processing, and the analysis of the data.

Description of the ITS Program

Seventy-four educators participated in Cohort I of the ITS program, which met for three-weeks during the summers of 2001 and 2002. The research themes for the program were:

- To include teachers in the research enterprise;
- To create the teaching scholar, make education an explicit component of the career of a scientist, and providing faculty development;
- To provide an opportunity for participants to become graduate students with training in education;
- To integrate research experiences in undergraduate educational programs;
- To design, develop and assess inquiry-based learning; and
- To develop, implement, and assess the role of information technology in the support of science and mathematics learning and the integration of research and education (ITS, 2004e).

There were five teams in Cohort I, but the focus of this study was on the Chemistry team lead by Drs. Vickie Williamson, Paul Lindahl, and Daniel Romo of Texas A&M,

College Station, Texas. Fourteen teachers were part of this ITS Cohort I and were unofficially known as the Chemistry team.

The activities for the first year for the Molecular Visualization of Chemical Processes and Properties of Matter team consisted of reviewing literature reviews over the student/learner misconceptions of the particulate nature of matter, the science education standards, and the research into molecular visualization as a teaching strategy. The team members identified factors that contributed to the effective use of molecular visualization and explored some of the visualization technology that they and their students could use in classrooms. The types of visualization technology that they explored consisted of computational animations, representational animations, and interactive visualizations. Some sample programs were Chime and RasMol, which are Molecular Visualization Freeware from NSF; ISIS/Draw, available from the University of Cambridge Department of Chemistry website; and ChemSense software freely available and developed by NSF, in addition to materials available through the Internet, on videotapes and CDs. A final product of the first summer institute was a visualization to be used in the participant's classroom (ITS, 2004d; Williamson & José, 2008).

The second summer institute for the Molecular Visualization of Chemical Processes and Properties of Matter team of Cohort I required the team members to produce a teaching module that was inquiry-based and incorporated some aspect of molecular visualization. Team members designed and implemented a method to assess the impact of a selected part of their teaching module, thereby addressing parts of the ITS research themes (ITS, 2004d; Williamson & José, 2008).

Theoretical Basis of the Study

In this study, the teachers' voices (Eisner, 1998) are heard and shared in order to develop an understanding of the influence of ITS professional development on their educational epistemology, ontology, and methodology. Rather than being objects to be manipulated and processed like data, teachers are people who have distinct characteristics and distinct life experiences that they bring to the classroom and ultimately affect our students. I selected this qualitative methodology as my research paradigm because I wanted to look inside the minds of science teachers at something that cannot be measured, but only interpreted.

Research on epistemological beliefs has been conducted using both qualitative and quantitative methodology. Schommer-Akins (Schommer, 1990) introduced the concept that epistemology is composed of independent domains rather than a result of developmental progressions. Her research focused on students' beliefs about the nature of knowledge and how comprehension was affected by their beliefs. In order to analyze the independent domains, she created a 63 item epistemological questionnaire in an effort to quantify epistemological belief systems. In her 2004 article (Schommer-Aikens, 2004), which revisits her previous research, Schommer-Akins explained that she chose to use a quantitative methodology for her studies in order to "tease apart aspects of previous thick descriptions and allow a more analytical inspection of individuals' epistemological beliefs" (p. 21) and have a means by which she could conduct a statistical analysis of each domain. In this same article, she acknowledged that qualitative methodology that used interviews with thick descriptions, which was the original methodology for the study of personal epistemologies (p. 19), can provide “a more holistic understanding of personal epistemology” (p. 23). Qualitative research “seek[s] to discover and understand a phenomenon, a process or the perspectives and worldviews of the people involved” (Merriam, 1998), or a holistic understanding.

The philosophical underpinning of the methodology for this research is constructivism, so it would be fitting to identify the epistemological, ontological, and methodological questions from the constructivist standpoint. Constructivists see the epistemological questions as reality-based, the reality that exists in the subject’s mind. Ontological questions for the constructivist can be difficult because reality, as determined by the epistemological question, is constructed by the subject, so that can make the two questions meld into one. As Guba (1990) states, “there is no alternative but to take a position of *relativism*” (p. 26). How constructed knowledge is interpreted or the “hermeneutic aspect” addresses the methodological questions (p.26). In this dissertation, the hermeneutic aspect is how the participants utilize the knowledge they have constructed.

Participants

I obtained, from Dr. Vicki Williamson, Texas A&M professor and team leader of the ITS Cohort I Chemistry team, a list of participants for the ITS program. From that list, I compiled contact phone numbers and e-mail addresses for five of the six members who had completed the program and were high school science teachers. I was the sixth member of the Cohort. I sent an e-mail (Appendix A) and then made follow-up phone calls when I had the contact phone numbers for the participants. Three responded and were willing to participate in the research. One member was not receptive to participating, and one did not respond to any inquiries. I insured the confidentiality of the data by assigning pseudonyms for each participant to protect their identities as required by the Institutional Review Board (IRB). Before the interview began, each participant read and signed the consent form (Appendix B). Through the interviews, I gathered information about their interactions and experiences in their world, the emic perspective (Matthews, 2000; Denzin & Lincoln, 2000; Merriam, 1998, Gall, Borg, & Gall, 1996).

My relationship with the group being studied was that I was an ITS Cohort I Chemistry participant, in addition, I took Dr. Williamson's Chemistry 698 Inquiry and Chemistry Concepts in the Fall of 2001 at Texas A&M with the other members of the Cohort. I was there and I knew of the frustrations, worries, and victories that they conveyed to me during the interviews. I had not met Alana before the ITS program. I knew Beatrix in the context that she had conducted workshops in which I had participated. I knew Candice in the context that she was a participant of a cohort group that was running parallel to one in which I had participated at Texas A&M prior to the ITS program.

Data Collection

I used Patton's (1990) six basic questions as a guide to write my interview questions. Patton advocates the use of experience/behavior questions, opinion/value questions, feeling questions, knowledge questions, sensory questions, and background/demographic questions. Questions, which addressed knowledge issues, I classified as epistemologically related. If the questions were more reflective in nature, I classified as ontologically related. Those questions that I related to the participants' methodologies were methodology questions.

I designed the interview questions (Appendix C) to seek out the teachers' voice concerning their epistemology, ontology, and methodology. When ideas can be "assimilate[ed], validate[d], corroborate[d] and verify[ied]" (James, 1995, p. 77), then "[t]ruth *happens* to an idea" (p. 77). The questions sought the teachers' perception of the change in their epistemology from before their ITS experience compared to their present epistemology after the ITS experience. Each interview began with questions designed to elicit their current beliefs about the nature of science teaching. I then asked them to reflect on how these beliefs had changed during and after their participation in the ITS program. This pattern of present description followed by reflection and comparison was used to gather information on ontology and methodology. As appropriate during the interview, and near the end of the interview, I asked the questions related to perseverance and continuance of the changes resulting from the ITS experience.

Each of the participants determined a convenient time and location for the interview. I interviewed one participant at an outdoor restaurant near her home. There, when the background noise became too distracting, we moved to a local hotel lobby. The other two interviews were conducted at the participants' homes.

After each interview, I transcribed the recorded tapes into word-processed documents as recommended by Merriam (1998). During the data collection and simultaneous analysis, I engaged in the practice of memoing, I jotted "down notes, comments, observations, and queries in the margins" (Merriam, 1998, p.181) Memoing encourages the researcher to approach the data collecting and analysis in a reflective manner. Integrating the memos into the analysis of the research produce the rich descriptions necessary to give voice to the teachers and shape their story (Schwandt, 2001; Merriam, 1998).

I printed hard copies of each transcript; each transcript had line numbers and was of a different font color so I could keep track of the data during the analysis process. For the actual coding process, I used six different-colored highlighters with coordinating index cards. The analysis commenced with the coding of the data and the development of a category system. I developed an inductive category system, as the data were coded (Merriam, 1998; Schwandt, 2001). This part of the endeavor was not static, but a fluid process where theories were developed. I went over my codes and grouped the ones that seemed to go together. I compared and merged my codes, and my "patterns and regularities [became] the categories or themes in which subsequent items are sorted" (p.181). I followed the process described by Merriam and melded it with Bogdan and Biklen's (2003) recommendations of using codes. Coding is the process of organizing the data and identifying themes and strands (Merriam, 1998).

Merriam (1998) suggested that the researcher create categories and subcategories using the constant comparative method of data analysis, while keeping in mind relevant knowledge, background, and purpose of the study. I was able to identify bits of data as code, and the codes fit neatly into categories. From the categories, I was able to see patterns (Merriam, 1998). I found many subcategories, as I read each transcript and jotted down tentative themes. After the last interview session, I went through each transcript again and found common themes throughout. My categories were exhaustive (all data could be categorized), mutually exclusive (no data fit in more than one category), and conceptually congruent (the level of abstraction for all categories was consistent), but they also reflected and answered my research questions (Merriam, 1998).

The data I collected could not be statistically analyzed, nor could it be standardized, thus requiring inductive analysis (Bogdan & Biklen, 2003). According to Merriam (1998), there is no set procedure or protocol to follow with qualitative research, but the researcher much be able to "adapt to unforeseen events and change directions in pursuit of meaning" (p. 21-22).

While actual categories were developed during the coding process, I looked for recurring themes. I looked for the commonalities of influences from each teacher's background that shaped their ontology, the teachers' conceptualization of their views of science education or in what realm they hold their knowledge of science education and any indications of paradigm shifts or epistemological changes, and the teachers' thoughts about science education, and how each translates that into a methodology.

Analytical Framework

Can the Rosetta Stone of educator excellence be found? The original Rosetta Stone was comprised of three different scripts. Two of the three scripts were known and led to an interpretation of the third, the hieroglyphics. The Rosetta Stone was a key to understanding an ancient and long-gone culture. Every study conducted in the name of research has the potential to add to the body of knowledge concerning educator excellence. Peddiwell (1939) acknowledged the complexity of the attempt to measure “the changing of human minds” (p. 55). However, I am going to attempt to do just that, because “education becomes scientific in proportion to the increasing willingness of educationists to test their hypotheses” (p. 11).

Any interpretation is value-laden. An understanding of the philosophy behind the methodology is a way of sharing with the reader the lens through which the researcher interprets findings. Constructivism has been called the “grand unified theory” for education as it has applications as a theory of learning, teaching, knowledge, and the origin of ideas (Matthews, 2000). Ernst von Glasersfeld’s developmental model of radical educational constructivism, based on the work of Jean Piaget, embodied the epistemology and ontology tenets, or paradigmatic underpinnings, of interpretivists (constructivism) (von Glasersfeld, 2001). These are: knowledge is created by the individual in a historical and cultural context dependent on an individual’s interactions and experiences in the world; conceptual structures can lead to knowledge when the individual can relate them to life experiences; and knowledge is the logical ordering of an individual's experiences

(Matthews, 2000; Denzin & Lincoln, 2000, p. 23; Merriam, 1998).

Ernst von Glasersfeld (1981) addressed radical educational constructivism by first examining Kant’s idea that although we may perceive properties of a “thing” differently than someone else and we may not perceive all of its properties, we may ask “what makes us so sure that the “thing” truly exists in the first place?” Radical constructivism, according to von Glasersfeld, answers Kant’s supposition that our experience can teach us nothing with a quote from Giambattista Vico’s *De antiquissima Italorum sapientia*:

> As God's truth is what God comes to know as he creates and assembles it, so Human truth is what man comes to know as he builds it shaping it by his actions. Therefore science (*scientia*) is the knowledge (*cognitio*) of origins, of the ways and the manner how things are made (von Glasersfeld, 1981, II).

Francis Bacon in *The Advancement of Knowledge* (Bacon, 1605, XXII, 7; Durant, 1962), charged that we should inquire into:

> those points which are within our own command, and have force and operation upon the mind, to affect the will and appetite, and to alter manners: wherein they ought to have handled custom, exercise, habit, education, example, imitation, emulation, company, friends, praise, reproof, exhortation, fame, laws, books, studies (p. 117).

Such personal inquiry is valuable because these are the influences on the mind. These influences create the foundation for previous knowledge that is the basis of the constructivist theory.

The interpretivist paradigm sees reality as a “construction of the human mind” and “beliefs rather than facts form the basis of perception” (Merriam, 1991, p. 48).
A drawback to an interpretivist paradigm is the lack of knowledge of objective reality; knowledge is constructed through experiences and it is relative (Matthews, 2000). Merriam (1991), states that there is “[n]o mechanism…for assessing the value or worth of one set of subjective interpretations over another” (p. 51).

This study is not a formal phenomenon study, a study which is conducted by the researcher while actually participating in the phenomenon, with the goal “to arrive at a structural understanding of specific and concrete experiences by being fully and critically present to situations where the desire experiences take place” (Giorgi, 2002, p. 9), but this study does look for the essence of the experience (Merriam, 1991).

The trustworthiness of the data is insured by member check and peer examination (Merriam, 1998). Member check is used to determine if the “data and findings reflect the respondents’ realities” (Hoffart, 1991, p. 523). The completed transcript was sent to each participant with a request for verification that the transcript was accurate. One participant requested that I delete her personal comments in regards to administrational procedures. Additionally, she clarified spellings and the chronology of her professional development involvement. The other two participants replied that the transcripts and findings were correct. After the transcripts were coded and analyzed, the portions of the findings from the analyzed data that were relevant to each participant were sent to them for verification of accuracy of my interpretation. Two participants responded that everything looked fine to them, whereas the third participant did not respond. Peer examination was conducted by two teachers who each have a Master's degree in education. One was a former participant of the ITS institute and the other was not. Additionally, my own experience as a teacher and Cohort I Chemistry member allowed me to analyze and interpret the data, thus employing the etic perspective (Gall, Borg, & Gall, 1996).

Part of my quest to establish reliability is to acknowledge and establish my relationship to my participants (Merriam, 1998), yet part of my perspective and bias is my relationship to my participants, an ironic situation. My subjectivity is based on my personal desire to really know how the other participants were affected by the ITS program experience. I identify with Peshkin's (1998) "Nonresearch Human I." This particular "I" feels comfortable within the realm of the science teacher. I have affection for my science teacher participants, but because of the "Nonresearch Human I," I am also reminded by Peshkin (1988) that I have an obligation to explore with dispassion their voices.

This chapter began with a description of the ITS program. I provided the theoretical basis of this study and provided a description of the participants, and the selection process. Additionally, I explained the data collection and processing procedure. Through the coding and the organization of the categories, there emerged a "coherent narrative" (Gall, Borg, & Gall, 1996, p. 547) that was laden with the values of the teachers who participated as members of Cohort I Chemistry team in the ITS program. In chapter IV, I provide my findings, which is their story unfolded and revealed. Their voice provided insight into how their teaching methodology reflected their epistemological growth and change in their ontological stance in light of the ITS influence and subsequent institutional and social pressures.

