Three Science Teacher Educators with Elementary Teaching Experience: What Do We Bring to Science Teacher Education?

By

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Dedication

I dedicate this work to my parents, Mark and Esther Novinska, who always believed in me. Their encouragement directed me to go to college and major in science.
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I would like to thank all of those who have accompanied me on this journey. I would particularly like to thank Dr. Barbara Spector who I consider a mentor and a friend beyond being my major professor. She “opened the doors” of qualitative research to me and inspired me to think in new ways. I am also grateful to the other members of my committee: Dr. William Benjamin, Dr Janet Richards, Dr. Paschal Strong, and Dr. Diane TeStrake for supporting my efforts and believing in me.

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Three Science Teacher Educators with Elementary Teaching Experience: What Do We Bring to Science Teacher Education?

Cyndy S. Leard

ABSTRACT

This research explored the common experiences, values, and beliefs of three science teacher educators with elementary teaching experience and how these commonalities influenced their thinking about teaching preservice elementary teachers. This qualitative study used a life story approach and included an autobiographical component. Data were collected through interviews, observations, and archival records. The findings were shared in eight chronologically ordered vignettes that portrayed an individual representing a composite of the participants.

The participants shared numerous life experiences including: growing up in small towns, having older parents, being part of a two sibling family, having strong female role models, learning science through everyday occurrences, and having successful experiences in school math and science. They also placed a high value on education, responsibility, spiritual development, and contributions of diverse groups. Two beliefs stood out in the data. First, each participant believed that she had been a “good” elementary teacher. Second, each participant believed in the importance of attending to the affective domain within teaching and learning environments.
These findings represent an extension of the existing limited literature base regarding qualifications and characteristics of science teacher educators. The findings direct our attention to the need for changes in science teacher education programs with regard to recruitment and design in order to attract more applicants with elementary teaching experience and understandings of the elementary school culture.
Chapter I-The Problem Statement

Introduction

As I recall how I became interested in the topic for this dissertation, a whirlwind of ideas and emotions come to me. I remember walking into my first doctoral level class and feeling completely out of place and overwhelmed. A usually punctual person, I arrived late and so I was flustered from the start of the class. Those feelings from years of schooling and not wanting to be anything but ordinary came rushing back to me. I initially felt uncomfortable with the formality of the situation, but as the class continued I began to relax and my curiosity took over. I listened attentively while the other science education students introduced themselves, noting their degrees in the natural sciences and recounting their experiences as high school teachers. It was at this point that I realized that I was different from the other science education students. While I had a degree in the natural sciences, my teaching experience was primarily in elementary school, a conscious choice.

As I continued to take courses and meet graduate students, I began to wonder if there were any other students like me. Then I met Sarah. She was a Ph. D. student at the University of South Florida. When we first met, we talked about our educational backgrounds and career paths. We found that we had many experiences in common including undergraduate degrees in a natural science, work experience in various science related jobs, alternate route
programs that led to elementary certification, and experience as elementary teachers. We also shared a mentor professor.

As we talked further she said to me, “You’re the first person that I have met like me. I didn’t know there was another one out there!”

Finally, I had found someone who could understand my perspective, had similar experiences, and had been successful in the graduate program. This meeting gave me more confidence and made me begin to wonder why there were so few people with our experiences in science teacher education. It made me wonder if we were indeed unique, and if so, what we might contribute to the science teacher education community? Since part of the science teacher educator’s job is to teach methods for preservice elementary teachers (Association for Science Teacher Education [ASTE], 1993; Barrow, Wang, & Long, 2005; Jablon, 2002), it made sense that educators able to share experiences with their students would be valuable to the science teacher education enterprise. It also seemed important to have people with elementary teaching experience as educators of preservice elementary teachers, since this population is much larger than the middle school or secondary school population (B. S. Spector, personal communication, November 5, 2005).

My thoughts about being different and the need for more people like Sarah and me in the science teacher education enterprise were reinforced as I started to attend the two major science education conferences: the Association for Science Teacher Education (ASTE), and the National Association for Research in Science Teaching (NARST). Even though I was a graduate student, seasoned
science teacher educators approached me for advice about how to work effectively with Kindergarten through sixth grade students and their teachers. It seems that these educators received numerous requests to interact with elementary students and their teachers. Although, it wasn’t stated in our conversations, I assumed that this trend was a result of the current science education reform movement’s emphasis on system wide change beginning at the elementary level, and the resulting high stakes testing used to measure the reform’s success (American Association for the Advancement of Science [AAAS], 1993; DeBoer, 2000; Huber, 2000; National Research Council [NRC], 1996, 2001; Smith & Fey, 2000). These experiences reinforced my earlier thoughts about trying to learn more about what Sarah and I bring to science teacher education and perhaps how these discoveries may influence programs designed for future science teacher educators.

It was at this time that I had a chance meeting with another graduate of the University of South Florida who had credentials and experiences similar to mine. Twila had been invited to share her expertise in science teacher education in one of my doctoral classes. Talking with her after class, I realized that she also had an undergraduate degree in a natural science, work experience in various science related jobs, elementary certification resulting from an alternate route program, and experience as an elementary teacher. We also shared a mentor professor. How fortuitous to find three science teacher educators representing this subculture within the science teacher education enterprise (Jablon, 2002). These incidents heightened my curiosity providing the impetus for me to look
more closely at what the three of us had in common and how these commonalities shaped our approach to teaching preservice elementary teachers.

Science Education Reform

*Historical Overview*

In my research, I found that science education has been in a continual state of reform ever since science was first introduced into the curriculum in the late 19th century. Initially scientists advocated for the inclusion of science in the curriculum because of its practical importance and the intellectual training it provided. In addition, they stressed science’s role in the development of independent thinkers who could contribute to a democratic society (DeBoer, 2000). With advances in technology and following WWII, people realized that not only was there a link between science and human progress, but scientific developments also had the potential to be destructive. Questions were raised about the importance of science and technology as they related to issues of national security and the ability of our educational system to develop workers with technical expertise (DeBoer, 1997; 2000).

The launch of Sputnik in the late 50s provided the impetus for the reform movement of the 60s (Bybee, 1997; DeBoer, 1991, 2000). During this time science education emphasized the development of a scientific elite through discipline mastery and deliberate exclusion of the social context of science that was previously included in the curriculum (DeBoer, 1991, 1997; Hurd & Gallagher, 1968). While this approach raised concerns, science continued to be taught in this manner throughout the 60s (DeBoer, 1997; R. E. Haney, 1966).
This era was also identified by the proliferation of curriculum developed for use at both the high school and elementary school levels (Dana, Campbell, & Lunetta, 1997; R. E. Haney, 1966; Hurd & Gallagher, 1968).

The 70s and 80s represented a period of heightened public awareness and government interest as people became disillusioned with the science reform efforts of the 60s. This effort, representing scientific elitism did not meet the needs of our increasingly scientific and technological world (Collins, 1997; Cross, 2003; Hurd, 1997). As numerous reports warned that US citizens were not prepared to take active roles in a modern world, the question of teaching science in context and the development of a scientifically literate populace were revisited (Bybee, 1997; Hurd, 1997; National Commission on Excellence in Education [NCEE], 1983). A call to action launched by the publication of A Nation at Risk (NCEE, 1983) elicited a number of uncoordinated efforts to change science education followed by the current reform movement (Bybee, 1993; Collins, 1997).

Current Science Education Reform

The current science education reform movement represents a comprehensive system wide approach to science education and focuses on science literacy for all (AAAS, 1993; Britner & Finson, 2005; DeBoer, 2000; Hodson, 2003; NRC, 1996; Pringle, 2004; Sandall, 2003). This reform began in the late eighties with the development of Project 2061, a long-term initiative that set the tone for the reform. Participants in this initiative represented science educators, scientists, classroom teachers, business representatives, government officials and others. They recognized it would take a long time to bring their vision
to fruition. Therefore they chose the year that Haley’s Comet would return, 2061, for this vision to be complete. It is not surprising then that the seminal documents upon which the current reform rests are now more than ten years old. These documents include *Science for All Americans* (AAAS, 1990), *Benchmarks for Science Literacy* (AAAS, 1993), and the *National Science Education Standards* (NRC, 1996). In addition, more recent publications such as *Educating Teachers of Science, Mathematics, and Technology* (NRC, 2001) continue the vision of the current reform movement. These documents also represent the only opportunity for universal agreement on the goals of science education in the past century (Jablon, 2002).

Scientific literacy, an elusive term, was originally coined by Paul DeHart Hurd (Bybee, 1993; G. E. DeBoer, 2000; Hurd, 1997; Laugksch, 2000). As a concept, it refers to what the general public should know about science implying an appreciation of the nature and limitations of science (Laugksch, 2000). *Science for All Americans* describes the attributes of a scientifically literate person and outlines the knowledge, skills, and attitudes or “habits of mind” that citizens need to live in a culture that is shaped by science and technology (AAAS, 1990). This description from *Science for All Americans* (AAAS, 1990) is based on the belief that the science literate person is one who is aware that science, mathematics, and technology are interdependent human enterprises with strengths and limitations; understands key concepts and principles of science; is familiar with the natural world and recognizes both its diversity and unity; and
uses scientific knowledge and scientific ways of thinking for individual and social purposes. (p. xvii)

The *Benchmarks for Science Literacy* (AAAS, 1993) builds on this document and contains the “common core” of learning necessary to become scientifically literate and provides tools for science curriculum design (AAAS, 1993; Collins, 1997). The *National Science Education Standards* (NSES) of 1996 were then developed to “bring coordination, consistency, and coherence to the improvement of science education” (NRC, 1996, p. 3). They specifically address changes in the K-12 education enterprise that are necessary to develop a scientifically literate populace (DeBoer, 2000; Posnanski, 2002). The NSES incorporate much of what we have learned through recent developments in brain physiology research as it pertains to how people learn (Bransford, Brown, & Cocking, 2000; Jensen, 1998). The standards further outline what skills and knowledge teachers and students should have. They also emphasize inquiry learning and teaching science through “doing” science following the processes that scientists use (NRC, 2001). With the science education reform movement underway, state education standards based on national standards are now commonplace followed by accountability in the form of standardized testing (Cochran-Smith, 2005; Smith & Fey, 2000). Beginning in 2007, the state science tests will “measure students’ progress in science at least once in each of three grade spans (3-5, 6-9, 10-12) each year” (U. S. Department of Education, 2002b).
Elementary Science Education Reform

Elementary science teaching and learning were impacted by the various reform movements in much the same way as were middle and high schools. The launch of Sputnik raised concerns about the education students were receiving in formal school settings (DeBoer, 1997, 2000; Hurd, 1997; Laugksch, 2000). In answer to these concerns, a proliferation of summer institutes were developed in which "experts" would share their content knowledge with teachers (Dana et al., 1997). It was thought that elementary teachers, considered generalists and who lacked content knowledge, would benefit greatly from these opportunities. Unfortunately, elementary teachers returned to schools in which beliefs about children learning science and policies related to this topic did little to encourage transfer of knowledge from these institutes to the classroom (Duckworth, Easley, Hawkins, & Henriques, 1990). Heading into the 70’s discussions of the appropriateness of teaching science to young children and the emphasis on the three R’s did little to increase the importance of science in the curriculum (Betkouski, 1987). Science was often taught at the end of the day, when time permitted (Sandall, 2003). These conditions continued into the 80’s and are still evident today even though there is a reemphasis on teaching science in elementary school through a system wide approach that includes science education standards. These renewed emphases represent school policy, classroom practice, and elementary teacher education programs (Pringle, 2004; Roth, 2001; Staver, 2003).
Today, we recognize that the elementary school level provides a significant opportunity for children to access science and develop positive attitudes toward science (D. C. Rice & Roychoudhury, 2003). We also know that children are natural scientists and possess the attributes that are valued in science such as curiosity, open-mindedness, and willingness to experiment (Betkouski, 1987). It is important then to provide authentic science learning at this level. However, elementary teachers are often thought of as ill prepared and unqualified to teach science representing a weakness in the system (Dana et al., 1997). Elementary teachers generally have limited science backgrounds, tend to understand and view science more like the general public than secondary science teachers or scientists and have high science anxiety (Cobern & Loving, 2002; Howes, 2002; C. A. Lee & Housel, 2003; McGinnis et al., 2002; NRC, 2001; Zembal-Saul, Blumenfeld, & Krajcik, 2000). They frequently believe that they are incapable of doing science and are unqualified to teach science, so they either rarely include it in the curriculum or eliminate it altogether (Duckworth et al., 1990; Ginns & Watters, 1999; C. Lee & Krapfl, 2002).

Even though these conditions persist, new developments in learning theory as it pertains to children, changing expectations for schools, annoyance with science practices in schools, and concern about the lack of positive outcomes resulting from heavily funded school projects have begun to create a paradigm shift that influences elementary science teaching and teacher preparation (Dana et al., 1997). This shift has raised new questions about teaching and the education of qualified teachers in order to increase student
math and science achievement (Staver, 2003; U. S. Department of Education, 2000). These concerns have led to numerous studies of preservice elementary teachers (Bryan, 2003; Cobern & Loving, 2002; Howes, 2002; McGinnis et al., 2002; Simmons et al., 1999; Zembal-Saul et al., 2000), but few studies have reflected on the science teacher educators responsible for the development of qualified elementary science teachers (Rice & Roychoudhury, 2003).

Rationale for the Study

Higher Education

The reform documents tell us that system wide change is needed to affect the teaching and learning of science in the K-12 enterprise. This change also includes reform in higher education programs responsible for the education of future science teachers in grades K-12 (NRC, 1996, 2001). However, in many instances K-12 science teachers are viewed as an inclusive culture in which the unique needs and dispositions of the elementary school science teacher are ignored.

For instance, the science education systems standards found in the National Science Education Standards (NSES), call for more emphasis on “university/college reform of teacher education to include science-specific pedagogy aligned with the Standards” and “teacher certification based on understanding and abilities in science and science teaching” (NRC, 1996, p. 239). Middle and high school preservice teachers whose programs require specializations in the natural sciences should be able to meet these requirements. However, preservice elementary teachers have few opportunities
to learn science and therefore have more difficulty passing certification examses based on science content (Crowther, 2003; M. Hewitt, personal communication, Jan. 15, 2006; Howes, 2002; Luera, Moyer, & Everett, 2005).

The NSES state, “Higher education, 2- and 4- year college professors need to model exemplary science pedagogy and science curriculum practices. Teachers need to be taught science in college in the same way they themselves will teach science in school” (NRC, 1996, p. 238). This presumes that those instructors who teach such courses have the knowledge and skills to model appropriate science teaching. Since programs are varied in this respect, science is often taught by professors from the natural sciences who have had little or no training in reform based science education instruction and continue to employ didactic lecture modes (Crowther, 2003; Wright, Sunal & Day, 2004; Winschitl, 2005). Additionally, elementary preservice teachers are usually taught science methods by science education professors who have taught secondary science, but have no elementary teaching experience (Jablon, 2002).

The NSES also emphasize that changes in higher education are a necessary part of the reform yet acknowledge that changes in the higher education system are difficult to achieve. Change in this system relies on individual professor’s willingness to change. A sample situation cited in the standards speaks to this difficulty as a district science education reform committee approached university scientists and science educators only to find that they “…were ‘reluctant' to modify their courses for the district because they had degree programs that had been approved, they had incorporated what they
had thought would be the most up-to-date science, and they met teacher certification requirements” (NRC, 1996, p. 235). It was only after pressure was applied in the form of reallocation of funds that the higher education system felt compelled to make changes. This situation reflects the inconsistencies found among preservice teacher education programs that future teachers are likely to encounter in higher education.

Additional studies by the NRC’s Committee on Science and Mathematics Teacher Preparation (CSMTP) echo these earlier findings pointing out that “increasing expectations under national, state, and local content standards are raising the stakes for what K-12 students need to know and to be able to do in science and mathematics. Concomitantly, expectations have risen for what K-12 teachers need to know and to be able to do” (NRC, 2001, p. 2). The CSMTP expects higher education to provide appropriate reform based instruction for these future teachers, but has found that some of these faculty are out of touch with what is happening in the K-12 education enterprise and many “have had little or no recent direct contact with teachers in classroom environments” (NRC, 2001, p. 2). This gap between instruction and practice is cause for concern as research shows that teaching effectiveness relates positively to the number of education courses taken by teachers (Smith & Gess-Newsome, 2004; Wilson, Floden, & Ferrini-Mundy, 2001). These findings should motivate science teacher educators to reconsider how and what preservice elementary science teachers are taught.
Two important themes concerning preservice elementary teachers emerge from the literature: elementary teachers are unique among science educators and increasing their self-efficacy is important for their development. Research in preservice elementary teacher education acknowledges that these students are overwhelmingly female and work within collaborative settings (Hargreaves, 2000; Howes, 2002). Their science phobias, often based on past negative science learning experiences, leave them doubtful of their abilities to effectively teach science (Bryan, 2003; Duckworth et al., 1990; Howes, 2002; C. A. Lee & Houseal, 2003; McGinnis et al., 2002; Zembal-Saul et al., 2000).

These students are often characterized as being at a disadvantage when trying to “border cross” into the male dominated culture of science (Aikenhead, 1996; Rosser, 2004; VanLeuvan, 2004). They often become intimidated by scientists whom they perceive to be more intelligent, knowledgeable and having prestigious careers than themselves (Christophorou, 2001; Xie & Shaumann, 2003). They also misunderstand the scientists’ male ways of working that include hierarchical, authoritative styles (Case, 1988). One study by Spector and Strong (2001) highlights the disconnect between elementary teachers and scientists and also indicates how elementary teachers are often portrayed within the literature.

Ethical traditions of science include: a desire for knowledge; view science as a way of knowing and understanding; value peer review; make work public; open to criticism; truthful reporting of methods, procedures, and outcomes of investigations; respect for the rules of evidence; use
empirical standards, and use logical arguments. The culture of education, as evidenced by preservice elementary teachers, has quite different ethical traditions. Preservice teachers often do not express a desire for knowledge, view science as a fixed body of knowledge, don’t value peer review-only review from the instructor matters, keep work private between student and instructor, criticism of ideas is offensive and not permitted in a group, expect to accommodate methods, procedure, and outcomes to arrive at the “right answer”, individual personal experience overrides evidence, use personal beliefs, use logical arguments, and unquestionable acceptance. (p. 13)

Much has been written about self-efficacy and how it pertains to the elementary teacher’s beliefs and actions within the classroom including their approaches to and willingness to teach science (Britner & Finson, 2005; Czerniak & Lumpe, 1995; Eshach, 2003; C. A. Lee & Houseal, 2003). These studies are based on Bandura’s social cognitive theory that “roots human agency in a sense of self-efficacy….self-efficacy beliefs motivate people toward specific actions in all aspects of their lives, and therefore have predictive value” (Cantrell, Young, & Moore, 2003, p.177). The Personal Science Teaching Efficacy (PSTE) indicator can be used to measure teachers’ confidence concerning their ability to teach science (C. A. Lee & Houseal, 2003). This indicator has been shown to correlate positively with preservice teachers’ success in student-centered learning and enjoyment of the learning experience (Watters and Ginns, 2000). This research points to raising preservice elementary teacher self-efficacy as a way to begin
incorporating the recommendations of the science education reform documents into higher education.

It is also interesting to note that while there seems to be much concern about the lack of content knowledge of preservice elementary teachers there are conflicting results concerning the impact of science courses on pedagogical knowledge as it relates to student achievement (NRC, 1996, 2001; Wilson et al., 2002). The CSMTP says,

Numerous studies and the results from a variety of Praxis and other teacher licensing and certification examinations demonstrate that many teachers, especially those who will teach in grades K-8, do not have sufficient content knowledge or adequate background for teaching these subjects. (NRC, 2001, p. 2)

In contrast, Wilson et al. (2002) report that research designed to elucidate the effects of subject matter preparation are few and the results are often contradictory. Their review of 57 studies resulted in 7 that directly addressed the effects of subject matter preparation. They further state, “The conclusions of the few studies in this area are especially provocative because they undermine the certainty often expressed about the strong link between college study of a subject matter and teacher quality” (p. 191). They also reported that in some cases a threshold effect appeared to support the idea that courses beyond a particular number did not affect teacher quality. In addition, several studies reported a greater correlation between content specific education courses and achievement than separate content courses.
Rodriguez (2001), concerned primarily with cultural inequities in science education, describes the following disheartening state of science education research:

Although science education research based on this orientation (individual constructivism) has been very fruitful, it appears to have mainly benefited the science education research community. That is, to date, there is little evidence that findings from this body of research have had an impact on: (a) how teachers continue to teach; (b) how new teachers learn to teach; (c) how students learn; and (d) most importantly on the pervasive gaps in student achievement and participation among traditionally underserved children and children from Anglo and Asian ethnic backgrounds.

(p. 289)

It would seem that it is time to redirect our efforts and focus the lens upon ourselves, the university science educators responsible for teaching preservice elementary teachers.

*Studies of University Science Educators*

Few studies have been conducted that focus on university science educators. The most recent review of science teacher educator programs was conducted in 1999. Data was collected from 64 doctoral programs nationwide. These programs produced 174 graduates who earned either a Ph.D. or Ed.D. degree. Of these 174 graduates, 10% had elementary teaching experience and 13% had no teaching experience (Jablon, 2002). The study did not indicate if
those with elementary teaching experience were actually certified classroom teachers. These statistics are alarming in the fact that these educators are responsible for educating future teachers many of whom will teach science in elementary school. Past applicants for these programs were largely recruited from the secondary teacher population, but this research shows the sharpest rise in applicant pools comes from two and four year post secondary science faculty. These instructors often have little understanding of the preservice elementary teacher culture or the skills to teach them effectively (Wright et al., 2004). This raises the concern of how science teacher educators will learn to provide appropriate and effective learning experiences for preservice elementary teachers.

I found two self-studies of science teacher educators. One was a self-study of an elementary science methods teacher’s reflection on her practice conducted by D.C. Rice and Roychoudhury (2003). The science teacher educator had previously taught middle and high school science and became interested in elementary education as part of her doctoral program. This inquiry was based on previous research that indicated “experiences in science methods courses can improve elementary teachers’ relationships with science and science teaching” (D. C. Rice & Roychoudhury, 2003, p. 120). The intent of the researcher was to use her findings to make changes in her methods course that would be more likely to produce more effective elementary science teachers. The second study was a dissertation conducted by Chacon (2002). This
autobiographical study explores the development of a Latino educator as he becomes a high school bilingual science teacher and university professor.

A study by Barrow et al. (2005) explicates the concern raised here about the availability of science teacher educators qualified to teach preservice elementary teachers. They reviewed advertisements in the Chronicles of Higher Education for the 2003-2004 editions with respect to the responsibilities and qualifications for science educators. Of the 139 positions advertised, 51 were seeking faculty to teach preservice elementary teachers. Of the 51 available positions, 78.4% required elementary teaching experience. Since the study of doctoral programs by Jablon (2002) indicates that few such candidates exist in the science education community, it is not surprising that earlier trends as reported by Castle and Arends (2003) remained true as 32.5% of searches from 1997-99 failed to produce acceptable candidates. Reasons for these failed searches included a response from 62% of the institutions indicating that applicants lacked the preparation to meet the colleges' expectations.

Purpose of the Study

The purpose of this research was to explore what values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common and how these commonalities influence their thinking about teaching preservice elementary teachers. I am interested in this question for several reasons. Elementary science teachers represent a minority within the science teacher education community (of which I am a part), as most science teacher educators have secondary or post-secondary teaching
experience. There is a need for more science teacher educators with elementary teaching experience as evidenced by the number of positions available annually. In addition, I have found no studies that have looked at science teacher educators with undergraduate degrees in the natural sciences and elementary teaching experience.

Research Question

The qualitative study addressed the following question:

- What factors do we (the sample population) have in common that contribute to the way we think about teaching preservice elementary teachers?
- What values and beliefs do the sample population have in common that influence our thinking about teaching preservice elementary teachers?
- What experiences do the sample population have in common that influence our thinking about teaching preservice elementary teachers?

Design

A qualitative methodology was the most appropriate way to answer my research questions (Pajares, 1992). As the main instrument of data collection, I used a variety of techniques that resulted in rich detailed data (Eisner, 1991; Merriam, 2002; Woods, 1992). I used a life history approach as my guiding theoretical framework. In this case, a life history is an individual’s past memories of particular life events that are shared in written or oral form resulting from my
prompts (Tierney, 2003). Two of the life histories represent biographical accounts as told to the researcher. The third life history portrays an autobiography or self-study.

I collected data using a qualitative interview approach that allowed for flexibility resulting in coconstructed contextually based results (Merriam, 1988; Plummer, 2001). In addition to the semi-structured interview format used with the participants, I also used an informant interview (Merriam, 1988). This interview type made use of another social actor in the field but outside the study who offered an additional perspective (Lindlof & Taylor, 2002). I tape-record and video-record the interview sessions. I also collected data from field observations and archival data as necessary. As an iterative process, I collected and analyzed data simultaneously. Initially I transcribed the tapes and inserted notes (Emerson, Fretz, & Shaw, 1995; Sanjek, 1990). This process resulted in “thick descriptions” that represented the research process and included ongoing researcher reflection (Emerson et al., 1995; Geertz, 1973).

I used purposeful sampling to select the participants. Purposeful sampling is used when a researcher wants small samples of information rich sources that pertain to the purpose of the study (deMarrias & Lapan, 2004; Lindlof & Taylor, 2002). I have known the two participants for five years and have developed personal relationships with them. They agreed to be part of the study. I entered the field as a full member researcher (Adler & Adler, 1987). My close association with the participants allowed me to collect more candid interview responses. My
close association also allowed me to draw from previous experiences and observations that include the participants.

Key Assumption

A key assumption for this study is that we as human beings cannot be separated from our life histories. These histories through our experiences and life choices show how our belief and value systems develop and in turn shape not only our life philosophies but also our teaching philosophies. In addition, as the researcher, my personal views and beliefs were inextricably woven into the study and influenced the research process and the conclusions drawn from the research. In order to avoid bias, I used audio and videotapes during data collection and transcribed tapes verbatim. I also made use of an outside reviewer familiar with qualitative research to review my data. In addition the participants and informant interviewer reviewed the data and validated my findings.

Definition of Terms

Science Teacher Educator

Science teacher educator is a term that carries a variety of meanings. A science teacher educator may be anyone involved in the professional development of preservice or inservice science teachers including: science education faculty responsible for science content/pedagogy, post-secondary level science instructors, district level science supervisors/coordinators, staff developers responsible for professional development activities, instructional materials developers, school based science lead/mentor teachers, personnel from agencies other than schools and universities who provide professional
development for science teachers, and others (ASTE, 1993; 2004). Although “science teacher educator” is a more explicit term, it is sometimes used interchangeably with “science educator”. This usage creates confusion as science educators may be teachers in the K-12 enterprise or college level science faculty who do not teach courses specifically designed for teachers.

**Beliefs**

Beliefs are psychological propositions that individuals hold and accept as being true (McGinnis et al., 2002). These propositions may be accepted by a particular group of persons to support and reveal their world (Dictionary.com; Simmons et al., 1999). In this sense, beliefs direct the actions of individuals based on their expectancies or perceptions. Beliefs act as a foundation on which philosophies are built (Simmons et al., 1999).

**Values**

“Values are rules that direct moral or ethical decisions that are considered with right or wrong…. values seem to be always positive in nature” (Kobella, 1989, Attitude and Related Concepts section, ¶ 3).

**Experiences**

In the general sense, experiences are events that are lived through (Dictionary.com). Gadamer describes experience using two German words: erlebnis and erfahrung. Erlebnis refers to an experience as an adventure or event that is connected to a subject. This definition allows an experience to be repeated by many individuals. Erfahrung on the other hand defines experience as “something that one undergoes so that subjectivity is drawn into an “event” of
meaning; experience so understood is integrative, unfolding, dynamic, and hence singular” (Schwandt, 2001, p. 86). I view experience as a combination of the two. People may share an actual event (experience), but they may interpret it differently.

Summary

*A journey of a thousand miles begins with a single step*

*(Confucius 551-479)*

This study represents a first step through which I explored the values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common. I used a life history approach (Chase, 2005) and incorporated semi-structured interviewing and observation for data collection. The results of this research add to the knowledge base of science teacher educators who teach preservice elementary teachers. It also helps us to understand what people with these qualifications bring to the science teacher education enterprise. I hope that the results also provide insights into the types of program changes that need to occur in order to meet the growing need for university science educators with elementary teaching experience. I believe that this study, focusing on atypical instances, is of value in telling us about the norms found within the science teacher educator community (Lindolf & Taylor, 2002).
Chapter II-Review of the Literature

Introduction

The purpose of this study was to explore the values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common and how these commonalities influence their thinking about teaching preservice elementary science teachers.

Much of the reform documents are based on the assumption that teachers will teach as they are taught (Greenwood, 2003). They also are based on the assumption that the teacher is the single most important influence on students and thus on student achievement (Haycock, 1998). It follows then that this teacher student relationship would also apply to preservice elementary teachers (the student in this case) and their teachers (the science teacher educator). In order to understand what we bring to preservice elementary science teacher education, it seems that we first of all need to know something about who the current science teacher educators are, who the current preservice teachers are, what types of programs with regard to science and science methods these preservice teachers are required to take, and something about the inherently human values and beliefs that we bring. Therefore this study is informed by literature that addresses elementary science teacher characteristics, programs of study, and beliefs; science teacher educator characteristics, development, and research; and beliefs as they relate to science teaching and learning.
Elementary Science Teachers

Characteristics

According to the National Center for Educational Statistics (NCES, 2003), approximately 47,000 undergraduates earn bachelors’ degrees in elementary education during the 2001-2002 school year. These graduates are predominantly women making elementary science teaching a feminized profession carried out in an atmosphere of professional and personal closeness (Howes, 2002; Hansen & Mulholland, 2005; Hargreaves, 2000). These students are socially adept and capable of entering these atmospheres in which attention to children and awareness of school/social relationships are important (Howes, 2002). These graduates generally have SAT scores lower than those students seeking secondary licensure (Gitomar & Latham, 2000). They are considered by some to represent an area of weakness in school science, since they usually have limited science preparation resulting in a lack of content knowledge and deep science understanding (Dana et al., 1997; Howes, 2002; Luera et al., 2005; NRC, 2001).

This situation coupled with negative science learning experiences has created a trend in science education resulting in elementary teachers that are ill prepared to teach science effectively, lack interest in teaching science, and have negative attitudes toward science (Bryan, 2003; Cobern & Loving, 2002; Crowther, 2003; Czerniak & Lumpe, 1995; Howes, 2002; Pratt, 1981). Elementary teachers have also expressed their anxiety toward teaching science citing science phobias, lack of confidence about their ability to teach science, and feelings of inadequacy as some of the reasons for this anxiety (Ginns & Watters,
1999; Koch, 2005, 2006; McGinnis et al., 2002; Newman et al., 2004; Watters & Ginns, 2000; Zembylas & Barker, 2002). Elementary science teachers are also often regarded as having science knowledge and attitudes similar to the general public rather than being like secondary science teachers and others with science degrees (Cobern & Loving, 2002). Spector and Strong (2001) also identified differences in ethical traditions between science and elementary teachers. They found that elementary preservice teachers viewed science as a body of fixed knowledge. When given a task, elementary preservice teachers would try to find the right answer instead of trying to obtain knowledge. During the process, they were also not open to criticism, did not value peer review, and preferred to keep their work private. This is in stark contrast to the public knowledge seeking engaged in by the science community.

**Teacher Education Research on Highly Qualified Teachers**

The results of teacher education research are used to substantiate claims concerning the need for and development of highly qualified teachers (U.S. Department of Education, 2002b). However since teacher education research is a relatively new field, it is not surprising that as colleges of education come under closer scrutiny there is little agreement as to what constitutes sound educational research (Cochran-Smith, 2005; Wilson et al., 2001). This disagreement impacts the defining of a highly qualified teacher (U.S. Department of Education, 2002a, 2002b; Wilson et al., 2002). The Education Commission of the States 2000 report echoes the current political view of teacher education research as being of low quality, nonreplicable, and unscientific while those within education lament the
narrowing of the definition of “quality educational research” to a few studies with quantitative schemes (Allington, 2005; Berry, 2005).

**Exemplary (or Highly Qualified) Elementary Science Teachers**

Although the literature supports the notion that good teachers are needed for positive student outcomes there is little agreement as to what characterizes a “good” teacher (Thomas & Loadman, 2001). The literature is unclear as to the criteria associated with the highly qualified teacher. The CSMTP (NRC, 2001) recognizes that today’s teachers need to understand and know content, they must also be able to develop and carry out activities that provide opportunities for authentic learning. The teaching standards associated with these ideas are found in the National Science Education Standards (NRC, 1996). They include being able to: plan inquiry based lessons for students, facilitate learning, engage in on-going assessment that matches the new expectations for learning, provide learning environments, develop learning communities, and take part in school science program planning and development (NRC, 1996; Thompson, Greer, & Greer, 1998). It is then assumed that teachers with these attributes will be highly qualified and thus effective. The highly qualified teacher is one whose students have high achievement (Haycock, 1998). The CSMTP (NRC, 2001) cites reports indicating that there is a direct correlation between teacher content knowledge and student achievement levels (U. S. Department of Education, 2002a). The CSMTP (NRC, 2001) goes on to say that K-8 teachers often do not have the necessary content knowledge to teach effectively, thus not being highly qualified. However, a review by Wilson et al. (2001) found that simply completing more
science content courses did not guarantee higher student achievement. In addition, Luera et al. (2005) found no correlation between the number of science content courses and the teacher’s ability to develop authentic learning experiences in the form of inquiry based lessons. Allen’s (2003) review of 92 studies supports the earlier conclusions of Wilson et al.

Government documents, such as the Secretary’s Annual Report on Teacher Quality, significantly narrow the definition of highly qualified teacher and recommend that this term be applied to those teachers with high verbal ability and content knowledge while negating the importance of education coursework (Darling-Hammond & Youngs, 2002). The NCLB Act refers to the highly qualified teacher as one who has a bachelor’s degree, full state certification, and demonstrates competency in the core academic subjects that are taught (Cochran-Smith, 2002; U.S. Department of Education, 2002b).