CHAPTER IV

FINDINGS

This chapter discusses the findings of the research. The first section introduces the participants and provides background information about their respective schools, which will provide the context for my research questions concerning the teachers' background and institutional and social pressures. I relate each participant's background educational experience because it pertains to their ITS experience and their motivation for participating in the ITS program. In order to understand the institutional and social pressures under which they work as teachers, information about their respective schools is included because their schools are the institutions with which they have the most interaction.

Information concerning my participants' schools was obtained from the Academic Excellence Indicator System (AEIS) on the Texas Education Agency (TEA) website (TEA, 2007). I included information for each school beginning with the 2002-2003 school year because that is when TEA began reporting the results of the Science TAKS tests. Since there was no information available for the 2006-2007 school year at the time of this writing, I am using the data from the 2005-2006 school year when the participants were at their current schools.

The remaining sections examined the epistemology, ontology, and methodology of the participants as I listened to the participants for evidence of a new understanding or a new way of thinking about what they knew about science and technology. In addition, I listened to the participants for examples, in their own words, where new understanding and thinking was or could be attributed to their ITS experience, thus indicating that there was a change in their epistemology and ontology. Finally, I wanted to know if they were using information technology as presented by the ITS program to explain science concepts as an indication that there was a change in their methodology.

The transcripts of the audiotapes of the interviews were subjected to a code analysis and subsequent analysis of the categories by the use of the constant comparative method as described by Merriam (1998) and Bogdan & Biklen (2003).

Throughout this chapter, I use the format "RQ1(1)" when I refer to the key interview questions. The example I used, "RQ1(1)", means the question asked of the participants refers to Research Question 1 and the first question on the list. The Key interview questions are in Appendix C. The questions numbered one through 13 concerns the epistemology of the participant. Questions numbered 14 through 27 concerns the ontology of the participants Questions numbered 28 through 38 concern the methodology of the participants.

Since I, too, was a participant in the ITS program. I include my voice to add to the body of knowledge provided by this dissertation. My responses are italicized at the end of the relevant sections in Chapter IV.

Meet the Participants

Six members of the ITS Cohort I Chemistry Team were high school science teachers I contacted the six members and, of the six, three responded and were willing to participate in the research. This section introduces the participants and their motivation for participating in the ITS program.

At the time of the interview, Alana, a tall, slender woman of 59 years of age, was nearing the completion of her fourth year of teaching. She has taught at two different high schools, two years at each school. During the year of the interview her teaching assignment consisted of one preparation for 10^{th} graders in an Integrated Physics and Chemistry class at the high school in her school district.

Her certifications are at the secondary level in chemistry and physical science. She has a Bachelor's degree in chemistry and a Master's degree in chemical education. She completed her Master's degree in 2004 and was working on it when she participated in the ITS program.

Alana worked as a bench laboratory assistant in an analytical chemistry lab and in cell research in a biochemistry lab before she became a "stay-at-home" mom. While a stay-at-home mom, she worked as a secretary in a construction firm for five years. Alana is divorced, and the divorce prompted her to go back to school to get her Master's and her teaching certification. While working on her Master's degree she worked as a laboratory assistant.

Alana had suggested that we meet at an area restaurant for the interview and sit outside where there were fewer patrons. When a bird in a nearby tree started to sing and compete with Alana's responses, we stopped and reconvened the interview in a lobby of a nearby hotel. During the interview process, Alana alternated between using wide and expansive arm and hand gestures to sitting very still with her hands in her lap. She shared that she did not think she would be very helpful to me because she had not been a teacher for very long. I assured her that what she had to say was very important.

As a student in the teacher education program at Texas A&M, Alana is the only participant interviewed who was not a classroom teacher at the time of the ITS program. Alana said that during one of her classes, a representative from the ITS program came to talk about the program and encouraged them to apply. The collaborative aspect of the program appealed to her, as did the prospect of learning more about information technology. She had taken a computer course that focused on various Microsoft programs when she started the Master's program at Texas A&M. In response to RQ1(5) concerning her motivation for participating in the ITS program, she stated she was "really interested in what utilization students could make of working with information technology in learning and understanding."

Alana's school has been rated Academically Acceptable for the school years between 2002 and 2006 which indicates that there is a higher than 55% passing rate but not more than an 80% passing rate of the TAKS test for those years (TEA, 2007).

The second participant in this study was Beatrix, an energetic and animated woman of 48. Beatrix had 25 years of teaching experience at the time of the interview, a Bachelor's degree in Spanish and chemistry, a Master's degree in chemistry education, and a PhD in Curriculum and Instruction. Her certifications are at the secondary level in composite science, chemistry, and Spanish. Her previous employment experiences consisted of part-time work while attending college. She built batteries for missiles, worked at a fast food restaurant, and was a lab technician at her undergraduate university with the chemistry department. All of her work experience since graduating from college with her Bachelor's has been in education.

Beatrix's teaching assignment during the time of the interview was teaching pre-AP® chemistry and AP® chemistry to 10^{th}, 11^{th}, and 12^{th} graders. Beatrix is also the science specialist for the district at which she teaches. As a science specialist, she is responsible for providing materials for teachers to use to prepare their students for the TAKS test.

When I went to see Beatrix at her home for the interview, she had been sitting on her living room sofa grading papers and watching a recorded episode of the Star Trek: Next Generation® television program. During the course of the interview, she had an asthmatic episode that, for me, was very unsettling, but Beatrix took it in stride and consented to continue with the interview. As Beatrix answered my questions, she emphasized her statements with energetic arm and hand movements. Beatrix was verbose, yet made her way back to the focus of the question in due time.

Beatrix, a self-described "workshop-aholic," attends almost every CAST, and has been involved in summer programs for years. She was in the Woodrow Wilson enhancements programs in physics and chemistry for seven or eight years. She was a participant in the Texas Teachers Of Physic Science (TTOPS) enhancement program at Texas A&M for three years and then a staff member for an additional three years. Next, she became an ITS participant for two years and a staff member for one year.

Beatrix was influenced to participate in the ITS program by a chemistry professor from Texas A&M while she was in attendance of the Texas Section of the American Association of Physics Teachers meeting at Stephen F. Austin University. She had worked with him for several years on another program and he thought she would benefit from participating. She is the only participant who mentioned the stipend as a motivating factor. After a particularly trying day during the first summer session for ITS, she said that she “would have gone home that night had it not been that they were paying us to be there. That’s the honest to goodness truth.” She is a divorced mother of two and her parents were babysitting her children during the program. She had called her mother and told her she wanted to come home, but her parents convinced her to stay.

She revealed that her level of expertise with computers was that “prior to joining that program, I hadn’t even done an internet search. If you had said ‘Google’, I wouldn’t have had a clue what you were talking about.” She emphasized her lack of computer skills by adding, “I started out with virtually zero knowledge. I could barely send an email and I couldn’t send an attachment, so that’s how bad it was.” The first year of the program was stressful to Beatrix because of her “low level of knowledge” about computers. An unexpected benefit was that she had to let “loose of a few reins which is very difficult for me to do” and allow the other team members to be responsible for parts of the many projects required of the participants, specifically the PowerPoint presentations.

Beatrix’s school was rated a Recognized school in 2002-2003 which indicates that there was a higher than 80% passing rate but not more than an 90% passing rate of the TAKS test for that year (TEA, 2007). For the school years between 2003 and 2006 her school had been an Academically Acceptable school which indicates that there is a higher than 55% passing rate but not more than an 80% passing rate of the TAKS test for those years (TEA, 2007).

The third participant was Candice, a woman with a calm and gracious demeanor. Candice is 60 years of age and has 39 years teaching experience; 21 of those years have been at her current high school. Candice invited me to her home that she shares with her husband who teaches at the same school as Candice. She apologized for being tired and stated that her husband and she were both recovering from a late night of chaperoning the Junior-Senior Prom dance the previous evening.

Candice has a Bachelor's in education in natural science with a minor in education and chemistry. She has a Master's in Curriculum and Instruction. Her certifications are at the secondary level in biology, physical science, and composite science. During the time of the interview, her teaching assignment was pre- AP® physics, AP® physics, regular chemistry, and pre- AP® chemistry. She is a sponsor of her school’s student government and the chairperson of the high school prom committee. All of her work experience since graduating from college with her Bachelor’s has been in education.

Candice said that she had been using inquiry methods for years; she just never called it that. She worked at the Superconducting Super Collider Center, in the education department during the late 1980s and early 1990s, developing a curriculum that was student-centered. She said the curriculum was designed to provide a “very deep learning” and encourage group learning.

She attended workshops in the late 1980s at the American Association of Physics Teachers conferences, which focused on group learning. She was a Physics Teaching Resource Agent (PTRA), which is a teacher trainer certified by the American Association of Physic Teachers. PTRAs are trained in inquiry learning and in turn train other teachers in the use of inquiry learning.

Candice had leadership qualities before ITS. Previous to ITS, Candice worked with the Fermi lab; she has presented at Conference for the Advancement of Science Teaching (CAST), and the American Association of Physics teachers (AAPT); and she was an instructor for the Physics Enhancement Program (PEP). Candice continues her leadership role not only when she teaches classes at her high school, but also when she teaches at a local junior college and university, in addition to presenting workshops around the nation.

Candice was motivated to participate in the ITS program because she “thought it looked interesting” and “I didn’t know very much about technology.” She added that, “Our school district didn’t have very much technology. I had really never worked very much with a computer except to put my grades in and do a few things like that.” Her desired outcomes for the ITS program were to be able to utilize the graphing calculator, Vernier’s LabPro® programs, and Pasco equipment, to learn how to program a computer to do simple things, and to hook up a Vernier Logger *Pro*®. She wanted her students to be able to actually "collect data and do that sort of thing and do real time stuff where you could look at sequence of events that were actually happening or had happened, and that's what I wanted to learn how to do." Her assessment of her computer skills prompted her to state that she "wanted to become a techno-nerd." Her hope was that she would be able to spend time with someone who knew what they were doing so she could become that "techno-nerd."

Candice's school was an Academically Acceptable school in 2002-2003, 2004-2005, and 2006-2007 which indicates that there was a higher than 55% passing rate but not more than an 80% passing rate of the TAKS test for those years (TEA, 2007). As a recognized school in 2003-2004 and 2005-2006, the passing rate was higher than 80% but not more than a 90% passing rate of the TAKS test for those years (TEA, 2007). At the time of the interview, Candice was one of 26 high school teachers and one of six that have been teaching for over 20 years (TEA, 2007).

The Participants' Epistemology

The first stated goal of the ITS center concerned the production of education specialists who in turn would share their knowledge with other teachers. In order for the other goals of the ITS Center to be carried out, there had to be education specialists, or education leaders, with a working understanding of information technology in science who were willing to continue to learn, to work with others, and to share what they learned. Ultimately, the ITS experience was designed to change teachers, teaching methods, and student learning (ITS, 2004a).

The ITS program encouraged the epistemological development of the teacher by introducing new concepts of learning and teaching while using information technology, which ties in with the National Science Education Standards for professional development. Four standards provide the criteria for quality science teacher professional development. They are: (Standard A) involve teachers in learning science through inquiry, (Standard B) helping teachers to integrate what is known about learning and teaching and apply it to science teaching, (Standard C) encourage lifelong learning in teachers, and (Standard D) provide quality professional development for science teachers (NRC, 1996). The ITS program provided an environment where the participants were able to engage in an inquiry experience into the current research on learning and self-reflection. The experience was not always pleasant, but through reflective practices the participants discovered where they had been and where they were going as professionals.

Each participant had in mind characteristics of what a good science teacher should posses and an idea if they met that ideal or not. I listened to the participants for evidence of a new understanding or a new way of thinking about what they knew about science and technology and for cases where new understanding and thinking was attributed to their ITS experience. I wanted to know if they were using information technology as presented by the ITS program to explain science concepts. With those criteria in mind, I would determine if they had an epistemological change, which would be a change in what they know concerning science education and technology.

These questions are the basis of my first research question. The questions I asked in search of an answer as to whether the teachers' background and experience of participating in ITS affected their epistemology concerned the teachers' perceptions of science education before ITS (RQ1(1)), the role of the science teacher in today's society (RQ1(3)), their understanding of their role as a science teacher (RQ1(4)), their motivation to participate in the ITS program (RQ1(5)), their initial perception of the ITS program (RQ1(6)), their interaction with the ITS project scientist (RQ1(7)), the parts of the ITS experience which were significant to the teachers (RQ1(8)), and their thoughts on the idea of "highly qualified" teachers as per the No Child Left Behind Act (RQ1(13)).

Part of my second research question concerned the sustainability of the changes in the teachers' epistemology made in response to the ITS program in the face of institutional and social pressures. The questions I asked the teachers in search for the answer to the second research question concerned the teachers' perception of a science teacher after the ITS program (RQ2(2)), a look at the professional development experiences the participants have had since the end of the ITS program (RQ2(9)), pressures from school administration concerning the TEKS and TAKS (RQ2(10) and RQ2(11)), and their ideas for utilization of the ITS experience (RQ2(12)).

Background and Experience

Science Educator

I asked the teachers what was their perception of a science teacher before they began the ITS program (RQ1 (1)) and what they considered to be their role as a science teacher (RQ1 (4)). These questions encouraged the participants to look back to the type of science teacher they were before the ITS intervention.

Alana shared that her encounters with science teachers in her early educational experiences provided an array of teaching styles. She had teachers who “brought science to the students and made it accessible to them, helped them to understand it and see how … [it] applied to their everyday life.” She had teachers who were not as helpful, “some were just treading in place. They, you know, did not really help, did not really help me to grasp the concepts as fully as could have happened.” She described their method of teaching as “very dry and very abstract.”

Alana’s perception of a science teacher tied in with her idea of the purpose of science education, which is to educate the student to think and to problem solve. “They [the student] have got to know when they listen to somebody: does that person seem to be speaking from real information, real evidence, or from opinion, and [how] to tell the difference.”

Beatrix knew what kind of science teacher she didn’t want to be before she ever heard of the ITS program. She called it the “science class from hell” where the student came to class, sat down, read the book, outlined the chapter, did the vocabulary, answered questions, did a review sheet, and then took a chapter test and moved on to the next chapter. She knew that she did not want to be that sort of teacher. Her early idea of science teaching was hands-on and laboratory-based, but she also thought of herself as putting the knowledge into the students’ heads, what she calls a “subject matter specialist.” She said, “I think I was that type of teacher, very structured in that respect that I had the knowledge and I was going to impart it to my students. So, a hands-on pour-knowledge-into-their-heads teacher, that's probably what I was before the program started."

Candice, who had been teaching the longest, had the hardest time responding to the question of her perception of a science teacher before ITS. She stated that she was "trying to teach real science to real students." She "didn't want to teach about science," she wanted to "teach science." Her previous workshop experience with the Superconducting Super Collider project in the Waxahachie area during the 1980s gave her the training she needed to conduct a student-centered classroom. She added that she had been doing the ITS type of inquiry science in her classroom for years, but she had never called it that. She was the participant whose perception of a science teacher best fit the ITS goals even before she started to participate in the program.

Candice acknowledges the difficulty of using inquiry all the time. There are some concepts that are not geared towards the inquiry method, and she just has "to stand there at my overhead or you know I just have to be at the board working equations." She has tried to develop inquiry lessons for formulas and equations, but has not yet been successful. She has defined inquiry as providing students the opportunities to take responsibility for their own learning, "because they would ask the questions and then they could seek out the answers on their own if you gave them just a little bit of information."

Summary

Alana based her perceptions of a science teacher on her previous science teachers and acknowledged that she had teachers who ranged from effective to not effective.

Beatrix had in her mind what kind of teacher she did not want to be, but she realized that her driving personality may not have been the most effective means of teaching for her students. For Candice, she was teaching inquiry; and although she was not aware of the research behind the method, she did realize that it was an effective means of reaching students and helping them to be successful in class.

Role of Science Teacher

I wanted to know how the participants defined the role of science education in today's society (RQ1 (3)). Alana shared that she defined science education in terms of what would benefit her students. She felt the focus needed to be on the students' awareness of their environment, how they were going to interact in their environment, and what kind of impact they would have on their environment. She said, "I feel like students who are inclined in school today really need to be aware of these situations." One example she cited was to raise environmental concerns. One very relevant concern is the source of energy for electricity and "using up fossil fuels that won't be replaced." Another concern she wanted to focus her students' awareness on was recycling:

> [Our] landfill is full. I see students at school, they're no longer buying sodas, and what not, but every plastic bottle they have [instead of] a glass of water gets pitched into the garbage and not recycled, and I think about waste, of what resources are being wasted.

Alana maintained that as her students mature and become active members of our society they will need to know "what kinds of issues they're going to have to deal with in their adult life." She hopes that they will get involved "when they talk to their legislators or if they even bother getting involved at all," because their life "is not necessarily going to be static." The skill of problem solving is also a major part of being involved in life, and Alana sees the process of problem solving as an important part of a science teacher's responsibility. The problems tomorrow's citizens face will be nothing like the problems Alana's generation has had to face. She thinks that knowing how to identify a problem, pose a questions, gather information about the problem, and analyze the results will help students in the future. "When they listen to somebody, does that person seem to be speaking from real information, real evidence, or from opinion, and to tell the difference." Alana acknowledges that her role as a science teacher at the IPC level "is to make students aware that science affects them every day." Despite the fact that, "they seem to think that science is some separate field of study that has no bearing on their lives whatsoever."

Beatrix shares Alana's idea of the role of a science teacher in today's society. She strives to "give the students the background to make informed decisions about their lives, about other people's lives in their community and in the world." She wants to give her students "the tools they need to be able to discover answers for themselves without having to trust an individual or group of individuals to give them that information." Beatrix said that the public has relinquished control of their own fate by allowing others to make their decisions, and she does not want her students to fall into that trap. "There are too many people that are willing to not know enough and thereby having to trust other people to be the subject specialist." She perceives herself as having more of a global perspective, "we are all living on this earth together." But,

> we have to challenge the way things are, because the way things are is not the best it can be; it can be so much better and I think that's what all of us should be doing, [we should be] working towards that.

Candice's perspective of the role of science teachers is not only from the perspective of a teacher of young students, but also from an adult educator's perspective - a teacher teaching teachers. She sees the role of a science teacher "as getting out there and getting those kids to understand what's happening in the world." She perceives a decrease in the number of science teachers coming out of the colleges: she thinks that is a result of science teachers not "getting them [students] to the place where they need to be" in schools. Candice said that she didn't want to "teach about science, I wanted to teach science."

According to Candice, "more and more people that are teaching science have fewer and fewer hours in science." She fears that their level of understanding is not up to the rigors needed to prepare students for a future in science. Candice's opinion is that giving students teachers that are not prepared to teach them will not create a comfortable learning environment,

> It's not presenting in a way that they feel like they [students] can take ownership. It's not going to be something they do and so we're seeing, at least from my perspective, fewer and fewer students that want to go into science.

Summary

Alana and Beatrix shared similar perspectives on the role of the science teacher in today's society. They view the role as a classroom teacher reaching students, whereas Candice introduced the perspective of a teacher of teachers and the need to prepare high school students to take on the role of science teacher in the future. Candice has had many years in a leadership role as a teacher of teachers through her experience with PTRA, and that is reflected in her perception of the role of the science teacher in today's society.

Motivation of the Participants for Joining the ITS Program

I asked what motivated the participants to join the ITS program (RQ1 (5)). I consider motivation of the participants an important factor when examining influences of professional development programs on individuals, because their answer would give me insight to their reasons for becoming part of the ITS program.

In the context of epistemology, knowing the participants' motivations gives me insight to what they knew about their reality of science education before participation. I also wanted to know if they could identify the parts of the ITS experience that were most significant to them, in order that I may identify the experiences that contributed to an ontological change. Dewey's (1997) idea of building on previous knowledge "takes up something from those which have gone before and modifies in some way the quality of those which come after" (p. 35). He wrote, "...every experience affects for better or worse the attitudes which help decide the quality of further experiences" (p. 37).

Alana, in response to RQ1(5) concerning her motivation for participating in the ITS program, stated she was "really interested in what utilization students could make of working with information technology in learning and understanding." Her objective was to get additional training to help her in the classroom when she became a certified teacher.

Alana said that science for her became “very accessible, very understandable when I could almost visualize myself as being a particle.” That experience, she relates, “unlocked a whole bunch of things for me.” As a laboratory assistant at Texas A&M, she used visualizations and analogies to teach her students. She realized how beneficial it was to her learning and to her college students’ learning, and she was excited about participating in the ITS program for that reason.

Beatrix was the only participant who mentioned the stipend as a motivating factor. She also was responding to an individual’s request that she participate, a professor she had worked with on a previous NSF funded programs. Beatrix was intrigued by the thought of getting a certification in information technology, but she did not realize that the program was going to entail more than just 12 hours in a workshop situation.

A teacher for 39 years, Candice said that she had always enjoyed learning and seeing new things. She stated that she will take the initiative to change around a lesson or lab if it is not working or if she has come across a way to make it work better for the students. In her words, “It’s a constant change to make it more relevant for the kids and it’s a difficult thing and there are days when I don’t think I do a good job of it either.” Candice knew her deficiencies were in the content area of chemistry, so she opted for the chemistry team of ITS. Although she was out of her comfort zone, “I had chemistry a long time ago, I’d been to one AP® thing, and I said I just need chemistry and …that’s why every time I found something I could sign up for I did it because I needed to know more chemistry.”

Summary

Johnson, in *Teachers at Work* (1990), noted that her group of teachers was self-sufficient learners, searching out their own professional development (p. 252), which is very similar to the mind-set of my participants. The participants of my study were looking for something more, something to make them a better teacher in the classroom, something that would improve their expertise with technology or with a content area with which they were not that familiar.

The Participants Perception of the ITS Program and What They Hoped to Gain

All three participants were motivated to join the ITS program because they were looking for ways to improve their teaching practice. Their motivation framed their initial perception of the ITS professional development program (RQ1(6)). In addition, their interaction with the project scientists (RQ1(7)) and what they perceived as the most significant parts of the ITS experience (RQ1(8)) also contributed to their perception.

Alana hoped to gain an understanding of what and how information technology could be used to help students learn. She wanted to become more “IT capable.” Alana had taken computer classes for her Master’s course work. However, the ITS program was an “opportunity to learn about the studies that have already been done about” using technology in the classroom, and that is exactly what she remembers doing the first year of the program. She shared that there was a lot of reading to be done, but she mentioned not getting any critique back on the work that she had completed, and wondered at the time if she was on target with her learning and meeting the goals of the program.

During the second year Alana was paired with a teacher in another community for an action research project. She said it was very difficult for her to work with the teacher because of the teacher's responsibilities during the school year. She shared that she became perturbed with the teacher, not realizing at the time, during her pre-service training, the time constraints that the teacher was under while working during the school year. Alana's position was that she was a Masters' student who was working on her own research and the requirements of the ITS action research project and she had time, so why did the in-service teacher not have the time? After Alana became a teacher, she appreciated what her partner had gone through.

Alana hoped to "go through the process myself on how to set up a learning experience for the students." She realized that part of the process would entail visualization projects, because one of her graduate professors was also the lead professor for the Chemistry Cohort, Dr. Vicki Williamson. Dr. Williamson's area of interest is using visualization, or models, to help students understand chemical concepts. Alana said the most significant part of the ITS experience was "using interactive websites...learning about support materials…available on the Internet...utilizing an action research in the classroom."

Beatrix's first summer was tough. She, "hated it, it was not what I expected. It was much more intense than what I expected it to be." She was expecting it to be more like the workshops she had attended in the past, not actual "graduate level course work." She wasn't sure if the program had been accurately described to potential participants. The amount of reading was tremendous and to get the reading done she would get "an hours sleep at night running in place to stay awake so I could get the reading done." She didn't feel she was smart enough to participate until she talked with some of the other participants and concluded that everyone was as lost as she was. At that point, she resolved to ask questions and risk being thought of as "the stupidest person on earth because I asked question after question after question." She realized that this program was "a jumping off point to further course work and further study and my PhD."

Beatrix shared that there was a "great deal of reading, a great deal of work on computers," which contributed to her stress level. She had to contend with group work that she said she didn't like, and she "found out after that first working bit I evidently was not as much of a team player as I though I was." She did not have much faith in the capabilities of others, "I never feel like anybody else is going to do as good a job as I would do if you would just let me do it by myself." Additional participant responsibilities, according to Beatrix, involved "a lot of introspection over material, learning to discuss, learning to participate in a classroom discussion, and learning to ask questions in that kind of venue."

She does remember that she received 500 dollars in support for an action-research project. Her project was about "how auditory, visual, and kinesthetic learners performed after being exposed to a computer-simulated gas law lab." She presented at a research conference.

Initially, Candice "was a little disappointed in the way some of it [the ITS program] was done" that first year. She wanted to learn about technology, but her idea of what she was going to learn and what was actually being taught at the first summer session were different. She did do “a lot of other things that were really, really worthwhile, you know, especially with the chemistry classes.” There were several things that she had to do that she didn’t think were relevant to what she wanted to learn about, for example “turtles and rabbits…stuff about population density” and statistics. She concedes that while she wondered about the relevancy of some, she did find “parts that I’ve been able to come back and use.” However, at the time she said, “...there were a few instances where I wasn’t sure why I was doing it, but for the most part it worked out really well in particular because of Vicki Williamson and Thom Jose.”

The second year for Candice was much better. She questions whether “…[it] was a perception change or if there was an overall change in what was going on because it seemed to be more of a user friendly situation the second summer.” She decided that everyone must have experienced a learning curve. She thought that maybe the program organizers reevaluated the situation and determined that there were some things that were “important, but this is not so important, so let’s level these things out.” She was excited about the chemistry for the second session because she had been taking classes during the year at A&M with Dr. Williamson and on-line. She knew the people who she was going to work with better. She said that there were professors who came to the dorms in the evenings to work with them on problem solving. “I just really think it was a great experience in terms of what I gained and how much I was able to learn,” she enthused.

Candice related that the most significant part of the ITS experience for her was the collaboration with the other chemistry Cohort I members. She was able to work with people who had a variety of experiences and different cultural and educational backgrounds. She appreciated the opportunity to “be around other people and have different perspectives on teaching.” Other professional development opportunities she participated in were more homogenous, but she felt this experience contributed more to her professional growth as a teacher, “…they were coming from a different place and a different time with different ideas about how things should be done. I think that was a really good learning experience for me.”

Summary

All the participants shared an initial disappointment in the first year of the ITS program. They shared that the rigors and expectations of the program were challenging. They were determined to continue with the program and returned for the second year. Beatrix and Candice felt the second year was much more enjoyable and beneficial. Candice even questioned whether there had been a change in the focus of the program or in the participants’ “learning curve.” Interestingly, none of the participants remember any significant interaction with the project scientist assigned to the Chemistry Cohort. They did remember the technology they learned and the theories behind learning with technology. Alana had less patience with the act of collaborating with a classroom teacher, Beatrix learned to enjoy and learn from others with more technology experience, and Candice, due to previous workshop experiences, relished the opportunity to collaborate with a Master’s student.

The No Child Left Behind Act and the Highly Qualified Teacher

The strategies specified in the NCLB Act (2001) include the following: training teachers to integrate technology into the classroom via curriculum and instruction (p. 202), the encouragement of collaborative efforts among education professionals (p. 207) with an added benefit of creating teacher leaders (p. 203), and the improvement of teacher content knowledge (p. 201). The NCLB requires that all teachers be highly qualified. I asked the teachers what they thought of that statement (RQ1(13)). I asked to ascertain the extent of their epistemology concerning their profession. The NCLB is a very pervasive topic in education, and I wanted to determine the level of awareness for an act that is so influential in the teaching profession.

Initially Alana commented that she thought the "highly qualified" statement was ambiguous. Alana asked if highly qualified meant that the teacher had an advanced degree, or was experienced, or had successful students. She said that no one has defined what highly qualified actually meant. Her own definition of a highly qualified teacher would encompass an evaluation of the product, the student. "Is that student more of an independent learner, has that student achieved basic understanding of the content presented and can utilize that content?"

Beatrix also thought the statement was ambiguous and wondered what a teacher has to do to be considered highly qualified. She shared that her district wanted her to participate in an information technology workshop although she has twelve graduate level hours of course work involved in information technology from the ITS program. She was frustrated with her district because they were so focused on her training being in a specific program, and they were not flexible enough to accept what certification she already had. She supports that there should be highly qualified teachers but she said that "people are in charge of it that have absolutely no idea of what's going on in education right now or what needs to be going on in education." To her ,the educational components that would qualify some one as highly qualified would be someone who had education courses and experience working in a classroom with students, a degree in their subject matter, and information technology experience.

Candice said, "I think it's [the NCLB statement] fine. I think all teachers should be highly qualified, but I want to see what the definition of highly qualified really is." Candice thought the NCLB needs some "retooling, just like a lot of teachers in this state need some retooling." She thinks a highly qualified teacher needs to have their degree in the area that they will be teaching or "at least enough hours in that area to be competent." She also wants them to have enough education classes so that they know how to work with students. She said that, "you can have the most brilliant person in the world and if they can't communicate and they can't get those ideas across, nobody is learning anything." She adds that the teacher needs to be well rounded in other subject areas. They should also have a successful teaching model, and they should "find a model that works for you, change it every now and then, and use this to help those kids learn."