These reports assume a correlation between their definition of highly qualified and effective. This assumption is supported by the work of the Education Trust as shared by Haycock (1998) whose findings indicate effective teachers possess strong verbal and math skills along with deep content knowledge. However the influence of pedagogical knowledge and skills as contributors to effective teaching are still inconclusive. In opposition, other research indicates that highly qualified by whatever standard does not always translate into effective (Garlikov, undated). Although there is some agreement across the literature that the teacher matters and is a predictor of student achievement, it is yet to be determined what it is about the teacher that makes
one effective (Haycock, 1998). J. K. Rice’s (2003) meta-analysis focused on
teacher quality and qualification studies lists five categories that appear to
contribute to teacher effectiveness including: program preparation and degrees,
specific professional coursework, test scores, certification, and experience.
Thompson, Greer, and Greer (1998) found that effectiveness is more related to
personal characteristics that encompass the theme of caring. These include
being positive, prepared, fair, creative, compassionate, willing to forget students’
past mistakes and willing to admit their own mistakes. They also include being
capable of developing learning communities in which high expectations, a sense
of humor, mutual respect, and personal connections with students are evident.
In a synthesis of 21 articles reporting on the relationship between teacher
characteristics and student outcomes, Wayne and Youngs (2003) found there
was a positive correlation between student achievement and the teacher’s
college ratings and test scores. However the results of studies focused on
coursework, degrees, and certification were inconclusive except in the case of
high school mathematics teachers. Their literature review indicated that “overall
teachers differ greatly in their effectiveness, but teachers with and without
different qualifications differ only a little” (p. 108).

*Elementary Science Teacher Education Programs*

Two areas of concern in elementary teacher education programs with
regard to science teaching and learning include the type and number of both
science content courses and science methods courses. The reform documents
and current political sentiment suggest that increasing the number of science
content courses will solve the problem of ineffective elementary science teachers (Dana et al., 1997; NRC, 1996; U. S. Department of Education, 2002b). A recent meta analysis by Wilson et al. (2002) suggests otherwise. In a response to continuing concerns about teacher education programs, they were commissioned by the U.S. Department of Education’s Office of Educational Research and Improvement to summarize the existing research on teacher preparation. While the study focused on five questions, one of them directly pertains to this study: “What kind of subject matter, preparation, and how much of it, do prospective teachers need? Are there differences by grade level or subject area?” (Wilson et al., 2002, p. 190). The commissioned group was also directed to include those “empirical studies, conducted with rigor and critically reviewed” (Wilson, et. al, 2002, p. 190). They were also given instructions to create a set of defensible criteria for research inclusion. For this study the research had to be directly related to the five initial questions, published in a peer reviewed journal within the past two decades and focused on teacher preparation in the US. If the research met these initial criteria they were further scrutinized. Only studies that directly related to the questions, contained sufficient detail for others to assess validity, consisted of arguments based on empirical evidence, and studies based on more than one course in a particular teacher education program were included (Wilson et al., 2001). As a result of this rigorous review process, only seven studies out of 57 met the criteria: four of the studies focused on secondary math and science teachers, one study focused on elementary and middle school reading and math teachers, one study focused on program graduates who had
completed subject matter tests, and one study focused on secondary teachers in general. These studies revealed inconsistent results, but two important points can be made from this review. These studies raise questions as to whether more content courses were better, because several of the studies found a threshold effect and that beyond four to six course in certain subject areas had no affect on student achievement. A second interesting point is that several of the studies, including the one focused on science, revealed a higher correlation between subject-specific methods courses and student achievement rather than content courses.

*Science Education Courses for Elementary Teachers*

Science education courses for elementary teachers could be considered science content courses or science methods courses. These courses are part of teacher education programs that are not standardized but driven by the certification requirements in individual states. The states mandate the distribution of credits across disciplines (J. Koch, personal communication, November 28, 2005).

This variability adds to the confusion as we try to determine the type and number of content and methods courses that elementary teachers take. There is not a comprehensive literature base concerning the science methods courses for preservice elementary science teachers. We can say the number of methods courses varies from institution to institution. For instance, in a large Florida “Research Extensive” university the program for preservice elementary teachers includes only one methods course that is taught either on campus or at the
Museum of Science and Industry (B. S. Spector, personal communication, January 4, 2006). Klein, Matkins, and Weaver (2001) describe an alternative approach. Their methods course sequence spans three semesters and is team taught across three institutions through collaborative technology.

We can also say that there is a lack of accepted goals or objectives for elementary science methods courses even though some studies indicate that experiences in science methods courses can improve elementary teachers’ attitudes toward science and science teaching (Gess-Newsome, Southerland, Johnston, & Woodbury, 2003; Huinker & Madison, 1997; D. C. Rice & Roychoudhury, 2003).

**Science Content Courses for Elementary Teachers**

Since programs vary, it becomes confusing to determine what content courses preservice elementary teachers take. David Crowther gathered information about science courses taken by preservice elementary science teachers in 1997. Although his data is not complete, it is the most recent we have to date (D. Crowther, personal communication, November 18, 2005; R. Yager, personal communication, November 18, 2005). The results of this study represented 32 institutions of higher education in 22 states. These institutions had programs designed specifically for elementary education majors. The study results indicated an average of two science courses per program although the number varied from six to one. Of these 32 programs, 7 programs taught content courses in the college of education. The majority of content courses were taught in departments of natural sciences by science faculty (Winschitl, 2005). The
majority of these programs also indicated that their content courses were
designed specifically for elementary education majors. Some of the programs
also met the college’s general education requirements while others did not.
Although this data is 9 years old, it still holds true today. For instance, at the
University of South Florida, elementary education majors may take a two-
semester course sequence for non-science majors titled “Science that Matters”
(Potter & Meisels, 2005). These courses are offered in the College of Arts and
Sciences and meet their general education requirements. The education program
requires no additional science content courses. Elementary education majors at
Central Missouri State University must take two science content courses with a
lab. All of these students will take at least one content course in the College of
Arts and Sciences taught by natural science faculty and may take one content
course specifically designed for elementary education majors taught by a faculty
member in the College of Education (R. Burkett, personal communication,
November 20, 2005). There are some concerns raised within the literature about
entry-level science courses that are taught by faculty in Colleges of Arts and
Sciences (AAAS, 1990; Boyer Commission, 1998; Siebert & McIntosh, 2001).
These faculty are often characterized as slow to change their beliefs about
teaching and learning even though one or two forward thinking individuals can be
found in most departments. Many times they lack the resources and
understandings to change what they are doing (Wright et al., 2004). Some of
these courses remain lecture based survey courses that fail to engage students
presenting science as a body of facts to be memorized rather than a way of
knowing (Britner & Finson, 2005; Craven & Penick, 2001; van Driel, Beijaard, & Verloop, 2001; Wilson et al., 2001). The literature further tells us that these courses have a major influence on preservice teachers’ future teaching, because teachers tend to teach as they are taught (Czerniak & Lumpe, 1995; Putnam & Borko, 2000). Their experiences in these courses also influence their beliefs in their abilities to teach science effectively (Appleton & Kindt, 2002).

**Educational Research on Elementary Science Teachers**

Beginning with the current science education reform movement there has been an increased interest in elementary teachers’ abilities to teach science and their beliefs that they can be effective science teachers (Bybee, 1993). Out of this interest grew numerous self efficacy studies appropriate for educational research (Pajares, 1992). Teacher efficacy, as a theoretical base was first conceived through Rotter’s external and internal locus of control work of 1966 followed by a second conceptual strand of theory based on Bandura’s work of the seventies (Tschannen-Moran, Hoy, & Hoy, 1998). It is this second strand of work on which the current elementary teacher efficacy studies are based.

Bandura’s social cognitive theory assumes that people’s actions are guided by observed consequences and their self-created beliefs (Czerniak & Lumpe, 1995). As part of this theory, his efficacy construct has two components: self-efficacy and outcome expectancy. Tschannen-Moran et al. (1998) define self-efficacy in terms of efficacy expectancy as “ the individual’s conviction that he or she can orchestrate the necessary actions to perform a given task, while
outcome expectancy is the individual’s estimate of the likely consequences of performing that task at the expected level of competence” (p. 210).

When applied to education, this self-efficacy construct is called personal self-efficacy or personal teaching efficacy. In this case, it is defined as the belief in one’s ability to teach effectively and is thought to have predictive value (Cantrell et al., 2003). In education, the second construct, outcome expectancy is called either teaching outcome expectancy or general teaching efficacy (Cantrell et al., 2003; Lumpe, J, J, Haney, & Czerniak, 2000; Plourde, 2001). This is the belief that effective teaching will have a positive correlation with student learning (Cantrell et al., 2003).

While most of the educational research involving efficacy prior to 1997 was quantitative in nature, today’s studies largely represent qualitative studies and those using survey instruments. (Bryan, 2003; Cantrell et al., 2003; Czerniak & Lumpe, 1995; Ginns & Watters, 1999; Plourde, 2001; Tosun, 2000; Tschannen-Moran et al., 1998). These studies also represent a broad array of perspectives that range from studies focused on teacher efficacy and beliefs through various program stages and teacher development (Britner & Finson, 2005; Eshach, 2003; Plourde, 2001; Wingfield, Freeman, & Ramsey, 2000). This body of knowledge spans thirty years in which researchers have made progressed in understanding self-efficacy and how it relates to other variables, such as student achievement. However, there are many areas to explore focused on the impact of methods classes on self-efficacy and to what degree teacher efficacy is context specific (Utley, Bryant, & Moseley, 2005). While the majority of
studies use the Science Teacher Efficacy Belief Instrument (STEBI) or the revised version (STEBI-B), some studies have concentrated on the development of instruments to measure these data such as the Context Beliefs about Teaching Science (CBATS) instrument (Enochs & Riggs, 1990; Lumpe et al., 2000).

Elementary science teacher self-efficacy studies are important in three respects. One, they give insights as to the relationships between teacher self-efficacy, beliefs, and action that impact the teaching of science in elementary schools. For instance, at the beginning of the current science education reform movement Czerniak and Lumpe (1995) recognized that teachers would have to act as change agents to institute the reform therefore teachers would need to believe in the reform and their ability to bring about change. Czerniak and Lumpe (1995) conducted a study in Ohio using a random sampling protocol. One hundred sixty-eight teachers completed two survey instruments: the Innovations in Science Education survey that measured teacher beliefs about the reform, and the Science Teacher Efficacy Belief Instrument (STEBI) that measured self-efficacy and outcome expectancy. The results of this study indicated that the majority of teachers thought most of the reform strands were necessary to be an effective science teacher. The only strand that teachers thought was not very necessary or unnecessary was constructivism. As a result it was found that only 14% of the teachers incorporated constructivism into their classroom teaching. This initial study supports the assumption that teacher beliefs are predictors of teacher actions.
Lee and Housel (2003) go on to say that teachers with higher personal science teaching self-efficacy are more independent and creative than their counterparts with lower teaching self-efficacy. They also strongly believe in teaching science for understanding and application. They are less likely to be textbook dependent and more likely to teach hands-on minds-on science. This is evident in spite of constraints within the system. J. J. Haney, Lumpe, Czerniak, and Egan (2002) examining the personal agency beliefs of six elementary teachers and their ability to effectively implement science instruction found results similar to those of Lee and Housel (2003). Teachers with more positive belief systems as indicated on the survey instruments were more likely to design lessons that incorporated inquiry, represented careful planning, accessed student prior knowledge, encouraged collaboration, and used alternative forms of assessment (J. J. Haney et al.).

Second, these studies provide data to be used by science teacher educators when developing more effective science teacher programs including science methods courses. For instance through a series of studies, Watters and Ginns (2000) identified five situations in which students’ science teaching self-efficacy was enhanced:

first, their previous experiences in school science were positive and teachers provided recognition of students’ interests in science.

Second, when learning science was fun, interesting, and enjoyable, the experience provided intrinsic rewards and positive feedback.

Third, self-efficacy was enhanced when opportunities were
provided for discussion and interaction, which promoted the maintenance or improvement of self-efficacy and provided an environment where risk taking was encouraged. Finally, it was also evident that students were driven by both internal and external motivation. A desire to finish the preservice program and graduate was a powerful motivator that in some instances outweighed feelings of anxiety about science. (p. 316)

Using this information they studied 154 undergraduate preservice teachers in a primary education program. Quantitative data was collected using the STEBI-B and qualitative data was collected through observation and focus groups. The results of this study suggested that learner centered course design addressing affect, meaningful learning, and motivation could change beliefs about science teaching ability. Students also were more accepting of the tentative nature of science (Watters & Ginns, 2000).

These outcomes are also supported by the work of Cantrell et al. (2003) who looked at the science teaching efficacy of preservice teachers across a three semester continuum including a seminar course, methods course, and student teaching experience. Their recommendations for increasing self-efficacy include: early field experiences, opportunities for preservice teachers to assist with extracurricular science experiences, opportunities for mastery experiences in teaching science to small groups, and developing a community of learners with a climate of safety for risk taking.
Huinker and Madison (1997) also found that methods courses that represented an integrated approach with field experiences increased teacher self-efficacy and outcome expectancy. In this case, science, math, and social studies methods were taught collaboratively to cohorts of students. Instructors co-constructed syllabi with overlapping assignments and field experiences. These courses were taught through a constructivist approach with hands-on, minds-on activities. The researchers suggest that the course design offers opportunities to increase self-efficacy as stated by Bandura through the following four sources of information: performance attainment, vicarious experiences, verbal persuasion, and physiological states. The work of Wingfield, Freeman, and Ramsey (2000) further substantiates the importance of field based methods courses as providing the four sources of information cited by Bandura to increase and maintain the self-efficacy beliefs of first year teachers. The implication for teacher educators is that self-efficacy can be enhanced and maintained over time. The work of McGinnis et. al. (2002) further validates the effects of integrated programs as evidenced by their comparison study of participants in the Maryland Collaborative for Teacher Preparation (MCTP) program versus those who were not in the program. Teachers involved in this integrated math and science program, which was taught by scientists and educators who modeled reformed based instruction, developed more positive attitudes and beliefs unlike their counterparts not in the programs. I would also note that the authors cite a difference between the two groups in that the MCTP teachers were willing to teach mathematics and/or science by making
connections between the two disciplines. The MCTP candidates took 18 hours of
science and 18 hours of mathematics while their counterparts only took 11 hours
of math and 8 hours of science.

In addition Tosun (2000) reports similar results when he administered the
STEBI-B to 46, seventh semester students enrolled in an integrated elementary
education program as a pre and post semester survey. He also provided a self-
report questionnaire asking students to indicate high school and college science
course work and letter grades to identify experience and achievement levels. The
results indicated that the integrated nature of the methods course increased
student science teaching efficacy although their outcome expectancies remained
the same.

Third, elementary science teacher self-efficacy studies provide
opportunities to gain understanding of the changes in teaching self-efficacy as
teachers pass through developmental stages. For instance, Plourde (2001)
analyzed preservice elementary teachers’ field experiences for factors that
impacted beliefs about science teaching ability and contributed to effective
science teaching. The results indicated that three areas contributed to decline in
efficacy: mentor teacher influence, curricular time for science, and materials and
equipment needed to do hands-on science activities. He goes on to say that:

this study demonstrated that preservice teachers’ beliefs and
attitudes about science teaching are set firmly prior to entry into
preservice programs as a result of their science related
experiences in elementary and secondary school. This study found
that these beliefs and attitudes are further amplified through the
science content courses digested at the college/university level.
Logically, preservice programs ought to provide situations that
produce positive changes in preservice teachers' beliefs about their
ability to teach science. (Plourde, 2001, Relevance of This Work to
Science Teacher Education section, ¶ 1)

Studies such as Eshach's (2003) also indicate that science teacher
efficacy can be increased in those who are no longer beginning teachers.
His study focused on a 4-day professional development workshop in
which elementary teachers were engaged in inquiry events based on
open-ended problems placed in real-world contexts. Results of this
experience as determined by the STEBI found an increase in teachers'
science teaching self-efficacy and confidence after this experience.

Science Teacher Educators

Characteristics

According to the National Center for Educational Statistics (NCES, 2003),
of approximately 7,000 doctorates conferred in education in 2001-2002, there
were only 35 earned in science education: 14 men and 21 women. This statistic
highlights the challenges in science teacher education as it is becoming more
difficult to find candidates to fill positions in higher education.

The most recent study profiling science teacher educators and the
programs that produce them was conducted in 1999 (B. Yager, personal
communication, November 18, 2005). This research reviewed 64 science
education doctoral programs nationwide. These programs lead to a Ph.D. or Ed.D. degree and represent pure science education degrees, curriculum and instruction degrees with science education emphases, or hybrid degrees such as environmental education or biology education degrees, etc. Applicants for these programs have traditionally earned undergraduate degrees in a natural science and have experience as high school science teachers. However, current statistics show the sharpest rise in applicant pools from post secondary institutions. It is not surprising then that approximately 86% of these program graduates have secondary and post secondary teaching experience while only 10% have elementary teaching experience (Jablon, 2002). The study did not indicate if those with elementary teaching experience were actually certified classroom teachers.

Little additional information was provided from a review of the membership roles of the two main science teacher educator organizations. The Association for Science Teacher Education (ASTE) and the National Association of Research in Science Teaching (NARST) each have approximately 1,100 members that represent slightly more females than males (W. Smith, personal communication, November 28, 2005; M. Estes, personal communication, November 18, 2005). These memberships do overlap and also include international members. This membership includes persons who are faculty members in colleges of education, higher education faculty who teach science courses to teachers, informal education enterprise personnel that provide professional development for teachers, policy makers, site based mentor/master teachers, graduate students
pursuing degrees in science education related fields, and others (ASTE, 1993, 2004; B. Spector, personal communication, November 18, 2005). We have no data that tell us who exactly is teaching the preservice teacher population (J. Koch, personal communication, November 12, 2005; B. Yager, personal communication, November 14, 2005). We do not know how many hold doctoral degrees, are doctoral graduate students, or are master's level adjuncts. We don't know if they are fulltime, tenure track, or part time adjuncts. We do not know if they have science education degrees, science degrees, or elementary generalist degrees. We can say that full time, tenure track, science teacher educators in NCATE accredited institutions need to have an undergraduate major in the natural sciences or masters in the natural sciences. If they have a doctorate in the natural sciences they need a masters in education. Most require the science teacher educator to have classroom teaching experience in the GK-12 enterprise. We can also assume that for each college of education there is at least one full time, tenure track, faculty member (J. Koch, personal communication, Nov. 12, 2005).