Summary

All three participants agreed that a highly qualified teacher should have the content knowledge and the pedagogical skills to teach teachers. Beatrix felt that her certification from the ITS program should qualify her as highly qualified, however, it was not enough in the eyes of her district. They also agreed that the success of the student was the ultimate indication of a highly qualified teacher.

Institutional and Social Pressures

In regards to institutional and social pressures, I asked the teachers for their perception of a science teacher after the ITS program (RQ2(2)) and after they had left the ITS environment and were back in the classroom. I wondered if they would be able to maintain the ideals of a science teacher or if their epistemology would aid them in dealing with the various aspects of a teacher's life. Additionally, since the ITS program was a professional development program, I wondered if they were continuing with other professional development activities (RQ2(9)).

Changed Perception of a Science Teacher

Alana admits that her perception of teachers was naïve before she actually got into the classroom. Alana feels stymied and frustrated in her attempts to help students be successful. She cites a lack of material that would help them to grasp the abstract concepts. She feels the "[school] system is bogged down. It moves very slowly, …it takes [a]tremendous effort to be able to …get to the point where the students have the tools that they can utilize often enough to get comfortable [with learning]." She knows she wants her students to become independent thinkers and she wants them to be able to use technology to accomplish that, but she has encountered some roadblocks. "There is not enough computer access."

She knows that the first year of any profession is difficult, but she thought that the second year she could do more. Since Alana has worked for two years at two different schools each, she calls herself a "newbie." She feels relegated to observe and see what the older teachers do and then do the same thing in her classroom, "...the first year when you come in you're the newbie on the block. You're going to observe, you know, do what they're doing maybe in your own classroom." She was hoping that she would be able to provide more input, particularly in the area of technology, "I was hoping to try and do a bit more inquiry things, for instance. Bring in more of the IT into the classroom." What she found was that she had to "get through these curriculum pieces and if you can fit it [technology] in, fine, on your own, but you're going to [have] to work it out on your own."

Beatrix still considers herself a subject matter specialist, but "I do see myself much more now as a facilitator." She does not do as much inquiry teaching as she would like to do and blames that on "the TAKS environment that we're in." She used the term "impart" in the sense that she has to impart "too many pieces of…surface information" to the students in order to prepare them for the TAKS. She also wants to "impart more exploratory opportunities" for the students. Her definition of exploratory opportunities is internet searches.

Candice, who told me she has been doing inquiry for years, says her perceptions of a science teacher had not changed after participating in the ITS program because of all of her pervious professional development experience. However, her understanding of the reasoning behind inquiry-based learning changed because of reading researched-based articles. She said that education goes in eighteen-year cycles. “education is like…you find something and use it a while and then you try something else and then you go back and say well this was ok and then you modify it a little bit and you try it again.” She has not seen anything new, just restructured and recycled strategies.

She did share that inquiry in the classroom is not always feasible. There are times when “I just have to stand there at my overhead or …I just have to be at the [chalk] board working equations.” There are some concepts that she feels cannot be taught by inquiry methods.

Summary

All the participants realized that the inquiry method of teaching was an important skill for a science teacher to have, and they acknowledge the training they got in inquiry from the ITS program. That was an epistemological change. Unfortunately however, the school districts resources, TAKS testing, or a specific scientific objective, deemed unsuitable by the teacher for inquiry method, interfered with the successful implementation of inquiry methods in the classroom.

Professional Development Since the Completion of the ITS Program

Alana travels ten hours a week to and from school and has children of her own. She finds it very difficult to pursue professional development during the school year. She finds it more convenient to go to summer conferences. The conferences give her access to current research in the sciences and in science teaching. She stated that working with the

Science Olympiad and going to national conferences, while they do not count for professional development credit, are beneficial to her as a teacher. She says that “they are more inspiring. Attending conferences in the summer helps to keep me aware of what some of the research is doing for teachers.” She can attend “various symposiums” and discover what other instructors are doing.

Alana conducted a workshop at her first school assignment. She showed the other teachers “what could be available to them [technology] and try to encourage them to get behind the ideas we can get more computer access for the science department.” Initially they seemed very receptive, but eventually it was “going back to what’s old and comfortable and doing things the way we’ve always don’t it.”

Beatrix still attends workshops and has become involved in another summer professional development program. The current program in which she is involved is dedicated to inquiry based learning just as the ITS program was. She is a participant and is learning to take familiar laboratory activities and make “it more inquiry based by just changing little things with the lab and making it even more inquiry based.” She is also working for a local science museum that presented a weeklong inquiry institute the preceding summer of our interview. Her additional experiences have enhanced the workshops she presents to other teachers within her school district.

Beatrix is quick to point out that not all hands-on activities can be considered inquiry activities. She said that before she started working on her PhD, her workshops provided “...activities, activities, activities” with no clear direction on how to use the activities. Now she focuses on the inquiry aspect of teaching. Her ITS experience influenced a change in her methodology, “my emphasis on that [inquiry] now is a direct result of the instruction we were given in that program [ITS].” She shows her participants how they can take the standard cookbook labs and change them “into more inquiry-based type of labs where students are exploring things, are discovering things on their own.” She also acknowledges that not all of the TEKS are suited to be taught with the inquiry method.

Currently Beatrix is one of three participants from her school district in a Texas Regional Science collaborative which she says supports inquiry-based learning. This program, working in conjunction with her school district, required the participants to attend a weeklong inquiry institute at an area science museum last summer - “forty hours worth of inquiry-based education.” In the follow-up for that program [during the school year] they met a total of ten days and explored different science related topics. They were required to go back to their school district and give workshops to at least five other teachers during the school year. Beatrix and another participant did their workshop in May for two days for twelve teachers. They were provided with financial support, “fifteen-hundred dollars is supposed to go towards the workshop and fifteen-hundred dollars for our own classroom.” She shares that she has a decent science budget for her classroom, so she opted to spend the money on her workshops in order to provide materials for the teachers of grades five through eight “with kits and things in their hands.”

Candice presents workshops all over the nation. She works, as a presenter, with other students or teachers, but says that she does get to attend some professional development as a participant. She is still involved with Fermi lab and as a Physic Teachers Resource Agent and presents at the Conference for the Advancement of Science Teaching and the American Association of Physics Teachers. She attended the American Chemical Society meeting in Galveston and was making plans to attend the Chemistry Education conference at Denton at the time of the interview. She also worked on material modules through an on-line course offered by the University of Nebraska. She found out about this program through the ITS program.

Summary

Alana contends with the time constraints and challenges associated with raising a family as a single-mother, in addition to the struggles experienced by new teachers, have affected her motivation to pursue professional development. The drive and curiosity that initially led Beatrix and Candice to find the ITS program still induces them to participate in multiple professional development experiences. Alana's professional development focus is technology, whereas inquiry is the focus for Beatrix and Candice. Alana was more successful and familiar with the technology than Beatrix and Candice. Beatrix and Candice had more teaching experience and more resources to use in making the switch from direct instruction to inquiry than Alana.

TAKS as an Institutional and Social Pressure

The TAKS test was mentioned by the participants as a reason why they could not implement as much inquiry in the classroom as they would like. The pressure from school administration concerning the TEKS and TAKS is a powerful influence on the epistemology of the ITS participants.

Alana volunteered that her students have not done well on the TAKS test in the past. There was a push by her district for Saturday tutorials and after school tutorials, in order to get the students ready for the 2007 test. She teaches TAK review classes, and she said "the amount of time spent on TAKS preparation is tremendous." A couple of her colleagues created a CD for the teachers to use during the fifteen days of TAKS review for science. To her, it "was just a tremendous amount of material, tremendous amount of time taken out of my instructional time to focus on this." According to Alana, "better than half of the material was instruction on a topic that I didn't even teach, which was very frustrating because then a student had questions about it I was not at a level at which I could necessarily always answer the question. Often, but not always, because the content was specific enough to biology that I [had] never encountered [it]."

Her high school's science curriculum was designed based on the standards that were to be tested. They looked at what could possibly be asked on the tenth grade TAKS test and then "decided to eliminate some content." The department told the teachers that they had to cover everything that would be tested on or, "at least introduce it by the time the TAKS test came even though it was not going to be instructed on till the weeks after."

Again, the time constraints come to the forefront for Alana, "trying to fit that in really hard, really, really tough to get around, to give up that time." She regrets that the time she could spend helping her students understand the content she is supposed to teach is taken up by preparing her students for the TAKS test.

Beatrix was emphatic in her assertion that a "professional in the State of Texas… [is] honor bound to teach what they're asking us to teach" in regards to the TEKS. Her dissertation findings showed her that most elementary school teachers are not using TEKS-based science activities. She found that many of the teachers have their favorite activity that they try to "bend" to accommodate specific TAKS, and that is not always successful,

> you know, we're suppose to be teaching them about, you know, physical properties or, you know, chemical changes or something like that. How is building roller coasters going to, you know, how is that going to help me with the TEKS? They don't know enough to take activities and adapt them to the TEKS.

Beatrix said that after being at the same school district for seventeen years and having the success that she has had with her students passing the TAKS, she feels no pressure personally from her school district. This is the first year there has been "sincere pressure" and she said "that was because of me." She was the one that instituted the two-week blitz of TAKS review. She said that prior to this year she thinks there was not enough accountability for the teachers in her district to adhere to the TEKS and TAKS. Part of the accountability lies in lesson plans, according to Beatrix, and she said that as far as she knows, "there's not a soul that really looks at lesson plans."

Candice said that her principal has said that "if we just taught the TAKS, that's all we needed to do….they [the district] have to have good test scores." This is the first year that her school district has had a principal actually voice to the teachers that they had to teach the TAKS. Her school district has had several principals over the last few years, but this is the first one who specifically addressed teaching the TAKS. The district's motivation is to receive the exemplary ratings and have more students with commended performance on the test. The plan of action that the teachers are to follow is to start earlier in the year in preparation for the TAKS and set aside times specifically to review for the test. Candice shares that it has been a very stressful time at her school.

Candice taught a Geology, Meteorology, and Oceanography (GMO) class for a few years until it became a TAKS preparation class last year. According to Candice, the course is still listed in the curriculum as a GMO course, so the students would receive a science credit, but it is primarily a TAKS preparation class for the students who failed the TAKS and still need a science credit and additional review.

Summary

The pressures of TAKS testing challenged the participants' epistemology of science teaching. Time that would be spent on science content is spent on reviews for the TAKS. Beatrix points out that if all the teachers have taught their TEKS effectively, then the rush to prepare students for the test would not occur. Candice lost a course she enjoyed teaching to TAKS review. Resources that would have been used to further students' science knowledge are used to review the students for the TAKS test. The participants expressed disgust over the push to prepare for the TAKS, which is instigated by their respective school districts. Not one of the participants suggested that the IT and inquiry strategies that they learned during ITS would be beneficial in preparing students for the

TAKS.

Utilizing What They Learned During the ITS Experience

The participants epistemology, or their knowledge and perceptions of science education and science teachers, was changed by their ITS experience. I wanted to know what they thought would be the best-case scenario for the utilization of what they learned during their ITS experience (RQ2(12)).

Alana wished for time to utilize what she learned during her ITS experience. She wanted time to conduct additional action research projects. She wanted time to search for and create IT resources for her students. She also wanted to have more interaction with other teachers. She wanted to “come together with people who are interested in doing [IT] and learning from them [and] sharing.” She actually does have a co-worker that she collaborates with for the creation of PowerPoint presentations. She feels the partnership is slightly skewed in favor of the partner since Alana does not have the luxury of time to search the internet for sources.

Beatrix and Candice each wished for money to use to purchase computers for their respective classroom so that they could use IT in the classroom with students. Beatrix felt that the ITS program fell short when it gave the participants the knowledge of what could be done with IT and inquiry, but didn’t provide support when they got back to their classrooms. Candice wanted all the hardware and software conveniently available to the teacher.

Beatrix added that having the original participants accountable for sharing what they learned at ITS would emulate what she understood as part of the goals of the ITS program, sharing with other teachers what was learned.

Summary

Alana's description of the best-case scenario sounded similar to the ITS program, except for the time factor. As discussed earlier by all participants, the lack of time during the program was a point of consternation. Availability of adequate resources, in the form of hardware and software, was another important factor lacking in comparison with the best-case scenario.

My Epistemology

Before the ITS program, I think I was probably more like how Beatrix describes herself before her ITS experience. I also felt I had to impart a certain amount of knowledge to my students in a short amount of time. As I questioned Alana about her idea of a science educator, I cringed inside as I wondered if any of my former students would consider my teaching not so helpful.

After the ITS program, I perceived a science educator as an integral part of a student's success and as a contributor to the body of knowledge for science and science education. My epistemology did change and it was a result of becoming aware of research in science education. I specifically remember reading about the nature of science in an article by Norman G. Lederman (Lederman & Zeidler, 1987) where the purpose of the research was to verify whether there was a connection between a teacher's conception of the nature of science and their methodology. I highlighted this sentence, "But it must also *be emphasized that science educators' concerns must extend well beyond teachers' subject-matter competence" (p. 731) because to me it meant that my role as a science educator was to stay abreast of current and relevant science topics and successful teaching methodologies.*

The Participants' Ontology

The second goal of the ITS professional development program was "to create new knowledge through research involving the impact of information technology on learning and teaching science and mathematics" (ITS, 2004a). The creation of new knowledge creates a new image, or a new reality, of what is known, which ultimately is a change of the teachers' ontology (Whitworth, 2006). The ITS experience was designed to change teachers, teaching methods, and student learning (ITS, 2004a).

I listened as the participants talked; to either see if they stated that their outlook on the nature of science had changed or that I could draw that conclusion from their statements. I listened for them to acknowledge a benefit they thought participating in the ITS program could give when compared to their initial perception, with regard to change over the course of the program (RQ2(18)). This criterion was what I used to identify a change in their ontology, or to determine an effect on their ontology, which is their perception of their reality as a science teacher.

To determine whether the teachers' background and experience of participating in ITS effected their ontology, I asked about the impact the ITS experience had on their teaching (RQ1(24)); if they considered themselves a change agent for their schools or their profession and did they identify anything from the ITS experience as an influence (RQ1(25) and RQ1(26)); did they perceive a change in their ontology and did they value the experience (RQ1(17) and (18)); and what they determined to be an ideal professional development program (RQ1(19)) .

Background and Experience

The Impact of the ITS Experience on Their Teaching

Alana had not taught in the classroom, therefore, this question was hard for her to answer. She did say that she took what she learned about how people learn with her into the classroom.

Beatrix, after the ITS experience, views herself as a facilitator, although she acknowledged she still has “that structure of a direct teaching.” She used the ostrich in the sand analogy to explain her attitude about education until she got involved in the ITS program. Her idea of what science teaching is all about has become more “globally-centered, much more critical-theorist centered.” She said that we have to “challenge the status quo, we have to challenge the way things are,” because she thinks that things in education can always be better.

Candice’s experiences with a diverse group of people opened her eyes to education in different parts of the world, and to different levels of expertise and experience. She said it gave her tools to evaluate the dynamics of her classroom.

Summary

Ontologically, the participants changed their reality from simply being aware that people learn differently to a more global perspective of learners and teachers.

Change Agents and the ITS Experience as an Influence

Producing educational specialists was a goal of the ITS program. I wanted to know if the participants had become change agents in their schools with regards to the use of educational technology and whether or not they would attribute the transformation to the ITS program.

Two ways to demonstrate that the participants had become change agents were if they conducted professional development opportunities for fellow teachers or completed an action research project in their classroom. Conducting professional development experiences after ITS proved to be easier for the three participants than conducting action research in the classroom. This was true even though all three had conducted action research projects in their classroom as a requirement of participating in the ITS program between summers I and II.

Alana has put on a small workshop for her fellow teachers, showing them what information technology has to offer. Her goal was to increase the teachers' awareness in hopes of getting "more computer access for the science department." She reported that the momentum was lost and most of the teachers fell back on the familiar and elected to stay in their comfort zone as far as technology was concerned. However, because of this professional experience, she felt she could accept a position on the technology committee, which was offered her at her current school district. She saw this as an opportunity to provide one more voice in asking for changes in technology for her school.

Beatrix's leadership role now is a departure from her role at her school before ITS. The ITS program gave her the opportunity to obtain her PhD in Curriculum and Instruction,

> Without their [ITS] financial support there would've been no way [a] single mom, [a] fulltime teacher, ….could quit teaching to get some kind of graduate assistantship. There was no way, not to mention there would have been no way to afford the classes in the first place. So that program is why I have my PhD, the only reason I have my PhD.

She says that she has not changed anything about herself, "but that title has made a difference to the powers that be and to the new teachers coming in." Her school district began to take her seriously once she had her PhD. Prior to receiving her doctorate, despite the fact that she had, "given workshops out of state, given workshops all over the state", she had a difficult time convincing her district to let her conduct workshops for her fellow teachers. In her words, "[I] have offered to give workshops for my district free and [they] just never would [take me up on it]; I guess because I teach here. You know in your own hometown, you can't do anything." She relates that she had to fight for the opportunity to give her first workshop, a two-day workshop for the teachers in her high school.

Beatrix exercised her leadership role for the 2006-2007 TAKS tests. She campaigned for what she called "a two week blitz" of TAKS review. The blitz approach was in response to students' requests for reviews. Beatrix presented her case for the blitz by also including an analysis of the test results of those students whose teachers provided a

TAKS review previous to the TAKS test and those who teachers didn't. She said that she did not think she would have had the confidence to pursue the blitz idea with the research because she had,

> always been a very non-confrontational person; but I think the fact that being in the ITS program in the first place and then going ahead and getting my PhD has really, really, really given me some credibility in the school district.

The teachers at her school district "realized that I just wasn't coming out of left field" with her idea. She had done the research, and she says, to their credit, they acknowledged the benefit to the students of the blitz. "That bubble of credibility has changed and so I think that has made it possible for me, to be an agent of change."

One of the drawbacks to a TAKS blitz was that some teachers were not comfortable teaching outside of their content area. For example, the physics teacher had not taught biology. For Beatrix, this event provided another opportunity for her to take on a leadership role by developing curriculum for a new teacher to use to prepare students for the TAKS test. She generated and provided the material the teachers needed for the IPC part of the TAKS test. There were also new teachers to the high school last year and she provided,

> all my materials from when I taught IPC - all of my labs, all my materials, all my notes, worksheets, everything that I ever created - I gave to them. And they've been using all of those materials and really trying and doing a much, much, much better job this year than for a long time in the past with putting more and more hands-on

activities in the classroom. So I'm really happy about that.

Candice's credentials as a leader have been discussed in previous sections. She also shared that, after ITS, she worked with "Material World Modules" and Processed Oriented Guided Inquiry Learning (POGIL) after taking on-line classes from the University of Nebraska. Those classes were an extension of the ITS Chemistry Cohort program. As a leader, she has tried many new things in her quest to engage her students, "…if there's something I see that I think is different or if I hear something that is unusual, I'll go check it out and see if I can find a way to incorporate that into my classroom."

Summary

Beatrix and Candice were more active than Alana was in giving and participating in professional development opportunities. Beatrix and Candice preferred to design their professional development with the inquiry method in mind when conducting professional development. Both Beatrix and Candice took on the leadership mantel long before the ITS program, but since the program they have more confidence. Alana does not have the confidence to speak freely about the needs of technology in the classroom because she had only taught for two years at her present school. She currently practices what she learned in ITS by infusing educational technology into her classroom and working collaboratively with her colleagues on educational technology products for the classroom.

A Change in Their Ontology and Did They Value the Experience

I asked questions RQ1(17) and (18) because I want to know if they perceived a change in their ontology and did they value the experience.

Alana saw the ITS program from the perspective of a graduate student. She said that she during the ITS program she was exposed to theories of learning that she had not been exposed to before, she had a tremendous amount of related reading for the morning and afternoon sessions, and she had to comprehend all the material she was reading and hearing about. Alana pointed out that one of the biggest influences on her perception of herself as a science teacher started at the beginning of ITS. She said the research about how people learned "was a big eye-opener to me." She had not gone through her education classes yet and so her knowledge of how people learned was limited. "Learning about a lot of the research, educational research, reading through a bunch of those education research papers, it was very difficult that first summer." Introspection is a key characteristic of a good teacher, according to Alana, a characteristic that she felt she did not possess while in the ITS program. The ITS program pushed participants to be introspective and reflective. Alana said that she was too busy to engage in the process of introspection,

> I almost felt like there would be some time in there to try and go back and chew over the stuff, yeah, chew over, the stuff we'd just been through and what does this all mean, mean in my relationship with education, in my relationship with students, in my relationship with, you know, what I've learned, and I just, it just seemed to be just really overwhelming and not able to do that.

Alana felt she needed feedback for the homework and projects that were required of the participants, saying that she

> …did not get the critique back. That was the one thing I felt I was lacking. I had no

> idea of what I did. If I was on target or not, did I accomplish the goals? Or was I, you know, off target. That was my first impression.

She said that the organizers were encouraging of anything that the participants presented, and there were some suggestions on how to make improvements. She wondered if perhaps the organizers were trying to get the teachers to participate and not discourage them by critiquing too much. Alana thought the objective of the ITS program was to get the teachers to "take this into the classroom…and if you critique it too much, I think before they even get started, then they're not going to do it." But she was in graduate school, so she was used to, and missed, receiving feedback for her efforts.

The ITS experience altered Alana's perception of a science teacher. Her original perception was of a science teacher that "would just take their content and try and convey it to the students." In response to the follow-up question "What activities with ITS contributed to a change in your perception of yourself as a science educator?" She said she had never really thought about teachers continuing on with their education as they did with the ITS program in the form of professional development. In her resolve to be a "good teacher," she said she would need to "continue with my own education, with my own, you can call it professional development, I suppose. But, just being aware of new information that is, that's coming forth, both in the content area and ways of teaching students." Despite the feeling of being overwhelmed, Alana thought the program was worth her time and effort.

Beatrix realized that the ITS program was a "jumping off point to further course work and further study and my PhD." She said she didn't know if it was her fault for not knowing what was going on or if the program wasn't presented to her for what it really was. She acknowledges that when she realized what the program was and the intentions, or goals, of the program, she conceded that the rigor and course of study were very appropriate. She emphatically stated that it was worth her time and effort to participate.

Candice came for the chemistry and technology and got more than she bargained for in the amount of work expected of her. She liked the second year of the program better than the first, "I don't know if it was a perception change or it there was an overall change in what was going on, because it seemed to be a user friendly situation the second summer." She said that "some of it just hit me where I thought I needed it" and there were parts that she has been able to use or change to her liking and some parts she did not feel the need to keep in her repertoire. The additional courses she took between the two summers helped her find the relevancy of what she had learned the first summer. She was excited about the second summer because her instructor had shared with her what she could expect. Candice thought her time was well spent in the ITS program.

Summary

Each participant had different expectations of the program. All three were unpleasantly surprised at the rigor, but ultimately pleased with the outcome.

An Ideal Professional Development Program

I asked the question pertaining to an ideal professional development program because I wanted to know whether their ontology concerning professional development reflected the goals of the ITS program and whether participants' descriptions of an ideal professional development program would include any acknowledged similarities to the ITS program.

Alana stated an ideal professional development was one where the presenters give her the background information and the focus of the program and they help her to work through how their program can benefit her in the classroom. Ideally, for Alana, that means she has an opportunity to have a hands-on experience herself and she has time to develop a product that she can take back to the classroom, followed by a critique of her product and time to compare what others have done. As she said, "time to learn about what it is they want me to learn…time to experience a program, an example of what they are doing, actually go through it as a student, time to develop one of my own and have it critiqued, this sounds really familiar (she smiled and indicated she was referring to the ITS program), and see how others have done it." She would like to work collaboratively with others in her ideal professional development experience, "being able to come together with people who are doing it, are interested in doing it, and learning from them, being able to share."

Beatrix thinks an ideal professional development needs to be TEKS-based. She wants to know how it is going to help with the TEKS. She wants, in her ideal professional development, inquiry-based hands-on activities because, as she said, "concept formation and retention is enhanced tremendously by a hands-on inquiry-based type program." During the course of the conversation, she started to describe how she conducts her professional development as her ideal professional development. She would provide conceptual learning behind the TEKS in her professional development. Her motivation came from her dissertation research with elementary school teachers. She found that they were lacking the ability to “take activities and adapt them to the TEKS.” She realized that the teachers did not necessarily have the background information in science to make sound choices in activities to teach the students what they needed to know from the TEKS. She proposed that the teachers learn what the TEKS mean then they can “expand it…you can turn it into inquiry.”

Additionally, Beatrix thinks that a professional development experience should make the participants accountable for their learning, so she thinks the participants should be required to present workshops, “but if you want a program to be effective, it’s got to be a situation where it’s spreading.” In response to the follow-up questions, “You think ITS spread enough?” Beatrix replied, “No, I think it could have spread more.” She went on to clarify her statement by questioning the purpose of the ITS program in regards to continuing the influence of ITS- was it to locate “groups of teachers that would go on with their education,” or was it to indirectly influence teachers who had not attended the program by providing workshop experiences for them. The ITS two-year review specified that one of the areas of impact within the goal of professional development was professional development experiences for “Colleagues of the ITS participants” (ITS, 2004f).

Both Beatrix and Candice said that an ideal professional development should provide computer stations for participants’ respective classrooms. They realize it probably is not feasible, but they think it would only make sense if you want the participants to take back to the classroom what they learned at a professional development experience. Candice said she would like a lab set up similar to Lee College (Baytown, Texas) or Southern Methodist University (Dallas, Texas) where she could keep everything set up and ready for each class.

Candice's idea of an ideal professional development is a self-proclaimed description of how she presents her own professional development offerings. She said an ideal professional development should be three to five days in length during the summer and run for eight hours a day with a working lunch and a working dinner. The professional development opportunity should give teachers several examples as to how a particular TEKS-based concept should be taught. The teachers should be able to build or receive the materials they need to teach the lesson or lab when they go back to their classroom. She said that there should be a two-day follow-up in the fall and spring where they receive even more information and equipment. She also mentioned the need for networking between the participants and the presenters of the professional development. What she described was the model of professional development that she uses for the PTRA workshops that she presents and the format she has used since "back in the late '80s at Texas A&M with a physics professor. We developed the model sequence of what we thought was the best way to do it." She personally likes "the instruction on top. I like to know what I'm doing, why I'm doing it, and then I want to be able to do it." She wants to leave the professional development with a product and she wants to know for sure that she can implement it in her classroom.

Summary

All three participants described their ideal professional development as similar to the organization of the ITS program. However, Alana was the only one who acknowledges the similarity to the ITS program.

Institutional and Social Pressures

Part of my second research question concerned the sustainability of the changes in the participants' ontology, in response to the ITS program, in the face of institutional and social pressures. However, since ontology is malleable, institutional and social pressures experienced in their day-to-day teaching experience could continue to alter their ontology (Duncan et al, 2007). The acknowledgment of additional changes as a result of experiences after ITS was the focus of my second research question. The interview questions I asked the teachers to answer to the second research question concerned: the participants' acknowledgement of changes in their reality (RQ2(14), (15), and (16)); and the participants' professional opinion of the activities that have changed their perception of themselves as science teachers (RQ2 (20), (21), (22), and (23)).

The Participants' Acknowledgement of Changes in Their Reality After ITS

Alana's perception of the role of a science teacher evolved as she encountered "young people that were so unaware of anything beyond their immediate environment …they just have no idea…don't seem to have some of the basic interactions that I had growing up." She shared the following example, "I remember doing an analogy in my class." She said that she asked her students to remember when they helped their mother cook. She continued, "Half of my class looked at me and went 'cooked? Who cooks?'" The deficiencies in their experiences have "shown me what can be done in a classroom."

Alana identified environmental issues as a major concern. She wants to heighten students' awareness of the "environment that they live in, how they're going to be integrating with that environment, how mans' impact is going to effect that environment, what kinds of issues they're going to have to deal with in their adult life." She wants to "get our students in front of computers on a much more regular basis" so that they could strengthen or augment their knowledge and skills, and to conduct research to share with others.

For Dr. Williamson's course, one of the activities Beatrix did was to "revamp [labs] into inquiry style with….some exploration and some engagement using computer simulations." She said that the process of rewriting the labs into the inquiry style was an activity that influenced her perception of inquiry science and her capabilities as a science teacher. That experience inspired her to pursue her PhD. The ITS program is what allowed Beatrix to pursue her dream of earning her PhD. She said the ITS program is the only reason that she has her PhD. She cites her dissertation work with the influence of the TAKS testing on teachers and students at the elementary level as a major defining moment and giving her credibility with her school district.

Candice, during her presentations of professional development, talks "with other teachers about what's happening in their districts." Her interactions with others, "to be around other people and have different perspectives on teaching," seem to have the most influence on her.

Summary

Changes in reality occurred for Alana and Candice when they interacted with others. The interactions allowed them to see the world through different eyes. For Beatrix, it was the more formal interaction of researching and writing her dissertation that opened her eyes and changed her reality.

Activities That Changed Their Perception of Themselves as Science Teachers

Alana was unique in that she was not a classroom teacher at the time of the ITS program. She credits the ITS program with giving her a perspective that she doesn't think she would have known existed had it not been for ITS. "I don't think I would have looked at my students or a classroom environment in quite that way as being able to try new things with my students." ITS provided a means for her to find tools that would help her "encourage students to be, to take more active part in their learning rather than just being receptors." What she is "really trying to do is help the students to build their own knowledge, with the students I got, they are in empty bucket mode." She stated that she is "a bit more reflective about what kinds of instruments I'm using with the students to help support their learning." The ITS program helped her to realize there are tools that she can use to "encourage them [students] to participate in their learning." She concedes that she is not where she wants to be, but the program has "given me a goal to aspire to that I wouldn't have known was there."