The following examples explicate the variability found in those science teacher educators responsible for teaching preservice elementary teachers. The first example is John R. Staver. He describes himself as a high school chemistry teacher who earned a masters’ degree in chemistry, a doctorate in science education, and taught preservice elementary teachers (Staver, 2003). In another example, at a large southeastern university, the majority of preservice elementary teachers’ science methods courses are taught by adjuncts who are
high school teachers or fulltime faculty members with secondary teaching experience (J. Lambert, personal communication, Nov. 10, 2005). In a third example, science methods courses at a smaller southeastern institution, may be taught by elementary generalists or specialists (M. VanSickle, personal communication, November 20, 2005).

Role of Science Teacher Educators

While we know very little about the qualifications of science teacher educators who teach preservice elementary teachers, within the enterprise there are specific roles identified for these educators. As Craven and Penick (2001) state:

To put it simply, the science teacher educator must be a catalyst for change. The changes required are conceptual and cultural. The changes must empower individuals to transcend the typically over-learned ways of thinking (or non-thinking) about the role of science education, to transform mental models of the roles and goals of students and teachers in the learning environment, and to translate new understandings about inquiry and meaningful learning into actual habits of practice.

The science teacher educator must also help his/her students to carefully consider what they will value in the learning community they seek to establish as teachers….

...must help the pre-professional and professional teacher understand how a teacher’s personal values affect the type of
community their students establish in the classroom….must understand that the process of challenging deeply held personal mental models…is extremely difficult….should establish a learning environment conducive to the safe expression and exploration of ideas and thoughts…..must help students understand the role of teacher as leader and professional change agent within the broader school community. (Introduction section, ¶ 1,3,4)

They go on to say that in order to facilitate this process, the science teacher educator needs to:

1) know how students learn; 2) use expertise to structure an environment that promotes meaningful learning; 3) purposefully design tasks that lead to conceptual understanding, promote professional attitudes, and foster reflective practice; and 4) use assessments that inform instruction yet cultivate meaningful strategies for learning by students. (Craven & Penick, 2001, Engaging Individuals section)

Highly Qualified Teacher Educators

In an effort to develop science teacher educators who can fulfill these roles the ASTE identified the following standards for highly qualified teacher educators: 1) have a strong knowledge of science content across several disciplines; 2) have a strong knowledge of science pedagogy represented by the possession of credentials required for practicing teachers; 3) possess a strong background in instructional design,
curriculum development, and assessment; 4) possess an extensive background in cognitive science and behaviorism and understanding of how they apply to student learning; 5) have in-depth knowledge of both qualitative and quantitative research approaches; and 6) possess the knowledge, skills, and abilities to guide science teachers through their developmental process (ASTE, 2004).

Resocialization from Practitioner to Researcher

The literature tells us that two of higher education’s primary goals are to extend knowledge and develop good researchers (Rieg & Helterbran, 2005; Stage, 2002). It follows then that doctoral programs are designed as research training experiences in which practitioners are resocialized into researchers which often creates a cultural clash between higher education faculty and their students (Boote & Beile, 2005; Labaree, 2003). This resocialization process was studied by Freyberg and Ponarin (1993). In their study of 19 teaching assistants, interview data suggested differences between candidates and precandidates rather than differences along gender lines or academic discipline. “Precandidates expressed profound stress, anxiety, and self-doubt during the interviews, whereas candidates were much more self-assured and confident” (p. 142). The precandidates expressed care for their students and felt alienated from their own professors. The candidates described teaching as tedious and students as ill prepared or unmotivated. They were also more aware of the time constraints placed on professors. Both groups felt the need to focus
on research rather than on teaching. As this research indicates, graduate students change their focus as they progress through their programs. The need to become researchers is echoed by the science teacher education community as Staver (2005) directs this commentary toward doctoral graduates:

Your new colleagues and administrators will push and pull you to get involved in a myriad of activities, some that will take you away from doing research. Amidst all of that pushing and pulling, I ask you to reflect on the fire that exists in your gut, that desire to learn by conducting research. (Let’s Change Before It’s Too Late section, ¶ 2)

Studies of Science Teacher Educators

After reviewing 30 journals, three databases, and dissertation abstracts, I found only two studies that focused on science teacher educators. The first study looked at the science teacher educator as methods instructor (D. C. Rice & Roychoudhury, 2003). The second study was a dissertation representing an autobiographical study of a Hispanic high school teacher’s transition to a college professor (Chacon, 2002).

D. C. Rice and Richoudhury’s (2003) study represented a qualitative research design focused on the self-reflection of a science methods’ teacher. The purpose of the study was to identify the science teacher educator’s behaviors and actions that supported the development of the preservice elementary teachers’ confidence in teaching science as indicated by the research
literature. The findings indicated that the use of a variety of teaching strategies, the creation of a low-risk learning environment, the development of mutual respect, opportunities for student input, and teacher enthusiasm increased preservice teacher confidence. Logistical problems such as time constraints, language interpretation associated with detailed assignments, and weaknesses in preservice teacher science content knowledge decreased student confidence.

The dissertation by Hugo Chacon (2002) is an autobiographical study using a qualitative method called *currere*. In this study the researcher focuses on educational and personal experiences that address language, science, social class, and cultural issues from the perspective of the researcher. The findings resulting from self-reflection, self-interview, and artifact collection revealed that self-reflection is an important component in the development of a science educator. The findings also revealed that self-reflection is an important component of the process necessary to develop a culturally responsive curriculum.

*Comparisons of Science Teacher Educators to Elementary Science Teachers*

Science teacher educators represent a college population generally comprised of persons who have undergraduate or graduate level science degrees and secondary or post-secondary teaching experience (Jablon, 2002). The school atmospheres to which they are accustomed represent personal and professional distancing. In this atmosphere, emotions are often considered intrusive (Hargreaves, 2000). They also have standardized test scores comparable to or higher than other college graduates (Gitomar & Latham, 2000).
Those who hold doctoral degrees have also been resocialized from practitioners to researchers who work within a system based on “publish or perish” philosophies and promote research over teaching (Freyberg & Ponarin, 1993; Labaree, 2003; Rieg & Helterbran, 2005).

This description is in opposition to elementary teacher graduates who generally have few science courses or positive science related learning experiences (Bryan, 2003; Luera et al., 2005). They represent a group whose science content knowledge and attitudes toward science are more like the general public rather than those with undergraduate or graduate degrees in science (Cobern & Loving, 2002). Their standardized test scores are usually lower than the average for college graduates (Gitomar & Latham, 2000). These practitioners are also entering school atmospheres characterized by physical and professional closeness (Hargreaves, 2000).

Beliefs, Values, and Attitudes

Definitions

Pajares (1992) provides the following list of synonyms for beliefs found in the literature: “attitudes, values, judgments, axioms, opinions, ideology, perceptions, conceptions, conceptual systems, preconceptions, dispositions, implicit theories, explicit theories, personal theories, internal mental processes, action strategies, rules of practice practical principles, perspectives, repertories of understanding, and social strategy” (p. 309).

Kobella (1989) cites attitudes, values, and beliefs as three terms that are often confused. He distinguishes them as follows:
The term attitude encompasses a wide range of affective behaviors…

Attitudes are learned either actively or vicariously, thus they can be taught….they are susceptible to change, but stable enough to be enduring….Attitude is also a correlate of behavior with personal, social, and cognitive variables thought to influence their level of consistency…. 

Values are rules that direct moral or ethical decisions that are considered with right or wrong. They are broader in scope than attitudes and unlike attitudes that range from positive to negative, values seem to be always positive in nature. Truth, beauty, goodness, liberty, equality, and justice are six values basic to Western Civilization cited by Mortimer Adler (1982)…. 

Beliefs are the cognitive basis for attitudes. They provide information for attitudes by linking objects and attributes. 

...Information provided by beliefs may be factual (e.g. copper is “malleable”) or nonfactual (e.g. the atomic bomb is the most important scientific breakthrough in the 20th century). Nonfactual or evaluative beliefs differ little from attitudes. A person has many more beliefs than attitudes and far fewer values than either attitudes or beliefs. (Kobella, 1989, Attitude and Related Concepts section, ¶ 1-4)
Bryan’s (2003) review of the literature led to the view that beliefs are psychological constructs that:

a) include understandings, assumptions, images, or propositions that are felt to be true; b) drive a person’s actions and support decisions and judgments; c) have highly variable and uncertain linkages to personal, episodic, and emotional experiences; and d) although undeniably related to knowledge, differ from knowledge in that beliefs do not require a condition of truth (p.837).

Nature of Beliefs

Pajares (1992) tells us that “theorists generally agree that beliefs are created through a process of enculturation and social construction” (p. 316). This process includes incidental learning and directed and purposeful learning. The former takes place through individual observation, participation, and imitation of all the cultural elements present in a person’s world. The latter is represented by either formal or informal education, whose main task is to align behaviors with cultural expectations.

Synthesis of Belief Literature

Pajares’ (1992) review of belief literature revealed the following assumptions that may impact studies of teacher’s beliefs. An individual’s belief system contains all the beliefs the person has acquired through enculturation. This belief system includes subgroups such as educational beliefs. These subgroups are related to a person’s attitudes and values. Many beliefs are formed early. The earlier a belief forms the more difficult it is to change. Adults
very rarely change their beliefs. Individual beliefs often persist even if the person is confronted with evidence that is contradictory to their belief. Individuals use their belief systems as perceptual screens through which they understand their world. Their beliefs and their knowledge act together as they interpret their experiences. Beliefs can reshape thinking and information processing. The strength of a belief results from its connection to other beliefs and how it fits into the cognitive and affective domains of the individual. Beliefs influence decision-making and thus influence behavior. For educational researchers it is important to note that beliefs about teaching are well established prior to college.

Relationship of Belief Literature to Science Teacher Educator Research

Olson and Einwohmer (2001) tell us that there has been very little research done on the identities of higher education faculty. This is substantiated by D. C. Rice and Richoudhury (2003) who report finding only one study on the attributes of good elementary methods instructors conducted by Barrow in 1985. This survey of elementary methods instructors in New England teacher education institutions provided demographic information but did not address instructor’s beliefs, attitudes or classroom actions. D. C. Rice and Richoudhury (2003) also acknowledge the importance of the science methods instructor’s impact on elementary teachers’ beliefs citing Shrigley (1976) and Martin (1985). Shrigley’s survey of 286 preservice elementary teachers indicated that they viewed the credible science methods instructor as a practitioner, possibly a former elementary teacher, who could draw on a wealth of real world experiences and a variety of teaching models. Martin’s findings cited by D. C. Rice and Richoudhury
(2003) found that the elementary teachers’ attitudes reflected the science teaching attitude level of the person they felt was most credible. This tells us that more research in the area of values and beliefs is important as we try to restructure teacher education to develop more effective elementary science teachers (Cochran-Smith, 2002).

It would also follow that the general belief literature and teacher belief literature would apply to science teacher educators. Generally the literature tells us that the earlier beliefs are formed the more difficult they are to change. Research indicates that the beliefs held by an adult are much more difficult to change (Pajares, 1992; Skamp & Meulier, 2001; Zembylas & Barker, 2002). For instance, it has been reported that given the opportunities to conform their beliefs, preservice teachers develop a deeper understanding of teaching and change their beliefs (Wideen, Mayer-Smith, & Moon, 1998; Zembylas & Barker, 2002). Teacher candidates’ beliefs have also been found to effect their views of teaching and learning including the process of their own education (McGinnis et al., 2002). The literature also supports the assumption that teachers’ world views, teaching and learning views, and their beliefs about knowledge and intelligence have direct impacts on the way they teach (Craven & Penick, 2001; Pajares, 1992). In other words, beliefs are good predictors of teachers’ classroom actions (Bryan, 2003; J. J. Haney et al., 2002). We also know that a teacher cannot separate what she teaches from who she is, because the educator is a teacher and a person at the same time (Berci, 2002).
Summary

In addition to the previous literature and arguments presented, Ginns and Watters (1999) also make this statement: “If a teacher’s preservice experiences are grounded in contemporary theory, if the learning experiences are relevant, and if the nexus between theory and practice is addressed, then one would expect the beginning teacher to be an effective practitioner” (The Effective Teacher of Science section, ¶ 1). To me this raises the question of why we are still not developing effective elementary science teachers (U.S. Department of Education, 2002b). We have made them the subjects of numerous research projects for decades (Bryan, 2003; Pajares, 1992; Utley et al., 2005). Perhaps it is time to turn the lens of inquiry upon ourselves, the science teacher educators, to try to determine what it is that we bring to this complex interaction between teacher and student.
Chapter III-Methodology

Introduction

The purpose of this research was to explore the values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common and how these commonalities influence their thinking about teaching preservice elementary teachers. I think this is an important area of research to explore because science teacher educators predominantly have secondary or post-secondary teaching experience and little understanding of the elementary teacher culture (Wright et al., 2004). Preservice elementary teachers are often characterized as lacking in science content knowledge and confidence in their ability to teach science (Howes, 2002; Luera et al., 2005; Watters & Ginns, 2000). While we have continued to study preservice elementary teachers, little has been done to turn the research lens upon ourselves.

I used the following guiding questions to explore this phenomenon:

- What factors do we (the sample population) have in common that contribute to the way we think about teaching preservice elementary teachers?
What values and beliefs do the sample population have in common that influence their thinking about teaching preservice elementary teachers?

What experiences do the sample population have in common that influence their thinking about teaching preservice elementary teachers?

This chapter contains the following sections: design, participants, data collection and analysis, and ensuring quality and credibility. The Design section includes the methodology framework for this study and a description of the life history and autobiography approach. The Participants’ section describes the researchers’ lens, the sample population, selection process, and sampling concerns. The Data Collection and Analysis section describes the three types of data sources including interviews, observation, and archival data. Details of data analysis are also included. The Ensuring Quality and Credibility section addresses validity and dependability. This section is followed by a timeline and a summary.

Design

*Qualitative Research Methodology*

I conducted this research using qualitative research methodologies. Qualitative research is defined by Denzin and Lincoln (2003b) as:

a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of
representations, including field notes, interviews, conversations, photographs, recordings and memos to the self….

Qualitative research involves the studied use and collection of a variety of empirical materials - case study; personal experience; introspection; life story; interview; artifacts; cultural texts and productions; observational, historical, interactional, and visual texts - that describe routine or problematic moments and meanings in individuals’ lives. (pp. 4-5)

A qualitative research methodology is appropriate for this study as Clough (2002) states:

…educational institutions and the individuals who are involved in and with them are a heterogeneous bunch with different attributes, abilities, aptitudes, aims, values, perspectives, needs, and so on. Furthermore these institutions and individuals are located within complex social contexts with all the implications and influences that this entails. On its own, research whose findings can be expressed in mathematical terms is unlikely to be sophisticated enough to sufficiently accommodate and account for the myriad differences that are involved…There is a need for rigorous research which does not ignore, but rather addresses, the complexity of the various aspects of schools and schooling; for research which explores and takes account of different objective experiences and subjective perspectives, and which acknowledges that qualitative
information is essential, both in its own right and also in order to make full
and proper use of quantitative indicators. (p. XI)

Some qualitative methodologies also presuppose the existence of a
subjective reality in which the researcher’s voice is heard. Clough and Nutbrown
(2002) argue

the inseparability of research and researcher is … an essential feature of
research in the social sciences; and the methodology which drives such
research is as much to do with personal values as it is to do with ‘rigour’
and ‘hygiene’ in research methodology. For in a sense, methodology is as
much about the way we live our lives as it is about the way we choose to
conduct a particular piece of research. Methodology is about making
research decisions and understanding (and justifying) why we have made
those decisions. Our research methodologies are (we would argue) rooted
in our own personal values which, in some form, inform our ethical and
moral responses to problems and challenges. (p. 68)

Denzin and Lincoln (2003b) echo this argument describing the researcher
as a “bricoleur who understands that research is an interactive process shaped
by his or her personal history, biography, gender, social class, race, and
ethnicity” (p. 9).

Since this study explored areas from a new perspective, I viewed it
through Shank’s (2002) lantern metaphor:

Lanterns are used to allow light to illuminate dark areas so that we
can see things that previously were obscure. Once we shed light on
things, we understand them better. Researchers are no longer trying to be clear and transparent; they are now willing to move forward to access whatever angles they need to take to get light into dark corners. (p. 10-11)

Life History

Life history, life story, biography, autobiography, ethnography, biographical method, oral history, autoethnography, personal narrative, memoir, and testament are a few terms often used interchangeably within the literature (Atkinson, Coffey, Delamont, Lofland, & Lofland, 2001; Chase 2005, V. Janesick, personal communication, October 18, 2005; Schwandt, 1997; Tierney, 2003, van den Hoonaard, 2002). Life histories also may be referred to as types of narrative inquiry, narrative, narrative materials, interview methods, narrative genres, phenomenological approaches, or sub types of one on one interviews to name a few (Chaitin, 2004; Chase, 2005; Kalekin-Fishman, 2002). In any event, these terms refer to a study of someone’s lived experiences and self interpretations of these events that are initiated by a researcher (Tierney, 2003; van den Hoonad, 2002).