Alana related that her first summer activities were "focused on learning about various IT [information technology] instruments, [either] software or hardware." As a participant, she acknowledged that she was responsible for learning about the research which focused on how people learned by "reading though a bunch of those education research papers." As someone who was not familiar with the educational jargon, she found that part of the program challenging.

The second summer session shifted some of the responsibility onto the shoulders of the participants with the assignment of an action research project. For Alana, the second summer focused on an action research project, which she said, was difficult because of her ongoing Master's work. She paired with an experienced teacher who was in another community for the project, but as a pair, they were not able to coordinate anything. Ultimately, the action research experience was not satisfying, "...it was really hard to get as much out of that as I would have liked to have gotten out of it." She had her own concerns with her Master's research, so "the focus was definitely split at that time."

She said that "the focus seemed to shift a bit [during the second summer session of ITS], the responsibility at that time seemed to be more of 'we want you to take hold of this and own it and take it to the classroom.'" She said that she has not taken what she learned from the ITS program, the research or the products, into the classroom, "[n]ot anywhere near too the extent that I would like." What she has in the classroom is "so much stuff we have to get through, I mean our list of objectives for the TAKS exam for the tenth graders in science is huge, it's just huge." She continued that she "was hoping to try and do a bit more inquiry things, for instance bring in more of the IT in to the classroom and it just, you just seem to hit more and more road blocks."

She mentioned that if she were to do action research for her classroom now, then it should focus on "checking with a student's understanding and using a particular method of presenting new concepts and then going back and checking how that presentation might have increased their understanding." Alana understood that the ideal scenario for a successful ITS action research involved determining the students previous knowledge, using a specific type of information technology with them, and assessing what they learned as a result of the information technology experience. However, she says the real life classroom does not provide the luxury of engaging in action research. She said, the "department head is really looking at making sure that we have gotten those concepts across. We've done those particular labs, and there doesn't seem to be any time available to do something that may not be strictly focused on what the department would like us to do."

Beatrix admitted that she was "too much of a subject matter specialist." Her teaching consisted of imparting knowledge to her students who "were supposed to regurgitate 'X' amount of data," and then they would move on to the next topic rather than giving them an opportunity to explore additional topics.

As a result of her ITS experience, she began to provide opportunities for students to explore related topics, she gave the example of nanotechnology as one topic she and her students have explored. In order to pique their curiosity, she used a data projector to show them information from the internet. Her opportunity to explore topics on the internet during her ITS, work with computer simulations, and revamp labs into inquiry labs influenced her perception of herself as a science teacher. Her students are able to benefit from her realization of the importance of giving her students the opportunity to have the same experiences.

The ITS program allowed her to "expand my own horizons." She doesn't "think we can be any better [of a] teacher than we are a learner and every time I expand my self and my abilities, [I] indirectly or directly expand my students' as well." She feels she has more tools to use in the classroom and she is "more enthusiastic today than I was when I started teaching."

Candice said that until she worked with the ITS group her approach to teaching with labs was "I did this lab, and this lab, and this lab, and then I just thought at the end they would know." Her own experience with the visualization/simulation/inquiry process was an eye opening experience. As each member of the chemistry team started adding their segment to produce one molecular visualization product demonstrating solubility, she said, "Oh, gosh, you know that's what we did, that whole cycle to show all of those things." She continues to use the final product in her classroom, but she has changed some of the components around to suit her students' needs.

Summary

The visualization and inquiry aspect of the ITS program contributed the most to a change in the ontology, or the participants' reality, of themselves as science teachers.

My Ontology

My participants stated that they started thinking differently about themselves as science teachers and about how people learned. I know that my epistemology changed because of the ITS program, primarily reading the research and creating a visualization product, but my ontology changed when I thought about my profession, as a science teacher, in a different manner. I learned about using technology in the classroom, about inquiry teaching methodologies, and constructivist learning during the ITS program and I felt like I finally had the tools and the knowledge to use in order to be successful in the classroom. But, I also felt like I was more analytical of the teaching and learning process.

I had been through a viable staff development and I was appreciative of what I learned and what I could take into the classroom. I found that when I started the school year that August, I looked at the staff development differently. Instead of sitting back and complaining about the school district staff development we had to attend at the beginning of the school year, I examined the components and the presentation. I tried to identify the goals and objectives of the presentation and I jotted down ways they could have improved it and made it more meaningful for the teachers. It was at that point, where the germ of the idea for my dissertation began.

I felt like I had changed and when I went back to my school, no one else shared my view of science education or my zeal for the new teaching methodologies about which I had learned. I missed the comradery of my Cohort members and the collaborative *opportunities we had shared. So what was it about the ITS experience that changed me so much and had my fellow Cohort members changed in the same way?*

We had changed our ontology. Beatrix and I stated working diligently on our doctorate; our way of dealing with our changed perceptions of ourselves. Alana presented a small workshop for her colleagues, even though she was a first-year teacher. First-year teachers are usually so overwhelmed with the mechanics of teaching they rarely entertain the idea of presenting workshops (This knowledge is from nineteen years of teaching experience and many mentees under my tutelage). Candice discovered a research-based validation for the use of inquiry in the classroom. When I listened to her talk about connecting the pieces of what she learned during the creation of the visualization product and then using the same concept of helping her students find "connections," I realized that she had an ontology change similar to mine. We were applying a methodology used at the ITS program to our own classroom, a new way of thinking about science education.

The Participants' Methodology

The third ITS goal was to aid the teachers' methodology by directing the professional growth experience into a useful product (ITS, 2004a). By having the participants engage in delivering professional development the first summer session and an action research project for the last summer session, ITS hoped to change in the participants methodologies. In addition, the chemistry team participants were exposed to inquiry learning and teaching with inquiry as the focus of the information technology professional development during the afternoon sessions. When the participants acknowledged changes in their methods and those changes related to an epistemological or an ontological change, then I would determine a change in their methodology.

In the state of Texas, there are seven days each district can use for staff development during a school year (Texas Statutes, 1999). The Texas Education Code (TEC) gives Texas school districts latitude in their staff development offerings, only stressing that the school district develops the standards for their district staff development (Texas Statues, 2003a). According to TEC Section 21.451 (Texas Statutes, 2003a), the district's staff development must be related to the campus performance objectives and may include training in technology, conflict resolution, discipline strategies, and training related to special education topics. Science training is addressed in Section 21.456 of the TEC Texas Statues (2003b) where the Code makes the Commissioner responsible for providing the material for school districts to use to train teachers to be experts in the science curriculum and the use of research-based methodology. The training materials can be made available to teachers through "distance learning, mentoring programs, small group inquires, computer-assisted training, and mechanisms based on trainer-of-trainer models" (Texas Statutes, 2003b). Within this framework, Alana, Beatrix, and Candice have formulated their opinions of the staff development offerings from their respective schools.

Using inquiry in the classroom is a preferred method of teaching found explicitly in the National Science Education Teaching Standards A, B, and E. Teaching Standard A states, "Teachers of science plan an inquiry-based science program for their students…" (p.

30). Teaching Standard B states, “Teachers of science guide and facilitate learning. In doing this, teachers focus and support inquiries while interacting with students…” (p. 32). Teaching Standard E states, “Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning...” (p. 45-46) (NRC, 1996).

In addition, the National Science Education Professional Development Standards contains explicit references to inquiry as part of the criteria in evaluating professional development programs as in Professional Development Standards A and B. Professional Development Standard A states,

> Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. Science learning experiences for teachers must ….[i]ncorporate ongoing reflection on the process and outcomes of understanding science through inquiry…(p. 59).

Professional Development Standard B states,

> Professional development for teachers of science requires integrating knowledge of science, learning, pedagogy, and students; it also requires applying that knowledge to science teaching. Learning experiences for teachers of science must….[u]se inquiry, reflection, interpretation of research, modeling, and guided practice to build understanding and skill in science teaching. (p. 62) (NRC, 1996).

The questions I asked in search of an answer as to whether the participants' background and experience of participating in ITS affected their methodology concerned the types and frequency in which the participants engaged in professional development experiences (RQ1(28) and (29)). In addition to, the activities and responsibilities the participants had as ITS Cohort I participants and the effect, if any, on their methodology (RQ1 (30), (31) and (38)). These questions were the basis of my first research question.

Part of my second research question concerned the sustainability of the changes in the participants' methodology made in response to the ITS program in the face of institutional and social pressures. The questions I asked the teachers in search for the answer to the second research question concerned: whether they were able to implement what they learned in the ITS program in their classroom (RQ 2 (32), (33), (34), (35), and (36)).

Background and Experience

Types and Frequency of Professional Development Experiences

Alana attended her school sponsored professional development that was to prepare her to teach AP® courses. She said the professional development experience was thirty hours, which trained teachers to identify younger students who would qualify for the gifted and talented program. Alana said that this program is required by her school district before a teacher can go on with the AP® training specifically for a content area, for chemistry in Alana's case. She said that there are six hours per year of additional training for renewal of certification. Alana shared that her school has had other professional development in the "Fred Jones teaching method." Outside consultants, not the school districts' teachers, conduct the professional development programs. She said that after just four years of teaching “sometimes you get to where you feel like you’re hearing the same thing over again, just slightly different words.”

Previous to the ITS program, Beatrix would inundate her students or her workshop participants with activities. Now with her students she focuses more on the inquiry, and with her workshop participants she helps them create inquiry products to use in their classrooms. She regrets not being able to do as much inquiry teaching as she would like to do because of the TAKS environment because, “it [TAKS testing] doesn’t lead to an inquiry style of teaching as readily as others do. There are too many pieces of information, ... surface information that has to be given, imparted, to the kids.” Her students experience inquiry through her laboratory experiences and internet searches.

Beatrix said that her school district’s professional development offerings were “very sad” and “pathetic for science.” Elementary science professional development for her district was presented by “a consultant group evidently, that came in but they paid them eight thousand dollars or some ungodly amount of money to come here for two days and give them games to help the kids.” She stressed that there was “not one piece of science equipment, not one mention of the nature of science, or any process skills of any kind. It was all, ‘here you can play this little cutsie game to help them remember the colors of the spectrum.’” Another group presented professional development that was TAKS-based. This professional development experience had “some very short, hands-onish activity, but I think there was a graduated cylinder involved in one, I’m not sure.” The high school science professional development involves disaggregating TAKS scores and identifying weak areas. She related that there were no opportunities to learn different methodologies, "there was no information on how to make an inquiry-based type of science course." She said that despite the research-based evidence that "concept formation and retention is enhanced tremendously by a hands-on inquiry-based type program," her district does not provide any type of instruction in that direction.

The only positive professional development experience Beatrix could relate concerning her schools offerings was a professional development experience conducted over a two-year period, and is a joint effort between her school district and a science collaborative. At the time of this writing, the school district was in the second year of the commitment and Beatrix was one of the participants. She shared that during each of the two years a different set of three teachers participated. The teachers go to a week long workshop in the summer, attend follow up sessions during the school year, and then the participants are responsible for presenting workshops to at least five of their fellow teachers.

Candice thinks her school district's professional development offerings are "garbage." The beginning of the 2006-2007 school year found Candice avoiding games of faculty 'Red Rover' by claiming to be too old to participate. The rationale behind this particular approach to professional development, according to Candice, was a way to strengthen "communication skills or to make me feel more of a group." She concedes that in the past the school has offered some interesting professional development in "dyslexia training and the visual and the hearing, several different handicap type things." Candice has thirty-nine years of teaching experience so she shared that education is cyclic, "fifteen to eighteen years and things come back." She adds that she hasn't "seen anything that's really just incredibly new, I've seen restructured, recycled."

The prevailing opinion of professional development offered by the participants' school districts is that it is not relevant to their teaching needs, or, if it is relevant, it is not presented it a format that would insure sustainability. After just four years of teaching, Alana is seeing professional development themes being repeated.

Activities and Responsibilities as an ITS Cohort I Participant

Alana saw her responsibilities during the ITS experience to learn the research concerning how people learn, focus on learning the software and hardware provided to the participants, learn about action research, and take on the responsibility of preparing a product(s) you could take into the classroom.

Beatrix's responsibilities while at the ITS program were to take the education and chemistry classes and learn as much as she could. She learned how to do things on the computer that she didn't think she "would have learned how to do, you know, like simulations of data and looking at molecular structure." She realized she was to take the information "about molecular architecture, molecular structure, interweave those two together with any kind of inquiry activity that we could come up with and try to find a venue or a format where those could be presented." Then take everything they had learned as a group and put it all together. "I think that is what we were doing because that's sure what I did."

Candice saw her responsibility at ITS as an opportunity to “take the education section and the chemistry section” and learn as much about the two as she could. She felt she was also charged with the responsibility to learn as much as she could about “molecular structure” and produce an inquiry activity.

Candice acknowledges that the people who were involved in the ITS program, participants and professors, contributed to her introspection and, “made me stop and look and think differently about how things should be done.” Influences included “building the levels of learning to be able to write the labs that we were going to put together or the activities we were going to put together.” Her approach to writing and creating for the classroom has been positively influenced by “a group of people that have variable backgrounds and come from different parts of the world and have different levels of experience and education.” She particularly felt the group molecular visualization activity changed her perspective on labs. Previously she said that she “did this lab and this lab and this lab, and then I just thought at the end they would know [what the objective was].” When she realized the group had created a lesson on solutions by each group contributing a part, she said she realized that “everything is interrelated, everything is connected.”

Summary

The participants were all aware of their responsibilities while at the ITS program. Alana was concerned with having a product for use in the classroom, while Beatrix and Candice marveled at producing a product as a cooperative group. Alana, as a Master’s student, had been working in this manner previous to the ITS program, whereas Beatrix and Candice, as classroom teachers, had worked autonomously.

Institutional and Social Pressures

Part of my second research question concerned the sustainability of the changes in the participants' methodology, made in response to the ITS program in the face of institutional and social pressures. The related interview questions concerned whether they were able to implement what they learned in the ITS program in their classroom.

Implementation of Technology in the Classroom

Alana's perception of information technology was that it "would be helpful in showing them [students] all the information that is available to them" so they could focus on scientific knowledge. Alana's school has a data projector hooked up to the computer in the classroom so she can show to her students interactive websites, that is, if they are not blocked [access to certain websites denied] by the districts computer system filters. She tries to use on-line videos in her PowerPoint presentations, and shares that most of her lectures are done by PowerPoint now. Alana's interpretation of "interactive" PowerPoint presentations are those presentations that have imbedded animations. As long as the sites are not blocked, then the PowerPoint presentations that she created at home are effective. According to Alana, "some things are blocked or can't utilize the interactive websites because it requires download of …Java Script or something like that." The whole process would be made easier if there was a technology person on campus. They had one "for three months and then that was it, it was wonderful during [the] three months, if we had something we needed we could get that pretty quick but now there isn't anybody."