As Narrative

Chase (2005) describes a narrative as follows:

A narrative may be oral or written and may be elicited or heard during fieldwork, an interview, or a naturally occurring conversation. In any of these situations, a narrative may be (a) a short topical story about a particular event and specific characters such as an
encounter with a friend, boss, or doctor; (b) an extended story
about a significant aspect of one’s life such as schooling, work,
marrige, divorce, childbirth, an illness, a trauma, or participation in
a war or social movement; or (c) a narrative of one’s entire life, from
birth to the present. (p. 652)

Life history is a more specific term that refers to an autobiographical or
biographical account of a person’s life that is prompted by another person. This
account could represent most of the person’s lived experience or could center on
a limited number of events. This account could be in oral or written form (Tierney,
2003). Some researchers will use life history and life story interchangeably while
others will distinguish between the two as follows: the life history is an
autobiographical birth to present account, and the life story is a narrative focused
on a significant aspect within a person’s life (Chase, 2005).

Methods for Life Stories

Life story data can be gathered through interviewing, observation, archival
data, writing, video recording, etc. (Merriam, 2002; Plummer, 2001). This usually
occurs by using a combination of data collection techniques. The interview is one
of the more popular tools for collecting life stories. Plummer (2001) tells us that
the life story interviews in a social science context fall on a continuum ranging
from positivistic to interpretive. Therefore the life story method representing an
interpretive approach “tends to favour conducting open and in-depth interviews in
a highly active and interactive fashion using only the most general guides in
order to help the subject construct a sense of their cultural world”(p. 140).
During this process the subject’s deepest memories, thoughts, and perceptions (unknown even to them) are revealed.

Accounts are built up through successive discussions over a period of time as the life history or ethnography is “reconstructed”. A first discussion reveals some parameters and sparks of ideas that are pursued in more detail in the next, and so on, until no new material emerges. Previous conversations are reviewed for accuracy and completeness. Subject and researcher work between meetings reflecting on material, refining points, discovering new slants, spotting apparent inconsistencies and contradictions, and attempting some preliminary analysis. Again the researcher does not stand above or outside this activity but, rather, shares in it….where both parties project part of their selves into the interaction and both construct meanings from it. (Woods, 1992, p. 374)

Plummer (2001) also reminds us of the importance of the flexibility of the interview design as he refers to Studs Terkel’s comments about life story interviewing: “You do it your own way, You experiment. You try this, you try that. With one person one way’s best, with another person, another. Stay loose, stay flexible…” (p. 140).

*Contexts for Life History Studies*

Life histories give us opportunities to “monitor the developing self within the context of local factors such as home life, parents, school and teachers, and
significant others as well as wider concerns, which the passage of time has brought into focus, such as social class, religion, and social, political, and economic climate” (Woods, 1992, p. 372). Within the field of education, it has been used to study attitudes and beliefs about teaching and learning (Hargreaves, 2000; Marston, Brunetti, & Courtney, 2005).

*Ethnography*

Ethnography has its roots in anthropology, but this method has recently been extended to areas including “cultural studies, literary theory, folklore, women’s studies, sociology, cultural geography, and social psychology (Eisner, 1991). It has also proved useful in a number of applied areas, including education, counseling, organization studies, planning, clinical psychology, nursing, psychiatry, law, criminology, management, and industrial engineering” (Tedlock, 2003, p.166). Ethnography literally means people (ethno-) describing (-graphy) (Lindlof & Taylor, 2002). The purpose of an ethnography is to describe and interpret a culture, social group or other identifiable system (McMillan & Schumacher, 2001).

The meaning of culture is also open to interpretation. The term was first used to describe the “tending of crops or animals” (Williams, 1985). Later it was used in the disciplines of anthropology and sociology to describe humans in general and evolved into a term used to describe groups (Jenks, 1993). Most researchers would agree that culture refers to the shared beliefs, values, and attitudes of a specific group that structure the behavior of the members of that group (Merriam, 2002).
As ethnographic methods are extended to areas outside of anthropology, such as feminist studies, education, literary studies, etc. some would say that these other disciplines have contributed to undermining the older idea of culture (Eisenhart, 2001). They have embraced ethnography and used it to fit their purposes. An example would be a form of ethnography found in education called the micro-ethnography. This type of study focuses on one aspect of a cultural component (Wolcott, 1995).

The method commonly associated with ethnography is participant observation although other standard methods such as interviewing and review of archival data may be used (Lindlof & Taylor, 2002). It is “only by watching carefully what people do and say, following their example, and slowly becoming a part of their groups, activities, conversations, and connections do we stand some chance of grasping what is meaningful to them” (Eisenhart, 2001, p. 23). The resulting texts “re-create for the reader the shared beliefs, practices, artifacts, folk knowledge, and behaviors of some group of people” (LeCompte & Schensul, 1999b, p. 2). A key assumption associated with this method is that the researcher will have a relatively close and prolonged interaction with people in their everyday lives (Tedlock, 2003).

Autoethnography

Autoethnography is a term first used in the late seventies by David Hayano in referencing cultural studies by anthropologists in which researchers acted as full cultural members (Denzin & Lincoln, 2003a; Plummer, 2001). Today it is considered a blurred genre borrowing from many disciplines and narrative
forms (Denzin & Lincoln, 2005). The result is considered by some to be a new type of life story that is still evolving. With this new form, comes a reinvention of the definition of autoethnography to capture the breakdown in distance (and the complex relationship) between ethnographer, biographer, and subjects—bringing the accounts together. So now the term ‘auto/ethnography’ has come to have a double sense: ‘referring either to the ethnography of one’s own group or to autobiographical writing that has an ethnographic interest. (Plummer, 2001, p. 34-35)

Autoethnographies vary in the emphasis on the following elements: research (graphy), culture (ethnos), and self (auto). The resulting narratives usually take the form of evocative, personalized texts in which the authors tell their stories connecting the personal to the cultural (Denzin & Lincoln, 2003a). It is in this way that we are reminded that autoethnographic studies are not limited to the self, because people do not have life experiences isolated from social interaction (Holt, 2003).

Self Study/Autobiography

There is a growing interest in self study research in teacher education that Bullough and Pinnegar (2001) tell us resulted from the convergence of four developments: 1) the introduction of narrative inquiry and the redefining of validity as accuracy or trustworthiness, 2) the influence of the Reconceptualist movement in curriculum studies in which a study of self also uncovered an understanding of education, 3) the increasing influence of international
educational researchers who follow sociological traditions, and 4) action research in which researcher/practitioner distinctions dissolve.

Bullough and Pinnegar (2001) would tell us that self-study becomes research:

When biography and history are joined, when the issue confronted by the self is shown to have relationship to and bearing on the context and ethos of time, then self-study moves to research. It is the balance between the way in which private experience can provide insight and solution for public issues and troubles and the way in which public theory can provide insight and solution for private trial that forms the nexus of self-study and simultaneously presents the central challenge to those who would work in this emerging area. (p. 15)

As autobiographical studies become more popular in educational research, Bullough and Pinnegar (2001) have developed some guidelines for quality self studies to help guard against limitations or concerns that may be raised in these studies such as self-servitude, lack of significance, or the use of blended methods. Quality autobiographical research should help readers see themselves and their connections to others, promote insights and interpretation by using engaging forms of narrative to express important themes, represent researcher honesty in an examination of biases, include authentic voice, focus on issues of consequence, attend to lived experience, and provide new perspectives to consider.
As interpretive models, the above forms assume that individuals are not passive vehicles and therefore interpretive theorists make these assumptions:

(i) the belief that any event or action is explainable in terms of multiple interacting factors, events, and processes. Causes and effects are mutually interdependent;

(ii) an acceptance of the extreme difficulty in attaining complete objectivity, especially in observing human subjects who confuse or make sense of events based in their individual systems of meaning;

(iii) the view that the aim of inquiry is to develop an understanding of individual cases, rather than universal laws or (predictive) generalizations;

(iv) the view that the world is made up of tangible and intangible multifaceted realities. These are best studied as a whole rather than being fragmented into dependent and independent variables. This recognizes the significance of the context in which experience occurs;

(v) the recognition that inquiry is always value laden and that such values inevitably influence the framing, focusing and conduct of research.

(Garrick, 1999, p. 149)

Phenomenology is considered a paradigm, perspective, or philosophy that shapes one’s qualitative inquiry approach (Patton, 1990). It enables the researcher to closely examine everyday human experience (deMarrias & Lapan, 2004). Patton (1990) describes phenomenologists as those who:
focus on how we put together the phenomena we experience in such a way as to make sense of the world and, in so doing, develop a worldview. There is no separate (or objective) reality for people. There is only what they know their experience is and means. The subjective experience incorporates the objective thing and a person’s reality. (p.69)

In this sense, this study took a phenomenological approach.

Participants

Researcher’s Lens

In this study, I played dual roles as researcher and participant. As a researcher, I brought my own experiences and subjectivity to this study and became part of the researched material (Alversson & Skoldberg, 2000; Flick, 2002; Putnam & Borko, 2000). I viewed these as strengths rather than contaminants that should be eliminated (Watson, 2005). Following qualitative methodologies, I became the main instrument of data collection and analysis, therefore it is important to know the “lenses” through which I approached this study (Merriam, 2002).

My first lens is that of a rural Midwesterner. I grew up in a farming community of 1100 people, all Caucasian and predominantly protestant, although I was Catholic. I had a large extended family and always felt like part of the community. It was here that I learned about God, country, nature, and the importance of an education. Sundays were set aside for church and fun. Fishing or picnics at the river were the order of the day. Life was very routine. Adults went to work and children went to school. Evening activities centered around
family, church, or school. Entertainment was cheap or free: a trip to the movies, the local drive-in or the town park. Shopping for school clothes or Christmas presents were major events requiring a forty-five minute car ride. Celebrations were whole town affairs, usually patriotic events such as Memorial Day parades or Fourth of July picnics.

I also used the lens of a female who has lived the majority of her adult life in the Deep South as a student, wife, mother, teacher, and person employed in various scientific enterprises. When I think about these years I have two differing feelings. I think about the great comfort, romance, and feeling of family that enveloped me. On the other hand it was during this time that I was introduced to prejudice in all forms. As a college coed, I was not accepted, because I was from the north. It was the first time in my life that I had to deal with racial issues. It was during this time that I developed a strong sense of injustice. I believed that people should be seen as individuals and judged on their own merit. I taught my children to believe the same without regard for race, gender, or religion. Most of all I always tried to be fair. Experiences during this time also raised my environmental consciousness and political awareness as I saw how government decisions impacted the environment.

I also brought the lens of my educational experiences as an elementary teacher, curriculum developer, informal marine science educator, teambuilding facilitator, and college instructor to this research study. I have more than twenty years of teaching experience in formal and informal education enterprises having taught children, adolescents, and adults. I have always believed that people learn
best when they are actively engaged in the learning process. I also believe that
we as teachers are facilitators that guide the learning process and must be aware
of the role that the affective domain plays in the learning process. It is our
responsibility to design learning communities in which students feel safe. It is
here that they can practice and take risks while engaged in extended inquiry. I
believe that this constructivist approach to teaching mimics how we learn outside
the classroom and should be the goal of education. I also think that it is our
responsibility to guide students to become enthusiastic autonomous learners
confident in their abilities. My classes reflect these beliefs by providing
opportunities for varied experiences for the students including small and large
group work, projects, outdoor experiences, etc. that value the individual.

The life experiences and educational growth as I pursued an
undergraduate degree in biology, a master’s degree in marine physiology, a
certification in secondary and elementary education, a master’s degree in
education, and a Ph.D. in science education brought another lens to this study. I
have always been a person that realized that there was always so much more to
learn, but these experiences have added to my content knowledge in both
science and education and my understanding of the system and process
associated with earning a degree. These experiences have given me more
confidence to share my thoughts and enthusiasm with a broader audience. They
have also made me aware of the various roles that we assume as we progress
through the educational system and how we need to balance the tension
between the roles in the various aspects of our lives. I am balancing the roles of professional and student in this process.

Since 2001, when I began to pursue my Ph.D. in science education, I have completed numerous papers and presentations focused on preservice elementary teacher education and marine science education. I have also co-taught the science methods course for elementary teachers, the middle school science methods course, the science methods course that is part of the MAT program, and the Scientist in the Classroom course designed to familiarize graduate students in marine science with the science education enterprise. I used these experiences to engage in qualitative research and to increase my understanding of the populations that are important to this study. I have also completed an in-depth qualitative research study focused on the communication issues between scientists and science educators. This was a bounded case study in which I audio taped members. The data were transcribed and analyzed. From the data four categories emerged. The categories of concern were presented as vignettes in the final paper. A prerequisite for completing this study was to become a certified researcher following the directives of the university’s internal review board. I fulfilled this requirement and my certification remains current. This last experience speaks to my ability to complete a qualitative study following university policy.

Selection of Participants

I chose the three members of the science teacher education community who are at various stages in their careers based on the following considerations.
First, I used a purposeful selection process employing a “unique” case selection strategy (LeCompte & Schensul, 1999a; Lecompte, Priessle, & Tesch, 1993; Merriam, 1998; Patton, 1990; Yin, 1989). The members of this sample are unique in the science education community in that they have undergraduate degrees in a natural science and have taught as certified elementary teachers. Purposeful selection provides small information rich samples (Lindlof & Taylor, 2002; McMillan & Schumacher, 2001; Schwandt, 1997). This process matched with the purpose of the study to explore in depth a few unique cases. Lindlof and Taylor (2002) also tell us, “Ironically, the study of atypical instances tells us quite a lot about the norms that usually hold “reality” steady in society, organizations, groups, or popular imagination” (p. 128).

Secondly, I chose participants who attended the same university for their doctoral degrees, knew each other, and shared a mentor professor. There were several reasons that I included these secondary criteria. I believe that the programs from which educators graduate will impact their development as science teacher educators, therefore choosing three participants from the same university situates their learning in similar circumstances. Since we knew each other, this offered me opportunity for entrée into the field and the ability to collect more in-depth data in a shorter period of time. We also shared a mentor professor, this provided an opportunity for validation of the data collected and the addition of another perspective of the data.
Descriptions of Participants

Participant One: Twila has spent most of her career at a private institution in a southeastern coastal area. She is a full professor who teaches classes for elementary and secondary education majors. She is often found in leadership positions and works diligently with the local schools to help the children who are the least likely to succeed. She is single and lives in a condo that overlooks the local estuary. Her professional and personal interests center around the ethics of caring. Her work with children in all circumstances and her genuine concern for humankind speak to her character. I have known her approximately five years, and I would consider us to be building a friendship.

Participant Two: Sarah is in the third year of her career as a science teacher educator at a Midwestern public university. She teaches science methods for preservice elementary teachers, biology for teachers, and technology classes at her university as well as participating in numerous committees. She is divorced and lives in a restored one hundred year old house. She likes to antique at the local junk shops and buying the latest high tech gizmos for her computer. She always has a joke to tell and is good-natured. I have known her for approximately five years, and I would consider us to be good friends.

Participant Three: I am the third participant. I am a doctoral candidate who has taught methods courses for elementary and middle school preservice teachers and provided inservice experiences for Kindergarten-12 science teachers. My current role is that of Ph.D. candidate. I am married and live with
my husband and my dog. I have two sons who are young adults who are still “finding their way”. My previous description speaks to who I am.

**Sample Size**

Some would consider the limited number of participants as a problem. I would point to Patton (1990) who says:

> There are no rules for sample size in qualitative inquiry. Sample size depends on what you want to know, the purpose of the inquiry, what's at stake, what will be useful, what will have credibility, and what can be done with available time and resources….In-depth information from a small number of people can be very valuable, especially if the cases are information-rich. (p. 184)

I would also say that Flick (2002) tells us that studies employing purposeful sampling often concentrate on “single examples or certain sectors of the field” (p. 70) which in this case was appropriate. This is further substantiated by a dissertation submitted by Susan Finley (1998) that studied three teacher educators as researchers.

Some would also view my participation in the study as a problem, I prefer to follow the view of Watson (2005) and say that my life experiences and subjectivities add strength to the study. I would also cite Bullough and Pinnegar (2001) who remind us that self-study speaks to the transformation in education research in the past quarter century and that now autobiographical and other forms of narrative writing are much more commonplace. This is substantiated by Chacon’s (2002) dissertation in which he studied his development as a bilingual
high school science teacher and university professor using a semi-structured interview technique.

*Institutional Review Board (IRB)*

My annual certification was updated and accepted by the IRB at the University of South Florida. I submitted my application along with all additional paperwork that was requested including an informed consent form to the IRB. I received approval from the IRB. I also received a stamped approved informed consent form (See Appendix A). I sent the official consent forms to the participants for signatures. I explained the terms of confidentiality through a phone call. I advised that their names would be coded to respect their anonymity. They were also reminded their identity may be unearthed, since they are members of a small subculture. I only interviewed, observed, audio taped, and video taped participants who gave their permission. Participants were also reminded that their participation in the study was completely voluntary and they could withdraw at any time.

I made copies of informed consent forms and gave them to each participant. Originals are kept in the home office of the principal investigator in a locked file along with other documents and tapes. Electronic files reside on the principal investigator’s home computer that is password protected. Any electronic files that were saved on portable devices are stored in locked files in the principal investigator’s home office.
Data Collection and Analysis

I used a wide range of data-gathering techniques for qualitative research as described by Wolcott (1992) in order to add “rigor, breadth, complexity, richness, and depth” (Flick, 1998, p. 231). They included: interviewing, observing, and examining. Interviews were primarily semi-structured incorporating probes focused on the presence of science and education in the lives of the participants. The face-to-face interviews were also audio and video taped. Observation took place in the field through my senses. Archival records in the form of materials prepared by others were examined as the data directed. Data collection and analysis, iterative processes, occurred simultaneously.

Interviews

Qualitative interviews have been described as purposeful conversation or active interactions between two or more people that result in co-constructed contextually based results (deMarrias & Lapan, 2004; Denzin & Lincoln, 2003a; Lindlof & Taylor, 2002; Merriam, 1988). Merriam (1988) tells us that it is appropriate to use interviewing as a data collection method when “we cannot observe behavior, feelings, or how people interpret the world around them. It is also necessary to interview when we are interested in past events that are impossible to replicate...”(p. 74). Further interviews have been described as structured, semi-structured, or unstructured. Structured interviews usually contain carefully worded questions administered to participants verbatim in a predetermined order. These interviews are often used with survey instruments or when data is required from numerous researchers (Fontana & Frey, 2005). The
semi-structured or guided interview is used to elicit certain information from all the respondents. Merriam (1988) tells us that “these interviews are guided by a list of questions or issues to be explored, but neither the exact wording nor the order of the questions is determined ahead of time. This format allows the researcher to respond to the situation at hand, to the emerging worldview of the respondent, and to new ideas on the topic.” (p. 74). Unstructured interviews, also referred to as ethnographic interviews or informal conversational interviews are used when a researcher needs to gather information about a situation in order to formulate questions (Lindlof & Taylor, 2002; Patton, 1990). Merriam (1988) reminds us that

It takes a skilled researcher to handle the great flexibility demanded by the unstructured interview. …Totally unstructured interviewing is rarely used as the sole means of collecting data in qualitative research. In most studies the researcher can combine all three types of interviewing so that some standardized information is obtained, some of the same open-ended questions are asked of all participants, and some time is spent in an unstructured mode so that fresh insights and new information can emerge. (p. 74)

For this study, I chose to follow the recommendation of Merriam and use all three interview types. I used the structured interview to obtain demographic information from the participants. Secondly, I used the semi-structured interview employing probes that elicited conversational style responses from the participants. These probes focused on the presence and importance of science
and education in their life histories and experiences. The initial questions or probes were followed by additional questions and probes based on what the participant had already described. The interview was flexible regarding the ordering of probes or questions to provide opportunity to elicit the richest responses and most detailed stories. I used the semi-structured interview for the majority of the data collection, since it best matched the purpose of my study and my level of expertise as a researcher. Using the semi-structured interview protocol allowed me to elicit responses from the participants that focused on the areas of our life histories that we have in common. This is directly related to the purpose of the study. It also allowed for flexibility in probing more deeply as the participant responses directed. These interviews conducted over a four to five day period were audio and video taped with permission of the participants. I also used follow up phone interviews to gather additional data and clarify points raised in the face-to-face interviews. I also used the unstructured interview or ethnographic interview while I was in the field. Opportunities to ask research questions occurred during informal conversations, lulls in the conversation, moments when some observation peaked my interest, during activities that reminded me of events related to the study, etc. (Lindlof & Taylor, 2002). These conversations were noted and recorded.

To gain an additional perspective, I also made use of the informant interview. This type of interview uses the knowledge of another social actor who is part of the culture, but is not part of the study group. This person may add additional perspective to the study through knowledge of areas pertaining to the
research study (Lindlof & Taylor, 2002). In this study the informant interview was conducted with the mentor professor to elucidate earlier findings from the participant interviews and provided direction for further investigation. This interview was audio taped with permission of the informant.

Since I (the researcher) was a participant in this study, prior to interviewing the other participants, I wrote a life story keeping in mind where science and education were prevalent in my life (See Appendix B). I chose to define a life story as “a narrative about a specific significant aspect of a person’s life” (Chase, 2005, p. 652). After writing the story, I put it aside and revisited it several times to add new information or details. An outside reviewer and I examined the life story separately and pulled out initial areas of interest. I used these areas to construct the interview probes (See Appendix C). In using this procedure, my design is similar to the one used by Hugo Chacon (1998). In his dissertation, he first prepared an autobiographical account based on his educational experiences and he was guided by his research questions. In his self-administered interviews, he developed questions and set them aside for a few days to allow for reflection before he answered them. I also completed a self-interview using the probes derived from my life story. I chose the person to interview me based on two criteria. First, I wanted someone whose relationship with me also represented my relationship with the participants. Therefore, I chose a friend that I had known for about three years. Second, I also wanted someone who had interviewing expertise similar to mine. My friend also met this criterion.
Observational and Archival Data

A second source of data included observations made in the field. These took place during four to five day visits and built upon earlier observations made from our five-year relationships. I conducted observations of participants within their environments during naturally occurring events such as conversations, dinner, sightseeing, etc. These events were noted and recorded. A third source of data included, archival data records. They included personal items such as family photos and work related items such as student evaluation forms. Additional sources of data included anecdotal data from previous conversations with participants.

Data Analysis

Data collection and analysis are sometimes considered two sides of the same coin (Wolcott, 1992). Analyzing is often considered both a scientific and artistic endeavor that involves trying to understand and interpret the data (Schwandt, 2001). This process requires the researcher to move back and forth between the data and ideas. In this process the data is systematically broken apart and reconstructed in new ways.

During the interviews, I made notes as a reminder of actions, statements, impressions, etc. of interest (Sanjek, 1990). I then transcribed tapes and inserted my initial notes. As I read and revisited the data I used “in-process” writing. This writing took the form of asides, commentaries, or in-process memos as described by Emerson et al. (1995): “Asides are brief, reflective bits of analytic writing that succinctly clarify, explain, interpret, or raise questions…. A commentary is a
more elaborate reflection on some specific event or issue…[In-process memos are] products of more sustained analytic writing” (p. 101). These in process writings basically differ in length and content depth. They progress from short “asides” to longer memos that represent reflective thinking and pattern identification. They show a natural progression from the quick aside to the longer memo that is much more of a reflective piece that seeks to find patterns within the data. These in process writings create “thick descriptions”, as described by Geertz (1973). Thick description does not refer to the text’s length but rather to the detail used to make an analysis. For instance, Gilbert Ryles explains through an example in which two boys are rapidly twitching their right eyelids. Just from observation, we don’t know whether they are winking or involuntarily twitching. “Ryles calls the ‘thin description’ of what the rehearser (parodist, winker, twitcher…) is doing (rapidly contracting his right eyelids) and the ‘thick description’ of what he is doing (practicing a burlesque of a friend faking a wink to deceive an innocent into thinking a consistency is in motion…” . (Geertz, 1973, p. 7)

Since data analysis is a recursive process, it occurred simultaneously with data collection. Topic areas were constructed from the interview probes. As the data were revisited initial categories were identified and coded in accordance with Spiggle’s (1994) definition of a category as “a chunk or unit of data … belonging to, representing, or being an example of some more general phenomenon” (p. 493). A unit of data for this study ranged in length from a single word to an entire story. Throughout this process, the text was revisited as often
as necessary to elucidate categories. Categories emerged from the data and were not imposed prior to data collection (Janesick, 2003). In this method each unit of data was compared to one or more categories and compared to other units of data to see how they fit together. As these comparisons took place, new categories and relationships between categories emerged (Merriam, 1998). These categories and patterns continued to be refined. I also found a middle ground from which to develop a balanced perspective as Roncaglia (2003) reminds us “creativity not chaos, imagination and yet organization” (Knowledge Making through Interviews section, ¶ 2).

It is important to note, that data analysis took place via manual means as opposed to computer assisted software. My coding philosophy and its implications for the use of computer software fits with that of Shank and Villella (2004) as they describe the two basic coding categories in qualitative research:

Researchers either already understand a piece of data in terms of preconceptions or preexisting ways of looking at an area, or else they are surprised because they cannot fit the piece of data into existing assumptions or explanatory systems. The second, surprising pieces of data are the most valuable, but they are often the most rare and, therefore, the hardest to find. That is one reason that we are wary of most computer-based coding programs; the emphasis on the use of frequency of occurrence actually helps bury most of the important examples of rare data that are described. (The Coding Assumptions section, ¶ 3)
Also, as the researcher I was intimately involved with, and was part of the data. As such, I wanted to minimize the following dangers that may arise when using computer-assisted programs as identified by John Seidel the developer of ETHNOGRAPH (one of these software programs):

1) an infatuation with the volume of data one can deal with, leading to sacrificing resolution for scope; 2) a reification of the relationship between the researcher and data wherein the researcher assumes that data are “things out there” that can in a relatively simple and straightforward manner be discovered, identified, collected, counted, and sorted, thereby ignoring the fact that data are artifacts of complex processes of identifying, naming, indexing, and coding that, in turn, are shaped by theoretical and methodological assumptions; 3) a distancing of the researcher from the data (as cited in Schwandt, 2001, p. 28).

Ensuring Quality and Credibility

In this section I discuss trustworthiness and describe how I addressed the issues of credibility and dependability. I also include the limitations of the study, a timeline, and a summary.

Trustworthiness

Trustworthiness is a way of judging the quality or rigor of a qualitative inquiry (Morse, Barrett, Mayan, Olson, & Spiers, 2002; Schwandt, 1997). Two important aspects of trustworthiness are credibility and dependability (Lincoln & Guba, 1985). Some would say these constructs are parallel to internal validity
and reliability respectively (Schwandt, 1997). Credibility (validity) is concerned with accuracy: descriptive and interpretive. Dependability is concerned with whether or not the findings make sense based on the data as opposed to whether or not the findings are replicable (Lincoln & Guba, 1985).

Credibility (Validity)

In this study, one area of concern may be with descriptive validity, that is the “factual accuracy of the account as reported by the researcher” (Johnson, 1997, Descriptive Validity section, ¶ 1). To address this concern, I used audio and videotapes to record the interview sessions with the participants. I also transcribed tapes verbatim or used voice recognition software for tape transcription purposes, therefore I had an accurate textual account as well as visual documentation to review for body language, etc.

Another area of concern involves the interpretive validity of the study. Johnson (1997) says that interpretive validity:

refers to accurately portraying the meaning attached by participants to what is being studied by the researcher. More specifically, it refers to the degree to which the research participants’ viewpoints, thoughts, feelings, intentions, and experiences are accurately understood by the qualitative researcher and portrayed in the research report…. Accurate interpretive validity requires that the researcher get inside the heads of the participants, look through the participants’ eyes, and see and feel what they see and feel. In this way, the qualitative researcher can understand things from the
participants’ perspectives and provide a valid account of these perspectives. (Interpretive Validity section, ¶ 1)

To address this concern, I used participant feedback also called member checking (Lincoln & Guba, 1985; Merriam, 2002). During the data analysis process participants were asked to scrutinize the data (Patton, 1990). Throughout the process the participants were given opportunities to review the categories as they emerged and my interpretations. I also used an outside reviewer who is familiar with qualitative research design to review my analysis (Janesick, 2003).

**Dependability**

Dependability can be reconciled by the reader’s ability to follow the researcher’s plan or steps through the process. An audit trail provides information that the reader can follow. An audit trail may include documents such as the researcher’s journal, original interview transcripts, field notes, etc. (Kane, Sandretto, & Heath, 2002; Schwandt, 1997). This information coupled with detailed descriptions of data collection and analysis help make the process visible to the reader. In order for the reader to understand my thinking, I included a detailed account of my reasoning and supporting quotes within the data analysis chapter.

Dependability or consistency can be strengthened through the triangulation of data sources (Schwandt, 1997). Several types of data including interview data, observation, and informant data were used for this purpose.
Limitations

The study has several limitations. One constraint of this study is time restrictions due to the schedules of individuals who work fulltime in an academic setting. Data collection took place within a one-semester period because the face-to-face interviews spanned a four-to-five-day period taking place in the participants’ homes. I conducted phone interviews over several weeks following the face-to-face interviews. The on-site visits did not include classroom observations to complement the interviews, since observations of participants’ teaching behaviors do not fall within the purpose of this study.

The sample size represented a second limitation although it is appropriate for a qualitative study. I chose to follow the thinking of Patton (1990) in that the sample size should match with the purpose of the study and that a small sample of information rich sources would result in valuable data. As in other qualitative research, the results do not allow for generalizations. In this case I did not make generalizations to other science teacher educators with elementary teaching experience, because I studied a unique subset of individuals within a particular context and time frame. However, the findings do add to the research base. Other science teacher educators with elementary teaching experience may “see themselves” in this research and use it as a base for other self studies.

Tensions also arose within the study due to the qualitative nature of the study and the dual role I played as both researcher and participant. As such, the perspectives I brought to the study and the lenses through which I filtered the data represented values that I used to structure and focus the research question
(Garrick, 1999). My lenses included my social class, race, gender, and ethnicity and impacted the way that I portrayed the data (Denzin & Lincoln, 2005; Siegel, 2006). In particular, my distinctly feminist approach followed the thinking of Powell (1996) as found in the following:

Feminists regard distance between researcher and respondent to be a barrier to, rather than an aid to the process of ‘finding out’. Discovery is best facilitated when a non-hierarchical relationship exists and where the interviewer is prepared to invest her or his personal identity into the relationship. In this sense feminist research ideally at least should be hailed as genuinely collaborative. (p. 6)

It therefore became difficult to determine if I had accurately portrayed the participants stories (including my own), because as Denzin and Lincoln (2005) tell us “even individuals, are seldom able to give full explanations of their actions or intentions; all they offer are accounts, or stories, about what they have done and why” (p. 21). This limitation is specifically concerned with the “degree to which the research participants’ viewpoints, thoughts, feelings, intentions, and experiences are accurately understood…and portrayed in the research report” (Johnson, 1997, Interpretive Validity section, ¶ 1).

To address this limitation I consciously portrayed my participants to the best of my ability by engaging in reflective practice throughout the process and by using a variety of data sources. I also asked the participant’s for their input during data analysis using the technique known as member checking. In addition,
I received input from the informant interviewer and outside reviewer as I collected, interpreted, and analyzed data.

There were also limitations associated with self-reported data. The stories told by the participants and elicited from my prompts during the semi-structured interviews were their memories recalled from past experiences. Memories change and fade with time therefore, there is a possibility that the stories the participants shared and their remembrances were not exact (Plummer, 2001). Shavelson, Webb, and Burnstein (1985) also remind us that the type of stimuli used to obtain verbal data influences the form and content of the participants’ retrospective accounts. In order to address these limitations, I revisited areas of interest with the participants and asked for additional information or clarification.

There is also a hermeneutical limitation to this study because various readers can interpret narratives differently. “Hermeneutics is an approach to the analysis of texts that stresses how prior understandings and prejudices shape the interpretive process” (Denzin & Lincoln, 2005, p. 27). “The process of understanding can be thought of as a coming together of the text and the interpreter “ (Sherratt, 2006, p. 91). As a result someone else could take the same data and come to different conclusions. To address this limitation I guide the reader through the process by providing a detailed description of data collection, interpretation, and analysis.

Timeline

Following my proposal defense, I conducted interviews with the participants and began the data analysis process. I completed these interviews by the end of the
Spring 2006 semester and continued to collect and analyze data as necessary through the Summer 2006 semester. I finished the majority of the work for this dissertation during the summer semester and completed graduation requirements for December 2006.

Summary

I have spent considerable time reviewing qualitative methodologies to ensure that the method and approach chosen is one that is appropriate for the purpose of the study. I also decided to use the following qualitative strategies throughout the data collection and analysis process: member checking, source triangulation, the use of an outside reviewer, and a researcher audit trail. These processes address questions concerning credibility, dependability, trustworthiness, and researcher bias.
Chapter IV-Data Analysis and Findings

Introduction

The purpose of this study was to explore the values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common and how these commonalities influence their thinking about teaching preservice elementary teachers. In this chapter I have presented my findings in two forms: a bulleted list, and a narrative. The bulleted list and description provide a quick overview of the findings and my data analysis process. The narrative offers an in-depth view of the findings followed by a discussion of my thought processes as I analyzed the data.

Findings

My findings outlined below represent the three categories of commonalities identified in the research question: experiences, beliefs, and values. In this section I have attempted to give a brief overview of my thought processes as I analyzed the data followed by the findings in the form of bulleted lists. This section is intended to give the reader a reference point from which to make sense of the narrative that follows. The narrative presents the findings in a more complete form.

Experiences

I derived the common experiences resulting from the data both directly and indirectly. Experiences derived directly represent factual statements made by
the participants such as, “I had a brother” or “I taught fifth grade”. Other directly derived experiences could be surmised from the data. For instance, all the participants told stories about taking part in summer camps for children. As a result of this and other data, I concluded that we all worked in informal education. I synthesized indirectly derived common experiences from the data. For example, while none of the participants stated that they had strong female role models in their lives, stories they told about female relatives working outside the home, a mother manipulating circumstances to reach a desired goal, or a mother involved in the political process along with other stories led me to this label. Therefore, I have listed the directly derived experiences in chronological order followed by the three synthesized experiences that I extracted from the data analysis.