They very rarely use computer software because they need administrative access in order to load the program onto the classroom computer or server. “We are not allowed to download anything on to our computers since they are all networked, or what not, and sometimes it seems like it is more hassle than it’s worth, which is disappointing, very disappointing.”

Her department has access to a Classroom Performance System (CPS) “book clickers that we could do on line. Answers, you know, quizzes and things like that.” CPS is an interactive wireless response system that the Cohort I participants used during the ITS program. Another department initially monopolized the CPS components, but now the science department is developing a database so that the units can be utilized by more than one department. Alana’s technology wish list includes a “computer on wheels for the science department” that she could see using at least every other week.

Alana compares her skills, or lack of skills, to others in her school. She mentioned an instructor in the social science department who has conducted workshops for others on the use of smart boards and CPS in the classroom. According to Alana, this instructor is far above the other teachers in her technological expertise, because of her level of involvement and understanding of technology, and is the head of the technology committee. Alana views her as a real driving force “to disseminate some of this information to the rest of the school.” In Alana’s department, there are six Integrated Physics and Chemistry (IPC) teachers and one Physic instructor who routinely use PowerPoint presentations. According to Alana, the other science teachers in the department do not use PowerPoint presentations. The IPC instructors have worked together for over a year getting all of the lectures on PowerPoint.

At Alana's school, there are institutional pressures to fully implementing her plans for information technology utilization. She cites the lack of computers available to the students and unreliable internet access as "a constant stumbling block at the schools I have been teaching at." There is one computer lab at Alana's school that teachers sign up for in advance, which impinges on the spontaneity of inquiry events suitable to having computer access in the classroom for all students. The system itself "is bogged down, [it] moves very slowly." She feels that if the students could just have access to the tools and get comfortable with utilizing technology they would accomplish so much more. As it is now "if you're lucky you can schedule in twice a year." At this pace, the students never get to the point where they will "be able to do investigations ….because they are still learning about what can be done."

Additionally, time to get everything done is a barrier "There doesn't seem to be any time available to do something that may not be strictly focused on what the department would like us to do." Alana's school has focused on preparing students for the TAKS, and they have a prescribed curriculum for the teachers to cover within the school year. She states that she was "hoping to try and do a bit more inquiry things….bring in more of the IT [information technology] in to the classroom, and it just…seem to hit more and more road blocks….[and we] have to get through these curriculum pieces."

Alana sees technology as a collaborative endeavor. She stressed to me that her fellow IPC teachers agreed with the development and utilization of PowerPoint presentations for lectures and the need for everyone to have a data projector,

> I've found myself pushing for some things, programs that I know are available, equipment that I know is available, and trying to push it for the science department to get it so we can have it available so that we can bring that into the classroom.

She doubts her abilities in utilizing technology when she compares herself to the social science teacher who is the head of the Technology Committee. But, she sees herself as a change agent by being involved in the Technology Committee and adding her voice to the push for improvements in her school's technology options, for example, pursuing the purchase by her school of a Computers On Wheels (COW). The participants used a COW for researching and working on projects while in the library at A&M during the ITS program. She has limited her information technology utilization to PowerPoint presentations to deliver content knowledge and CPS for assessment because of time constraints and internet access inconsistencies that keep her from incorporating more molecular visualization into her lessons. She has to contend with a large department with entrenched teaching methodology. The IPC teachers are the largest group that uses technology, and they all use the same PowerPoint presentations and the same database for the CPS. Alana mentions that other science teachers in the department prefer to engage in "chalk talk" as opposed to using the data projectors, although the physics teacher does use interactive websites. "Beyond that, I'm not sure that anybody uses them."

Beatrix's experience with information technology was limited before she attended the ITS program, but now she says that "the exploratory nature of information technology is what I got the most out of….for myself and my students." During Dr. Williamson's course, Beatrix reworked some of her labs into inquiry style labs "with some exploration and some engagement using computer simulations." She believed the exercise of converting known labs into inquiry experiences was the most beneficial for her and allowed her to "expand my own horizons." She added that she didn't think "we can be any better teacher than we are a learner and every time I expand myself and my abilities indirectly or directly [it] expands my students' as well because it gives me more tools."

When a student does not understand a concept or if they need enrichment, Beatrix likes to refer them to the internet to search out an answer and have them report back to the rest of the class, as time permits. The data projector is the piece of technology she uses the most with her classes, she will "pull up [search for and access] some things and let them see some simulations or let them see some pictures of some little nanomolecules, little eighteen wheelers, little nanoguitars, or something." The availability of the data projector allows her to show her students a variety of websites that contain "simulations on the gas laws….soluble gas behavior, animations that I can pull up." In addition to the use of the data projector in class, she wrote a grant for six stations of Vernier's LabPro® and material. She uses both Vernier's LabPro® and Texas Instrument's Calculator-Based Laboratory™ (CBLs) with her classes.

One of the institutional pressures that preclude the use of information technology in the classroom is the lack of computers at Beatrix's school. She wishes that the ITS

Center could have supplied computers for her classroom. She feels that the "inequality is just rampant among school districts" and contributes to the lack of information technology opportunities for students. Other institutional pressures to information technology usage in the classroom she mentioned were time constraints, no computer lab, a COW that does not work, and students who do not have computers or computer access at home. She has developed labs with computer simulations but cannot use them because her school district doesn't have a computer lab where students could work on the simulations. She has extra-credit projects that are computer simulations, but only the students who have a computer with internet access can participate, which puts the other students at a disadvantage, so she opts not to use the projects in her classes.

Candice defined technology as:

> being able to use…something as simple as a graphing calculator and a Vernier's LabPro® program or any of the Pasco equipment, learning how to use a computer to write programs to do simple things …being able to hook them up with a Vernier Logger *Pro*®, and have students actually collect data and do that sort of thing and do real time stuff where you could look at sequence of events that were actually happening or had happened.

She also stated that technology is:

> being able to use equipment that has a learningship or capability in it so that the instant you get the data, you get a read out and that read out then can be put on a graph. It can be put on a data table. The calculations can be done from that. It is

> taking the standard labs that you might normally do and simplifying the way that you process the data. Not simplifying the lab, but simplifying the processing and giving you a more in-depth way to look at that data. So it's just not superficial, it is the depth that you need, to have some really, really good understanding of what's going on with that concept.

Candice used the program RasMol during her ITS experience and created some molecular visualizations of her own that she had on a computer disk. She used the programs on the computer disks for several years. "The kids could look at them and rotate them and then we had a place where they could go in and add bonds and see what they made or if they made anything." The school purchased new laptop computers and her RasMol technology became outdated. She knows that she can go online to a search engine to look at molecules, so she has not updated the RasMol technology. She has used those sites along with physical models of molecules with her students. She credits the ITS program and the molecular visualization training for her ability to present bonding to her students in this manner. "Holding the model going, looking, looking at the screen and the model and going, ok, but I don't think I would have done that had I not been through ITS." Candice uses AP® Chemistry PowerPoint presentations with her students, in addition to Vernier's LabPro® and Vernier Logger *Pro*®.

At Candice's school, one of the institutional pressures to information technology utilization stems from lack of computers for her students. She has one teacher computer and two very slow computers for the students in her class to share. She does have access to six lap top computers, but she has to share those with another teacher. Because her room was not designed with technology in mind, hooking up six laptops in her room can cause the circuit breaker to trip. Another problem with her room's technology design is the location of the room's computer drop, "behind the science demonstration desk, in line with the shower, behind the vent." An unexpected barrier has been the students themselves. She shared that for some lessons some of her students preferred that she just work it out on the board or write it on the overhead as opposed to a PowerPoint presentation,

> they [her students] said, 'Could you just do it on the board? Could you just talk through it?' You know they didn't want to look at that screen any more. They said, 'It's ok, show us the little movie, show us the clips, show us the pictures, but could you just work it out on the board?'" Candice also identifies time as a barrier because, "it is so hard to find time for me to learn how to do it and then get it ready for my classes because I have so many different classes during the day.

Of the three, Candice had the clearest picture on how to utilize technology in the classroom in her use of Vernier's LabPro® connected to a computer for labs and molecular visualization to help explain solubility. She used technology in the classroom as a means to an end when she said that "you can do the same lab and collect five or ten times as much data and process that through in the same time you would be doing it manually." She encouraged the students to concentrate on the concepts and not be bogged down with the processes. Candice, while she was at the ITS Center, co-created a hybrid inquiry lab that used standard lab procedures and incorporated simulations to explain the hard to understand concept of solubility at the molecular level. She said that when students get to the end of the lesson, "it makes them stop and say: everything is interrelated, everything is connected, and one thing reacts this way because these are the properties."

Summary

Beatrix started the program with the least amount of experience with technology and, although she has increased her experience level, she limits herself to internet searches and the use of PowerPoint presentations via a data projector. Alana has the most recent experience and the strongest desire to become involved with technology at the administrative level. Candice is fearless in her approach to technology and embraces a variety of sources.

My Methodology

My participants talked about the technology they used in the classroom and some of the methodology. The last school where I taught did not have much technology available. They installed a data projector in November. I did use PowerPoint presentations with graphic visualizations to help my students with abstract concepts. However, most of my success with my students came from using inquiry and constructivist methodology.

When I taught my students about stoichiometry, balancing chemical equations, there was rending of garments and gnashing of teeth for about two weeks and then all of a sudden, they "got it." I told every class, every year, that they would absolutely hate me *and think I was a horrible person during this lesson because I was making them learn something with which they had minimal or no previous experience (this sounds a lot like the first year of the ITS program). But then, when they felt like they had done nothing but bang their head against a wall for two weeks, it would seem as if their head found a window in the wall and they would be on the outside of the box and wonder "what was so hard about that ?" I did not realize before the ITS program that I was using constructivist methodology with my students by helping them create their own knowledge. Nor did I realize at the time that I was changing their epistemology and ontology. They had learned a very difficult concept, their epistemology had changed, and they held a more positive view of their ability to learn science, their ontology had changed.*

At my last teaching assignment, the juniors of the 2005-2006 school year had a 58% passing rate for the Science TAKS test. I did not know the passing rate was so low when I applied for the job and did not learn of the passing rate until our first day of staff development. I asked the students how they had been taught in their previous classes and how they had been prepared for the TAKS test in previous years. I discovered that most of my juniors have never been in a lab and had no hands on experience in science, their science classes had consisted of worksheets and bookwork. I used what I learned at ITS, primarily a constructivist methodology. The students needed to be successful on the TAKS test, so I created activities that used inquiry and constructivist methodology. My students had a 78% passing rate for the science TAKS test for the 2006-2007 school year.

CHAPTER V

CONCLUSIONS

In this chapter, I present my conclusions about the evidence supporting my research questions. The conclusions of this study are the result of my analysis of the extent and endurance of influence the Information Technology in Science (ITS) program had on the epistemological, ontological, and methodological beliefs of high school Chemistry teachers. Three prominent strands were apparent:

- The teachers' belief system of their views of science education or their epistemology,
- The teacher's background and experiences which shaped their concept of the nature of science, or their ontology,
- The teachers' instructional practices they utilize or their methodologies.

Research Questions

Research question one asked how the teachers' background and experiences of participating in the ITS program resulted in changes in their epistemology, ontology, and methodology. I was searching for evidence that their epistemology, ontology, and methodology was influenced by their participation in the ITS program. In research question two I sought to determine if the training the participants received, which influenced their epistemology, ontology, and methodology, was sustained in the face of institutional and social pressures after the ITS professional development.

Alana's Epistemology, Ontology, and Methodology

Alana had been teaching for four years when we talked. I expected her to have the strongest epistemological beliefs and to be the participant who would make the connection between her epistemological beliefs and the ITS program's influence. I expected this because immediately before the ITS program she had been working on her Master's degree with Dr. Williamson.

She used what I describe as ITS terminology, "visualization," as she explained the difference between an effective teacher and an ineffective teacher. She explained when an effective instructor used visualizations she, as a student, was able to understand abstract science concepts.

However, Alana was looking at the ITS experience through the eyes of a graduate student and not a classroom teacher since that was her only frame of reference. She acknowledged that she is more appreciative of what she learned at ITS now that she is in the classroom. Therefore, her beliefs about knowledge and knowing of science education were limited to her experiences as a student and her perception of a change was contained within that parameter.

The IT program effected her epistemology of the use of information technology in the classroom. While she may not be able to use all of her information technological expertise all of the time in the classroom, she expressed to me that she knew how instrumental the use of visualization was to her students' learning.

Ontologically, Alana was influenced most by the ITS required reading over research about how people learned. She interpreted what she learned into her classroom environment where she is "more reflective about what kinds of instruments I'm using with the students to help support their learning." She did directly credit the ITS program for her insight.

Alana's opinion of staff development offered by her school district was another indication that her ontology had changed. She mentioned that she felt like she was "hearing the same thing over again just in slightly different words." *I thought this too, I wanted them to deliver to me professional development that was of the caliber of what I had received through ITS. To me the districts were delivering first year professional development year in and year out.* Alana sought substantial professional development from other sources, specifically, professional conferences. At the conferences, she found research-based methodologies that she thought she could use in her classroom.

Despite Alana's claims that she is not that skilled in information technology, she had a very positive outlook on the utilization of information technology in the classroom. Following her participation in the ITS program, Alana had created, co-created, and used PowerPoint presentations for lectures. She also worked on creating a database for the Classroom Performance System, which students use in the classroom, she conducted information technology-related workshops, and she is on her school's technology committee.

I was surprised that Alana had conducted workshops for her peers in the use of information technology. Ontologically, along with serving on the technology committee, this means she is confident in her information technology knowledge and abilities.

From an ontological perspective, she knew she could use information technology to determine her students' previous knowledge, she knew what types of information technology to use to address any misconceptions or lack of knowledge, and she knew she could use information technology to assess their learning experiences. However, institutional pressures interfered with Alana using information technology in the classroom. She cited the time constraints of teaching a set curriculum (the Texas Essential Knowledge and Skills, TEKS), lack of classroom computers, and lack of internet access as limitations to the use of information technology in the classroom.

The use of information technology was not the only methodology that the ITS program promoted. Inquiry-based learning was part of the afternoon sessions for the Chemistry Cohort. Alana disclosed that because of the set curriculum, inquiry learning was "not being done at our school, it's just not a way that they are set up." Apparently, the TAKS test objectives drive the curriculum for Alana's school. She said that they culled many science concepts from the curriculum in favor of those concepts that were to be on the Texas Assessment of Knowledge and Skills (TAKS) test. I was surprised that Alana never mentioned any use of visualization or inquiry-based learning as a means of teaching her students TAKS related concepts. The teachers received CD disks with TAKS review material from the Texas Education Agency (TEA) website, which consists of practice test questions, to use for students' reviews.