**Directly derived experiences**

- Small town backgrounds
- Parents in their 30s when we were born
- Parents all had siblings
- Grew up in households with a mother, father, and children
- Two sibling families-male siblings
- Similar relationships with our brothers-none of us expressed a particular closeness to our brothers
- When growing up had one or two good friends as opposed to a lot of friends
- Attended kindergarten
- Avid readers as children
- Recreation as children including considerable playing outdoors
• Attended and graduated from public high school
• Involved in extracurricular activities
• Graduated from small high schools—senior classes were less than 150 students
• High school math and science teachers were all male
• Matriculated in the same high school science courses—biology, chemistry, physics
• Undergraduate majors were in biology and minors were in chemistry
• Career in a science related field
• Received financial assistance for graduate level college courses
• Graduated from alternative certification programs
• Earned M.Ed. degrees
• Came into education as a second career
• Initially preferred to teach elementary students
• Taught fifth grade
• Worked in informal education
• Did volunteer work
  
  *Indirectly derived experiences*

• Learned science as a normal part of life
• Had Strong female role models
• Took advantage of opportunities when they presented themselves
Participant Beliefs

The beliefs revealed in this study represent two categories: general beliefs and beliefs associated with teaching and learning. The general beliefs listed below were synthesized from the data. For example, the belief concerning a balanced lifestyle results from recollections by the participants that included thoughts such as doing chores at home and spending time playing outside, or remarks that spoke about the importance of family and friends as well as work. The beliefs about teaching and learning resulted from probes that directly addressed these topics but also came from stories recounted as remembrances resulting from a general life probe. For example, all of the probes focusing on teaching and learning were reviewed for key words and phrases such as caring or experiential learning. Once all of the phrases had been identified they were compared across the three participants to find similarities. All of the similar phrases were then grouped into categories and refined into the four beliefs associated with teaching and learning and the two beliefs addressing teacher education.

General beliefs

• Girls can do school math and science
• One should lead a balanced life
• We were all good elementary teachers

Beliefs about teaching and learning

• People learn by experiencing
• Good teachers act as facilitators who use their creativity to develop a community of learners in which critical thinking is supported
• Attention to the affective domain is critical in teaching and learning
• Constructivist approach to teaching

*Beliefs about teaching and learning concerning preservice teacher programs*

• Instructors teaching methods for preservice teachers should know something about science and how science works
• Preservice teachers need opportunities to engage in field experiences

Values

The data from this study did not explicate instrumental or terminal values that are viewed as rules that direct ethical decision-making (Kobella, 1989), rather the data revealed four areas in which we placed value. They are found in the following list.

• Placed value on being responsible as revealed within the family and work ethic
• Value development as a spiritual being
• Valued diversity as identified by acceptance of everyone’s contributions
• High value placed on education

Narrative Introduction

I chose to portray my findings as a descriptive narrative so the reader could “see through my eyes” and vicariously experience the lives of the participants (Merriam, 1998). In this way I hoped to share with the reader the complexity of my findings not afforded by a bulleted list. Concomitantly I want
readers to understand that my intention is as Stake (1995) describes: “I want to present a body of relatively uncontestable data, not completely without interpretation, but a description not unlike one they would make themselves had they been there” (p. 123).

This narrative tells the story of Kathy, an individual who is a composite symbolizing the collective yet incomplete voice of the three study participants. I say that she is incomplete, because she only represents our shared values, beliefs, and experiences revealed by the research analysis. I did not intend for the character, Kathy, to portray the depth and complexity of an entire lived experience. While the scenes and events found within the narrative are interpretive in nature, the core theme that each represents is derived from the data.

The descriptive narrative that I synthesized from the data was divided into eight chronologically ordered vignettes. Each vignette highlights several of the themes arising from the data. There is some overlap in the themes represented in each vignette. This overlap denotes the interconnected nature of these themes and how they are interwoven throughout the course of one’s life. To ensure an accurate portrayal the vignettes were scrutinized by the participants, informant interviewee, and outside reviewer. All agreed that the narratives reflected the commonalities of the participants as derived from the data.

Following each vignette, I have included a discussion section to help the reader understand how I arrived at my results. Quotes from the participants are included as supporting documentation.
Narrative and Analysis

Vignette One-The Garden

It was a beautiful day! Puffy cotton ball clouds skidded across the azure blue sky. As I ran through the fields of overgrown grass, I spied a bird in the distance circling low over the old oak tree. It was that time of year, according to my Dad, when baby birds could be found trying their wings. Perhaps I could catch a glimpse of such a spectacle, and I might even be able to tell if the babies were robins hatching from those notable blue eggs. As I approached the tree, the mother bird called out a warning and flew to protect the small fuzzy feather balls cheeping loudly from the bottom of the tree. I couldn’t get too close, but I could tell that I had spied a nest of robins, a sign of spring. That would mean coming days of summertime play and fishing trips to the creek. After a short time of observation, I ran on to the edge of the stream to see if the tadpoles that I had spied earlier in the week had begun their magical change. As I peered down into the water, I saw them. Those big fat black tadpoles could only mean bullfrogs! As I thought about them, I began to muse.

“I wonder if any of them will grow to be as famous as Mark Twain’s frog?” I thought to myself. After all, some of them seemed to have a pretty good start on a pair of jumping legs.

As I puttered around in the water, watching the tadpoles and searching the nearby bank with sticks looking for who knows what, my play was interrupted with a voice from the distance.
“Kathy, it’s time to come help with the garden!” my mother called, “Dad and John have almost finished with the tilling.”

“John tilling?” I laughed to myself as I ran to the garden plot. “I’m sure he’s not helping at all. He just likes digging in the dirt for worms!”

As I approached the plot, I saw dad finishing the last row of tilling. He had a determined look on his face as he tried to maneuver the tiller to the row’s end. Mom was arranging the seed packets and seedlings to be planted. She read the packet directions intently as if she had never done this task before, even though this was a seasonal ritual. Just as I thought, John was sitting at the end of the last row hands full of dirt squeezing intently until the clods fell apart revealing the prized worms.

As we took our respective spots, mom and dad discussed the placement of the various seeds and seedlings as they referred to the Farmer’s Almanac.

“Let’s put the tomatoes on this end, so they will get the right amount of sunlight”, said Dad. Mom agreed and directed John and me to begin dropping corn seed into the rows.

“Don’t drop in handfuls mother reminded. Space the seeds apart and not too deep!, she said, “I think we’ll put the pepper plants on that end.”

After what seemed to be hours, we finished the planting. Five rows holding carrots, beans, corn, tomatoes, and peas had been neatly planted. Hills planted with melon and squash seeds graced the ends of the plot while four pepper plants rounded out the row of tomato seedlings. Now it was time to water! As mother pumped water from the well, John and I filled coffee cans and ran back
and forth from each plant giving them an initial drink. Reminders not to be wasteful followed an occasional, accidental, splash on our feet and legs. Still John and I made a game of our watering racing to see who could fill the most cans. After the watering was done, dad cleaned the blades of the tiller. We could only watch because we were not allowed to come too close to the sharp blades. After the tools were put away and the area tidied up, we all sat down on the porch to survey our work and have a big glass of lemonade.

“With a little luck and a little prayer, I think this will be the best garden we’ve ever had,” Dad pronounced. Mom just smiled at the remark. We had all heard dad make this prediction before.

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The first vignette introduces four themes that I determined from the data: small town background, family structure, the importance of being responsible, and learning science as a normal part of life.

When I think of a small town background, I think not only about the actual population of the town, but also about the daily activities of the inhabitants and how they view themselves in relation to other members of the community. The opening description of playing in the woods or near a pond also depicts the types of recreation available in small towns. In this case I chose to convey these ideas by transporting the reader to a place in which it was possible for children to play and explore outdoors in natural areas. I also intended to portray the closeness of the community. Here the child is considered to be safe even though she is left
alone in the woods. An adult who has a vested interest in the child is always within earshot. A site commonly found in small towns

The following quotes are a sample of the data from which I derived the findings related to a small town background:

Sarah
  o I think my mother knew everybody in town. You couldn’t do anything without her knowing about it …. I’m not even sure what the population was…It was a bedroom town….There were a lot of family farms.
  o We played outside a lot especially in the summertime, because you had to be at home by the time the streetlights went on. I can remember climbing trees with my brother. He always liked to go higher than I thought was safe.

Twila
  o I grew up in a very rural part of Michigan. It was mostly swamp and farmland. My father was a farmer. My mother worked the farm and raised children….It was a village of maybe 2000. I lived 9 miles outside of the town on a small farm. It would look like Mayberry on television with a few storefronts, a few churches, and a couple of bars.
  o I liked nature. I lived near a swamp. I would walk in the swamp and look at things. I would see what was there.

Cyndy
  o I grew up in a town of about 1180 people. I think the population sign today says 1382 or something like that….there’s a tavern on every
That's pretty much what the town is. It's the typical Midwest town with one grocery store. The public library, which is the big ornate building in town, was donated by one of the founding fathers…a municipal swimming pool, a high school and elementary school, and that's pretty much it…a butcher shop, a feed store, and a fire station.

I mostly remember just doing things outside…entertaining myself…always doing stuff with my dad like going fishing.

The family structure described in this vignette represents a nuclear family living together in one household. This family consists of a mother, father, and two children. The female child, Kathy, symbolizes the participants as a composite. John represents our male sibling who was close to us in age. When I initially collected the data, I found that two of us had sisters who were considerably older. Twila describes her relationship with her sisters in the following quote, “My sisters were all six to 13 years older than I am. Consequently by the time I remember most of them, they were finishing high school or already married or in college or off somewhere.” She went on to say that she would consider her family to be two separate families: one that included her older sisters, and the other that included herself and her brother. She seemed to make this distinction based on her childhood memories of having played with her brother but not with her sisters.

I also felt that I came from a two-child family since my brother and I were close to the same age while my sister was twelve years older. My recollections are similar to Twila’s in that my sister was a senior in high school when I started
kindergarten. I have only one memory of my sister in which, as a child, I would say we bonded. That memory includes my sister trying to teach me to dance to the sound of the “Purple People Eater” as it blared from the television set on Saturday morning “Band Stand”. In retrospect, I don’t believe that bonding was my sister’s intent, but rather a way to deter me from wanting to watch Saturday morning cartoons.

Therefore, I chose to portray “our” family as a two-sibling family. I also found that our perceived relationships with our brothers were the same. Each of our brothers was within three years of our age. None of us described our relationships with our brothers as especially close. We merely considered them playmates. Sarah summed it up when she said, “If you didn’t play with him, you didn’t have anybody to play with!”

The next theme that appears is the importance of being responsible. In this vignette, responsibility is elucidated within the family unit as each person takes part in the garden planting: dad tilling, mother directing the planting, and children following the directions of the adults to complete the planting and watering. I chose to describe the theme of responsibility within the family environment since this was the strongest context found within my data. I wanted the reader to feel the closeness of the family unit as they help and support each other in this endeavor. The overarching theme of responsibility also included subcategories that dealt with roles within the family and work ethic also represented by the garden scene.
The following quotes are a representative sample from which I derived the findings related to responsibility.

Sarah

- …we always had chores and things to do.
- The one thing we did as the family was work in the yard …work in the garden.
- I helped put the roof on the tractor shed, which was a concrete block garage that he [dad] built.
- We had a garden so that meant taking care of it. We had raspberries to pick, and we made raspberry jam. We also made pies. We had sour cherries that we picked. We had apples….So she [mom] would go and get a couple of baskets of those [peaches]. That kept us off the streets and out of trouble in the summertime. Then we would have fruit pies in the winter, and she [mom] sewed all my clothes growing up.

Twila

- I think having been raised on a farm…when you have to take a crop off. You have to take it off. If that means you drive that machine for 48 hours without any sleep, then you drive that machine for 48 hours without any sleep. If it means that you have to push or pull that wagon to get it in line even without a tractor attached to it, that’s what you do. Even when I was little, I remember telling my father I was tired….He said, “What arm have you been using?” I said, “Well I’ve been using this one.” He said, “Then keep going and use the other one.”
Cyndy

- My mother worked at the Advanced Transformer factory starting when I was in about fourth grade. She would leave early in the morning to get to work by six o’clock. She would always talk to my brother and me the night before, or leave us notes telling us what chores needed to be done. I always had to put the meat into the oven for supper. Usually mom had prepared everything else ahead of time, but I would turn on the oven timer and make sure the meat was cooked. I also was in charge of doing dishes, and my brother mowed the yard. He was also supposed to help pick up stuff around the house.

The final theme that I have chosen to discuss from the first vignette is “learning science as a normal part of life”. This finding represents one of the biggest surprises for me. Although this study was directed toward science and education in the lives of the participants, I did not anticipate the amount of data that would resonate with this theme. This theme appeared repeatedly in many aspects of the participants’ lives. They recounted episodes as children in which they observed nature while alone, as introduced in this vignette. They also gave accounts of learning science within a social context either through recreational events with their families or work related activities. I chose to detail the latter in the garden scene.

The following quotes are a sample of the data from which I derived the “learning science as a normal part of life” finding:
Sarah

- He [Sarah’s father] built a back porch. He’d taken a course in bricklaying and concrete block and masonry, so he could lay block and brick. So he built the porch, and it was about two and half or three feet high. He put a concrete slab on the top….but to support this baby, this big concrete slab that he’s putting down, he’s got old railroad tracks as beams under it. Then of course, he’s got concrete reinforcing wire on top of that [the railroad tracks]. All the neighbors are saying they know where the local bomb shelter is if anything should ever happen to the house.

- The dog hated the dog run. I couldn’t say that I blamed her. It was on the wrong side of the shed. It was on the south side of the building, which in winter wasn’t so bad, but in summertime it was a bear. We couldn’t put her in there for very long, because it was too hot.

Twila

- I can remember being in kindergarten and being asked to color what I had determined were baby chicks. My teacher called them baby ducks. Chicks are yellow and ducks are brown as babies, especially in a four-year-old’s world. And I said, “Those are not ducks, those are chicks. They’re on land. Look at their feet. Look at their body shape. Those are chicks, and chicks are yellow.” And I colored them yellow or the reverse. I don’t remember. Maybe they were really ducks, and they were on the water. Anyway I ended up in lots of trouble, because I
wasn’t coloring the right color. It must’ve been baby ducks, because she said, “You have to put yellow on the page.” And I said, “I can put yellow on the page, but I know to put it where it belongs.” And I made a great big sun on the page that wasn’t already drawn there.

Cyndy

- I remember that my brother came back from my uncle’s farm screaming and crying. They had been playing up in the hayloft, and he had stepped on a pitchfork. He had a nice deep hole in the bottom of his foot. I can still see it, right in the bottom of his arch. My mother took an egg out of the refrigerator and cracked it open in a bowl saving just the white. She dipped the white into strips of bandages she made from old sheets and wrapped those around the wound. That egg white would suck all the puss and blood right out of those wounds. My mom said it would work for any puncture wound. I still use it today. It never fails.

- But the one thing that they [my dad and his brothers] always did when they picked what they called the toad stool mushrooms… They always cooked them with onions, and if the onion turned black they [the mushrooms] were poisonous. Dad and his brothers threw those mushrooms right in the garbage if the onion turned black. If the onion didn’t turn black, we ate them. We’re all still here today, so apparently they weren’t poisonous.
Vignette Two-A Special Day

I was awakened early the next morning by the sound of my mother’s voice calling me to get up. It was that all-important church day when we arose early, dressed in our finest, and went to meet our friends and neighbors for the Sunday worship service. Shortly after we settled in our seats, I became fidgety. As the sermon droned on, I surveyed every nook and cranny in the church, but was unable to find anything to hold my interest. As the choir sang, I began humming the melody in my head and soon found myself wondering what my best friends Sue and Ann were doing. No doubt they were also sitting in church across town. They were probably as bored as I was. There was one thing that I was certain of though. On Sunday morning the only activity in this small village of about one thousand residents was that taking place in the two or three church buildings. I felt that I knew many of the residents and I was sure that my parents knew them all. I certainly remember the time that I left John behind on the errand to the grocery store. When I got home mother knew every sordid detail, because of course someone was just looking out for us!

As I sat in the church swinging my legs back and forth ankles crossed, I wondered what we would be doing today. Sometimes on Sunday dad would take John and me fishing. Other times friends or relatives would come over for a barbeque. My brother and I would spend the day outside playing chase and riding bikes and perhaps climb a tree while the grown ups talked and relaxed while the meat blazed on the grill. I really didn’t know what would happen today, but I knew there were no plans for a special event like a trip to the state park or a
gathering downtown or I would have heard. I didn't really care if there was anything planned to do or not, because I could always entertain myself reading a book. I always had one on hand that I couldn’t wait to start or finish. I would have to remember to put the book down while I was setting the table though. The last time that had resulted in disaster! Mom wasn’t very happy when one of her hard earned teacups nearly tumbled to the floor due to my lack of attention.

Finally the service was over! Enough already! I know that I am not supposed to lie, cheat, or steal. Yes I know that I am supposed to live by the golden rule. How many times a week do I need to hear this? I think I’m doing O.K. As we left the church, groups of people began to form outside. Dad talked with his brother about crops and fishing. Mom chatted with her friends about her concerns over a neighbor’s illness or congratulated someone on their latest accomplishment. An occasional question or comment was directed toward John or myself. We answered proudly or smiled sheepishly. When the customary five minutes had elapsed we all headed for home in the family car.

As we drove the five minutes to our house, the family discussed what we would do today. As I suspected it seemed that no formal plans had been made. When we arrived home everyone changed into everyday clothes and gathered around the table for a big breakfast. There would be no formal lunch served on Sunday, so everyone filled a plate. After breakfast when the dishes were done, each of us set off to entertain ourselves. It wasn’t long before dad was reenergized and ready for an adventure.
“Kathy, do you and John what to go over to Uncle Gene’s house with me?” Dad asked.

Of course the answer was yes. We knew there would be cousins to play with and places to explore. The three of us jumped in the car, leaving mom behind for some peace and quiet.

“Let’s go see how Uncle Gene is doing with his kitchen remodel,” dad said, “I think he probably needs a little help.”

I liked going to visit Uncle Gene. He was always doing some kind of project. When we arrived, true to form, Uncle Gene was in the middle of what used to be a kitchen. There was sawdust on every surface and tools strewn across the floor.