Although Alana had an epistemological change in favor of information technology and inquiry-based learning, in the face of the institutional pressure of TAKS, there was not an ontological change strong enough to change her methodological approach to preparing students for the TAKS test.

Beatrix's Epistemology, Ontology, and Methodology

Beatrix was and continues to be very involved in science education. She was an avid workshop participant and presenter, she had been teaching for 25 years when I interviewed her, and she graduated with her Ph.D. in 2006.

An early epistemological change that I identified related to Beatrix was her realization that her driving personality might not have been the most effective means of teaching for her students. She said that she saw herself as a teacher who poured "the knowledge in their heads." Another epistemological change occurred for Beatrix when she realized that although she used a hands-on methodology with her students, it was not necessarily inquiry learning and she credited the ITS program with helping her to see the distinction.

An example of an ontological change related to inquiry-based learning was that Beatrix converted lab activities that she used as cookbook labs or hands-on labs into more inquiry-based activities. In this example, she has the epistemology of knowing or learning about inquiry-based education and it has changed her ontology so that she goes beyond recognizing the difference between hands-on and inquiry-based activities to generating inquiry-based activities.

Beatrix viewed her PhD course work, which she began in tandem with the ITS program in 2001, as a turning point and I perceived it as an epistemological influence on her ontology. An indication of an ontological change is in the story Beatrix shared. Before the ITS program, Beatrix told me that her school district did not entertain her offers to present workshops at the district. Since she received her PhD, she said that she has much more credibility with her district and presents workshops. She is also the Science TAKS Coordinator for the district. I perceive the ontological change gave Beatrix the confidence, as she said, "to fight [for] the first one [professional development] I was allowed to give."

Beatrix admits that she does not do as much inquiry-based learning as she would like because of the "TAKS environment that we're in." She does not think that TAKS review lends itself to inquiry-based learning because there is so much information she has to "impart to the kids." I got the impression that she considers inquiry-based learning time consuming. Consequently, in the fast-paced TAKS preparation climate of her school, she does not have time.

I perceive an epistemological change in Beatrix as far as information technology is concerned. Beatrix admitted she was inadequately prepared for the information technology aspect of the ITS program at the start of the program. She said that the "exploratory nature of information technology is what I got the most out of...for myself and for my students" from the ITS program. She used the computer, internet, and lab probe ware.

Her instructional strategies when she used the computer were to conduct information searches, to show simulations or molecular visualizations, and display pictures related to content from the web in order to enhance the lesson. She has a teacher computer and a data projector for the classroom and limited access to a computer lab for her students' use. She used Texas Instrument's Calculator-Based Laboratory™ and Vernier's LabPro® for lab activities. Incidentally, she wrote a grant for her school and received six Vernier's LabPro® lab station sets.

When I asked about pressure from the administration concerning TAKS testing she replied that she was responsible for "a two week blitz" of reviewing for the TAKS test. She did not mention that she used an inquiry-based or information technology methodology during the blitz. She had said before that TAKS preparation does not lend itself well to inquiry-based learning. It seems as if she knows epistemologically what she should be doing with the ITS related methodologies, but in the interest of expediency, she opts for other teaching strategies.

Candice's Epistemology, Ontology, and Methodology

Candice shared that she had seen educational theories and ideas cycle around every 15 to 18 years in response to my question about a change in her perception of herself as a science teacher. Therefore, I did not expect Candice to have indications of changes in her epistemology, ontology, or methodology based on her response to one of my first questions.

Candice provided me with a litany of professional development experiences she had been involved with and added that she had been using inquiry-based learning with her students for years, but she never called it that. She said that she was not aware of the research behind the strategy until she participated in the ITS program. The research validated what she had known for years, that it was an effective means of helping students to learn science. I identified an epistemological change that was attributed to the ITS program.

Candice thought the solution visualization activity on which the Chemistry Cohort team collaborated had the most effect on her methodology. She described that she and her partner created a molecular visualization of one part of a solution process. The other team members contributed there parts of the molecular visualizations and it depicted the complete process of a compound dissolving. Candice exclaimed that she had never thought of bringing all the parts together. She said that in her high school classes she had always done "this lab and this lab and this lab and then I just thought at the end they [students] would know," now she uses inquiry and has her students complete projects. Although she has changed her methodology, I interpreted this as an ontological change because her concept of the nature of science had altered, in this case, creating learning opportunities for her students to find the connectedness of concepts.

An unexpected ontological change that I identified was Candice's personal experience of working with a diverse group of teachers. She was excited about learning from people who where from different countries, who were younger, and who had different levels of experiences and education. She learned from those who had a different perspective on teaching and embraced the collaborative nature of science.

Candice was the participant that utilized the most information technology in her classroom. She used the Texas Instrument's Calculator-Based Laboratory™, Vernier's LabPro® programs, Vernier Logger *Pro*®, PowerPoint presentations, and visualizations/simulations. Using the technology has been a challenge for Candice because of the lack of equipment, inadequate wiring in the classroom, and the time to prepare information technology related lessons for her students.

Candice thinks that using technology to take care of some of the more mundane aspects of laboratory work frees the student to pursue a more in-depth understanding of a science concept. She also credits the molecular visualization training for a better understanding of bonding, which she can now convey to her students more effectively. I interpreted this statement as a methodological change.

Although her encounters with the visualization/simulation/inquiry process were an eye opening experience for Candice, she finds that she cannot use inquiry-based teaching all the time. She admits that she is at a loss for another way to show some science concepts other than using the overhead projector or the chalkboard. Candice's experience with her students' resistance to her information technology efforts surprised her. Candice explained that she had prepared a PowerPoint presentation, but her students wanted the material written down on an overhead transparency as she talked about it. Candice responded to the needs of her students by resorting to writing the information on an overhead transparency. They were familiar with the delivery of information via an overhead transparency and this helped them grasp an unfamiliar concept. In this instance, the format was problematic for the students, which is a social pressure to utilizing information technology in the classroom.

At Candice's school, the principal told the teachers to teach the TAKS. She did not mention using any sort of information technology or inquiry-based learning for the TAKS reviews. She did share that it had been a very stressful year so far.

Summary

My research began when I perceived a parallel between the No Child Left Behind Act of 2001, a life altering technology-based professional development, and three philosophical/educational definitions of epistemology, ontology, and methodology.

The epistemological connection is that the NCLB and the ITS program both encouraged the production of education specialists. In order for that to be accomplished, teachers need the opportunity to establish a belief system of their views of science education. The constructivist approach used in the ITS program changed the level of awareness the participants had concerning educational research and the use of technology in the classroom. When a belief system is established using a constructivist approach, as the ITS program used, an education specialist is produced.

Ontology is a change in teachers' concept of the nature of science. An ontological change will occur when new knowledge or a new way of thinking about a concept result from an epistemological change. My perception of the parallel between the NCLB and ITS program was that the NCLB mandated teachers' content knowledge be improved and the ITS program's goal was to create new knowledge for the field, but in the process, teachers developed new knowledge. The rigors of the ITS program which involved leaning how people learn and reflective practices facilitate a conceptual shift in understanding science, learning, and technology.

Methodologies are effected by changes in epistemology and ontology. The instructional practices presented to the ITS participants included inquiry-based learning and information technology methodologies. The perceived parallels between the NCLB and the ITS program were that there was technology-based training and it would be carried forward to the participants contacts, students and other teachers. The ITS program provided a safe environment that allowed participants to feel comfortable in taking risks in using learned skills. In the presence of the institutional pressure of the TAKS test, there was an epistemological change, but not an ontological change. The result was that ITS instructional practices were not used to prepare students for the TAKS test.

Ideas for Further Research

1. What was the extent and endurance of influence the ITS professional development program had on the epistemological, ontological, and methodological beliefs on ITS participants who returned to their school districts and had the technological capabilities to fully implement the methodology and methods acquired from ITS?
2. How do teachers, who exhibit a change in epistemology, ontology, and methodology when teaching science, rationalize the use of a different epistemology, ontology, and methodology when responding to pressures to prepare students for a state mandated standardized test (i.e. the TAKS)?

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APPENDIX A

RECRUITMENT LETTER

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903/268-5568 cell 903/883-4258 home

Greetings, alumna/alumnus of the ITS Cohort I Chemistry Team,

Currently, I am working on my doctoral dissertation which is titled: Teachers' perception of the persistence of procedures learned during a prolonged staff development program (ITS) in the face of institutional and social pressures. I am asking you to participate in this research because you were a member of the ITS Cohort I Chemistry team. The purpose of this study is to explore the extent and endurance of influence the ITS interdisciplinary graduate program had on you as a participant.

If you agree to participate in this study, you will be interviewed by me; in addition, I would like to examine some of the IT you use in the classroom. During the interview we will talk about your ITS experience and the effects on you as a professional. There will be follow ups for clarification and member checks. All research material will be kept confidential with the use of pseudonyms throughout the coding process, the analysis, and the results. All research material will be kept indefinitely and secured in my personal locked file cabinet.

I realize that this is a busy time of the year, but I would greatly appreciate your participation. When you respond to this e-mail, please provide me with dates and times that would be convenient for you and me to meet.

Sincerely yours,
Deena Harper

deenasan@yahoo.com

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APPENDIX B

CONSENT FORM

Teachers' perception of the persistence of procedures learned during a prolonged staff development program (ITS) in the face of institutional and social pressures.

You have been asked to participate in a dissertation research study concerning your experience with ITS. You were selected to be a possible participant because you were an ITS Cohort I Chemistry participant. A total of 20 people have been asked to participate in this study. The purpose of this study is to explore the extent and endurance of influence the ITS professional development had on participants.

If you agree to be in this study, you will be interviewed by the researcher. The interview will be audio taped. The tapes and coded transcript will be secured in the researchers locked filing cabinet. The data from the survey or interview will be coded and respondents will be given pseudonyms for the purpose of identification in the text. This study will take approximately two hours for the interview. The risks associated with this study are none. There are no direct benefits of participating.

You will not receive monetary compensation.

This study is confidential. All research material will be kept in a private and locked file cabinet. Audio tapes will be retained indefinitely. The records of this study will be kept private. No identifiers linking you to the study will be included in any sort of report that might be published. Research records will be stored securely and only Deena Harper will have access to the records. Your decision whether or not to participate will not affect your current or future relations with Texas A&M University. If you decide to participate, you are free to refuse to answer any of the questions that may make you uncomfortable. You can withdraw at any time without your relations with the University, job, benefits, etc., being affected. You can contact Deena Harper at 903-268-5568 or deensan@yahoo.com and/or Dr. Lynn Burlbaw at 979-845-6195 with any questions about this study.

This research study has been reviewed by the Institutional Review Board - Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, you can contact the Institutional Review Board through Ms. Melissa McIlhaney, IRB Program Coordinator, Office of Research Compliance, (979)458-4067, mcilhaney@tamu.edu.

Please be sure you have read the above information, asked questions and received answers to your satisfaction. You will be given a copy of the consent form for your records. By signing this document, you consent to participate in the study.

Signature of Participant:____
Date: ___________________

Signature of Investigator: ____
Deena Harper
994 Mary St
Quinlan, Texas 75474

APPENDIX C
KEY INTERVIEW QUESTIONS

To address Research Question (RQ) 1 and 2 the following questions will be utilized. The questions are grouped as related to epistemology, ontology, or methodology.

Questions related to the participants epistemology:

RQ 1: (1) Before you began the ITS program, what was your perception of a science educator?
RQ 2: (2) What is your perception now?
RQ 1: (3) How do you define the role of science education in today's society?
RQ 1: (4) What is your role as a science educator?
RQ 1: (5) What motivated you to participate in the ITS program?
RQ 1: (6) What was your initial perception of the ITS program?
RQ 2: (7) What sort of interaction did you have with the project scientist?
RQ 2: (8) What were the most significant parts of the ITS experience for you?
RQ 2: (9) What have you been doing for professional development since you left the ITS program?
RQ 2: (10) Do you feel pressure from your administration, whether at the school level or the district level, to attend to topics that are tested on the TAKS exam?
RQ 2: (11) What is the nature of that pressure?
RQ 2: (12) Thinking back over your ITS experience, was there any time when you thought "Oh this would be perfect if…."? In other words, what would be the best-case scenario for the utilization of what you learned during your ITS experience?
RQ 1: (13) What do you think of the statement: "The No Child Left Behind Act requires that all teachers will be 'highly qualified' "?

Questions related to the participants ontology:

RQ 2: (14) If there has been change, to what do you attribute the change?
RQ2: (15) What factors contribute to your definition?
RQ 2: (16) What factors have contributed to your understanding of your role as a science educator?
RQ1: (17) What do you think the ideal professional development program should be like?
RQ 2: (18) How did your initial perception of the ITS program change over the course of the program?
RQ2: (19) In retrospect, do you think it was worth your time and effort?
RQ 2: (20) What activities contributed to a change in your perception of yourself as a science educator?
RQ 2: (21) Why do you think those particular activities had an effect on your teaching?

RQ2: (22) Why do you think those particular activities contributed to a change in your perception of yourself as a science educator?
RQ 2: (23) If you determined there was a change in your perception of science teaching and of yourself as a science teacher, how would you explain the influence of the interaction with the scientist as a contributing factor?
RQ 1: (24) What kind of impact has that experience made on your teaching?
RQ 1: (25) To what extent do you consider yourself a change agent in your school?
RQ 1: (26) Do you think your experience with ITS has anything to do with your assessment?
RQ 1: (27) In your opinion, what are the components of a ‘highly qualified’ teacher?

Questions related to the participants methodology:

RQ 1: (28) In what other kinds of professional development have you participated?
RQ 1: (29) How often do you participate in professional development opportunities that are not offered by your district?
RQ 2: (30) Thinking back to the ITS experience, what were your activities and responsibilities as an ITS Cohort I participant?
RQ 2: (31) Identify which activities you feel had an effect on your methodology.
RQ 2: (32) Are you able to implement what you learned in the ITS program in your classroom?
RQ 2: (33) If yes, what has made it possible for you to do that? If not, what have been the barriers to you doing so?
RQ 2: (34) How do you utilize information technology in your classroom?
RQ 1: (35) There were several different types of software used by the Chemistry Cohort. How often do you use any of the software (RasMol, etc.) you worked with during ITS?
RQ 2: (36) Could you elaborate on the reasons for the rate of use?
RQ 2: (37) What influence did the interaction with the scientist have on any aspect of your teaching methods?
RQ 1: (38) If there have been changes in your teaching methods, what part of the ITS experience fostered changes in your teaching behavior?

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