“I need a little help here,” Gene said as we entered the door. He pointed to the heavy porcelain sink that was leaning against the cabinets. Dad rushed over and grabbed one end while Gene took the other. Together they hoisted the sink into place. John and I stood watching. When they were finished Uncle Gene announced that our cousins weren’t home today. Disappointed, John and I began to look for something to do. Dad told us that we could help. He said that we might need to know how to fix a sink someday, so he showed us how the pipes fit together under the sink and let John and me take turns holding the wrench. When we finished Uncle Gene wanted to show us his garden plot. He was always planting something different.
“This year I thought I would try to plant peanuts. They’re legumes you know,” he said as he looked at John and me. “I don’t know if the soil is quite right for them,” he said looking at my dad, “What do you think?”

My dad reached down and put some soil from the plot in his mouth.

“A little acidic,” he pronounced.

I tried some of the soil too! Making a face I quickly spit it out. Dad and Uncle Gene laughed as John followed suit. Then it was time to go.

When we arrived home, mom met us at the door.

“Did you have a good time?” she asked. We recounted our tales of sink fixing and soil tasting.

She laughed and said, “The next time our sink is broken you can help fix it.”

She also told us that Aunt Betty had stopped by on her way home. Aunt Betty lived in the big city where she had her own apartment and everything. Dad would always say that Aunt Betty was a “sharp” lady and knew how to handle her money. I dreamt of being a “sharp” lady like Aunt Betty someday as the day wound down and the afternoon soon turned into evening.

We all gathered on the porch, for our Sunday night ritual. We reminisced as we watched the sky turn from blue to brilliant orange and finally black before it began to twinkle with stars. It was the end of a perfect day as dad talked about helping Uncle Gene with the kitchen sink.

“You know he can do anything a man with two arms can do,” dad remarked.
Although I heard what dad had said I continued to chase fireflies with John. I had never really thought about Uncle Gene having only one arm. He just seemed normal to me and I still think he is.

“Can we make firefly lanterns?” I asked.

Mom nodded her head and said, “You know where the jars are.”

I ran to get the jars and lids. I had punctured the lids with nails, so the fireflies would not suffocate. John and I captured fireflies until our lanterns shown brightly and we tired of watching them blink.

“Time for bed,” mom announced, “I have a big meeting tomorrow with the lady’s club to discuss changes in the voter registration process.”

“Come along, Kathy,” dad added as he pulled my attention away from the last flickering bug, “Budding scientists need their rest.”

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The second vignette extends the themes discussed above, provides a deeper understanding of Kathy, and introduces three new themes related to spirituality, diversity, and strong female role models.

In the first vignette we learned that Kathy was one of two children. She liked to play outside and was expected to help with family chores. Here we learn that she also has an extended family in the form of aunts and uncles. Statements from the participants in this study revealed that all of us had aunts and uncles, and none of our parents were only children. While our extended families may not have lived in the same community, we felt a connection to them. Therefore I chose to represent this closeness by geographically locating some of our
extended family within the same community. We also learn that Kathy has one or two close friends, a finding mined directly from the data. In addition to spending time playing outside, we discover that Kathy is an avid reader as well. The following quotes support this finding:

Sarah
  o I remember going to the library in the summertime, and we would take out books. I can remember my mother being really angry when I didn’t get the dinner table set, because I didn’t want to put the book down…
  o Well, when I was little my favorite part [of school] was reading.

Twila
  o …I was always a very avid reader. I still read. It drives my graduate students nuts. How much did you read this week? How do you read that much? Who can read that fast anyway? Do you ever read for pleasure too? Oh ya, I read a novel or two last month too. They’re like wow how do you do that?

Cyndy
  o I read a lot of books. I’d ride my bike to the library to get books, and I would read three or four and then ride back the next day to get three or four more. They had a hard time keeping up with me at the library with the children's book section, because I was reading so much.

The spirituality theme is introduced in this second vignette as Kathy day dreams during a church service and silently rebels. This scene depicts my view of spirituality as Roof (1993) states “In its truest sense, spirituality gives
expression to the being that is in us; it has to do with feelings, with the power that comes from within, with knowing our deepest selves and what is sacred to us, with, as Matthew Fox says, “heart-knowledge” (p. 64).

The spiritual theme revealed itself in the observational data, informal conversations, and quotes found in the semi-structured interviews. On the occasions that I visited Twila and Sarah, I observed that they talked about church activities that were part of their weekend schedules. Sarah also pointed out the church she attended as we drove around town and added that she sang in the choir. I also accompanied Twila to a choir practice at a Presbyterian church where she directed the children’s choir. In addition to these observations, past conversations with Sarah revealed her knowledge in the area of church doctrine. She was well versed on just about any topic and remarked that her former husband had been a minister. Sarah’s data also included recollections of attending Friends meetings in middle school and being introduced to her husband who attended the same Episcopalian church. My own upbringing was in the Catholic Church. When I was in college, I explored various religions. I attended services with my friends from various Baptist churches. I also remember having heated religious discussions in our lab with other graduate students and professors. One of my friends considered himself an expert on Judaism and added to the discussions. After speaking with the study participants, we agreed that we would consider ourselves spiritual beings rather than religious persons.
The following quotes are samples of the data from which the finding related to spirituality was derived:

Sarah

- Evolution has been a dirty word in their school systems, so all they know about evolution is there’s evolution here and Charles Darwin and over here is God. Those are polar opposites. Then they find out that Charles Darwin was trained as a clergyman. Then they go oh wait, oh wait, and that sets up some cognitive dissonance, which is a great place. As soon as you’ve got that going on then you need to do some learning. A lot of them by the time we get to the end of three or four weeks of working on evolution, they’re like now I don’t know what to think. Good. That’s where you should be. That’s a fine place to be. You’ll probably develop your own thinking about this and this is the science part and that’s what one would say. And the religion part you’ll have to deal with on your own….My dad at home is going through the bull catalog picking out the best semen for cows because evolution isn’t very….But is he playing God when he goes through that catalog? Hello? And they’re like Oh, I never really thought about it that way.

Twila

- Well you have to realize that I was really raised a great deal by my Quaker grandmother. So I think there’s far too much noise in this world, almost all the time. And one of her comments was to always be still and really what that means be contemplative. Think before you
act. Think about the impact of what you say and how you say it. Think about what it would feel like to be in this other person’s shoes. If you had to trade places, what would it be like? And I think that if we did more of that even for an hour or two a day that we would change a whole lot of outcomes. Even when you go to a church service today, a lot of them are just constantly moving, constant noise, constant, constant, constant, more, more, more, more…

Cyndy

- I think it was at that time [middle school] that I really started recognizing that there were people in different religions. I’m looking at these people in public school, and a lot of them went to the Methodist church, although I had an aunt who was Lutheran. I think that’s when I started realizing that people had different religions. It wasn’t an issue. I had friends who were Catholic, Lutheran, and Methodist. Of course, my first boy friend was Baptist. It just kind of was part of what was. Religion was a big part of our lives. We went to church every Sunday. We’d say to my friends, “Could you come over after church?” She’d say that she had to go to Sunday school etc. It was just kind of what we all did.

Another theme introduced in this vignette addresses the value of diversity. Diversity in this case refers to the ability of everyone to make some type of contribution (Darling-Hammond, 2000; Lawrence, Undated). In every sense, diversity is viewed as a strength rather than a weakness. In a diverse society, we
build on the unique attributes, talents, and perspectives of all individuals to create an enriched society. I chose to present the theme of diversity in the character of Uncle Gene. We are introduced to him as he remodels his kitchen, but we don’t find out until much later that he has only one arm. I used this particular approach for two reasons. First, I wanted to convey that in our worldview differences are assumed to be ordinary. Second, I wished to communicate that diversity could mean many things beyond the stereotypical ethnic or racial distinctions. It could mean differently abled in a physical sense, or it could even mean dissimilar family units.

The following quotes are a sample of the data from which the finding related to diversity was derived:

Sarah

- Our neighbors were Middle Eastern, probably Syrian. No one treated them any differently. They were just like everyone else….My best friend was Jewish. I never really thought about religious differences at that age.

- The word I got was family [referring to a class assignment]. I found this book in the library that had all these black and white photographs of families in different configurations. I went into class and asked everyone to talk and to say a little bit about their ideas about families. I asked if they had thought about this and thought about that. Then I showed them some different configurations of family, and I had some data to support it.
Twila

- My mother's family came through the Ohio Valley and Cherokee country. Her family was part of the second line of the Underground Railroad through Detroit.

- Diversity to me is the strength of the system, and it does sometimes cause friction. It does take more work, but I think it’s worth it in the end. I would hope that people would start looking at other people, other places, and other things through a lens of strength…. Let's start with what you do well. Let’s build from there.

- If I'm doing culturally relevant science, I love working with a cultural anthropologist in education. I think it makes the discussion richer. When I am working on some specific content in science that is not my background, I like being able to work with a person for whom that is a strong background.

Cyndy

- I think from early on that I never associated physical disabilities with mental disabilities. I think this idea or belief probably came from my experiences as a young child (before I was in fourth grade) with a neighbor. This young man had muscular dystrophy and was confined to a wheel chair. I never really knew how old he was, but I think he was high school age or older. … He had this great collection of model cars. His dad had made him a workbench in their garage where he put all of these models together. He worked a lot using his mouth to hold the
paintbrushes and stuff because his arms and hands remained in a more clenched or crippled position…. I also remember asking Paul why he didn’t go to school. I thought he was really smart. He said that he just didn’t. I was only in third grade at the time.

The final theme from the second vignette is the experience of having a strong female role model. I decided to use the label “strong” in describing the female role models, because to me it meant that these women were influential in a variety of circumstances. These women had a sense of self-identification and empowerment that they used both inside and outside the home. It is also important to point out that Kathy was born in that transitional period between the War Baby Generation and the Baby Boomer Generation in which thinking about men’s and women’s roles were changing. Therefore, I chose to introduce this theme through the character of Aunt Betty, a woman who was self-sufficient and respected by her family. The strong female role model theme is also part of the mother character in this vignette as she takes a more covert approach to influence and uses her lady’s club as an avenue to reach her goals.

The following quotes represent some of the data from the finding related to “strong female role models” was derived:

Sarah

○ She [paternal grandmother] comes from a middle class Tyler City family who owned some property in Tyler City. She in her own right had a good chunk of change and was pretty shrewd apparently about investing…
After one miserable Christmas when he [dad] had done the (roar) all through Christmas, my mother said, “That’s it! You will be on vacation for Christmas.” so he took another week at Christmas.

Occasionally we would take a trip to the mountains, but usually Daddy was too busy to go.

Sarah discussing her mother] She was a strong woman, a strong willed woman. Left to her own devices, she would have survived. She manipulated him [Sarah’s father], so he didn’t know he was being manipulated.

Twila

My mother just felt that I was ready academically to go to school, and she took me. They did the developmental testing of some form at that time, and I did well enough on the tests to go to school. Then when they found out how old [four] I was, they weren’t going to allow me to go. My mother said, “She will go!” They created another test for me. I was going to have to go forward when the superintendent of schools called my name, so my mother made sure that he knew how to pronounce my name. When it was my turn, he called every name except mine-Tweela, Twitta, Twota. I crawled under the chair and refused to answer him. So they said, “Well she can't go [to school]. She didn't answer him. My mother said, “They didn't call her name, and I told him how to pronounce her name.” My mother said that if you call her name she will answer you. Then they called my name. I looked at
them, and I answered them. They said, “Why wouldn't you answer this other guy? I said, “He never called for me.” So I guess you could see that I was determined from quite young.

Cyndy

...then my mom ran the drive-in, and we would help. We would go over there....Prior to that my mom had worked in the hotel restaurant, and she had done a lot of other things too. She had also worked at Parker Pen Company during World War II. During World War II they made things other than pens. It was kind of interesting that my mother always worked, and mothers’ didn't work then. I was probably the only kid that had a mother who worked, and I never thought that was unusual or strange. That's just the way it was.

Vignette Three-The First Day of High School

It was the first day of high school and I was excited, nervous, and apprehensive all at the same time. Thank goodness it would be a short day just for orientation and scheduling. I knew most everyone and I was familiar with the high school campus, since I had been in the lower wing last year for middle school. I had gotten up early so I could walk to school with my best friends, Sue and Ann. As we walked along the familiar route, we passed some of our favorite places including the town library and city park. As we turned the corner and headed down the block, I saw the little white house that had been home to my kindergarten class. It still looked pristine and new although the kindergarten had
been moved to the two-story brick building across the street where the rest of the elementary school was located.

“Do you remember when we were in kindergarten?” I asked Ann and Sue. They did indeed have memories of kindergarten and were eager to share them. I shared a memory of coloring baby ducks yellow instead of brown. I knew that baby ducks were brown, but I couldn’t find a brown crayon to use. When I got home from school, I was upset because I didn’t want the teacher to think that I didn’t know that ducks are brown and chicks are yellow. My mom just couldn’t seem to calm me down, so she went to school with me the next day to talk with the teacher. After that I thought school was just fine.

“So do you think your mom will show up to calm you down if you get upset in high school?” Ann asked laughing.

“I sure hope not,” I replied as thoughts of horror ran through my brain. What if mom or even worse dad showed up one day on campus just to “check on things”? How embarrassing would that be! They would probably be mistaken for my grandparents! I can see it now. Mom and Dad going door to door entering every classroom and talking with every teacher. I can even hear their words ringing in my ears. They would be saying, “Well, Kathy is preparing for college…”

I quickly returned to the present and tried to put such thoughts out of my head as we climbed the stairs and walked down the hall toward the school gym where orientation was to take place. We squeezed through the open door at the back of the gymnasium pushing past groups of students talking and laughing. We
quickly found a seat in the bleachers assigned to the incoming freshmen. As I looked around I felt a renewed sense of anticipation. What would the day hold?

The students began to fall silent as Mr. Banks, the principal, strode across the floor and took his place behind the microphone. I knew Mr. Banks. He lived down the street from us. I often saw him playing catch in the yard with his children. Sometimes he would hire John to mow his lawn especially when the dog days of summer arrived with their squelching heat.

“Good morning and welcome to another school year,” Mr. Banks greeted us, “I am sure all of you are looking forward to an exciting year.”

I listened attentively for the first few minutes and then my mind began to wander. I was thinking how stuffy it seemed in the gym even though fans were whirring overhead. One huge fan, probably five feet across, set on the floor opposite the bleachers blowing warm air toward us. The blades were moving rapidly within the wire cage.

“...will move to the center of the bleachers,” said Mr. Banks.

I looked around hesitantly as I saw some students walking toward the doors and others shifting their positions. Ann and Sue started moving to the center of the bleachers and I followed suit.

“What are we doing?” I asked Ann.

“We’re going to complete our daily schedules,” she replied.

This is the part that I had been waiting for. I wanted to know what classes I would be taking, whose class I would be in, and if Sue and Ann would be in the classes with me. As I surveyed the remaining students I realized that this would
be the freshman class comprised of approximately one hundred students. I had heard mom and dad talking about this class being one of the largest in the school’s history.

“We will be handing out your daily schedules,” announced Mr. Smith, the guidance counselor. “When you receive your schedule look it over and make sure that you are enrolled in a math class, freshman English, social studies, and a science class. If you are not enrolled in those four classes, then you will need to see Mrs. Franklin. She is sitting at the table near the stage. You will notice that you will only have one elective this year. The other courses are all required. All students are required to take math, science, and English courses each year. These courses are particularly important since many careers today and in the future require math and science backgrounds and good communication skills. You will also notice that P.E. is also required. In the space for electives you may enter any one of the following classes: home economics, introduction to drafting, or wood shop. After you have entered your choice, you will find one open class period on your schedule. If you are joining the band, choir, or one of the sports teams enter the course name in this empty slot. If you will not be involved in any of these extracurricular activities, then write “study hall” in your last slot.”

As we followed Mr. Smith’s directions, various people asked questions or visited Mrs. Franklin’s table. I didn’t have much trouble with my schedule. All the required courses seemed to be in place. Home economics would be my elective and band would fill my final slot. Sue, Ann, and I compared schedules. We would have math and biology together. I would be in band while Sue chose choir
instead. Ann would be playing basketball. After everyone had resolved their scheduling problems, Mr. Smith introduced the teachers for each class.

“Mrs. Heberlein will be teaching freshman English. Mr. Coles is our algebra, introductory math, and trigonometry teacher. Mr. Nobles teaches biology and chemistry. Mr. Wild teaches physics. Mr. Spellman teaches geometry and senior advanced mathematics. Miss Farley teaches home economics. You will find Mr. Lester in the drafting and wood shop classes while Mr. Farrell teaches social studies. Our band and choir director Mr. Rich is new to our school this year. Our P.E. teachers Miss Jacobs and Mr. Thurston are also the coaches for our sports teams.”

After that long, final announcement, we were dismissed for the day.

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The third vignette revisits the small town background theme and learning science as a normal part of life theme; describes Kathy’s formal school life; and establishes the high value placed on education.

Kathy’s formal schooling began at an early age as a kindergarten student. This is reflective of the participants’ experiences in that we all remember attending kindergarten. Twila went to kindergarten at age four largely due to her mother’s insistence. Sarah recalled that she was part of the first kindergarten class available in her town. I remember that kindergarten had only recently been established when I attended, and it was not mandatory. In the vignette, I chose to convey this kindergarten experience and parental involvement in education as part of the scene in which Kathy shares the “duck” episode. I also included
another scene in which Kathy expresses her concern about her parents’ age and the possibility that they might be mistaken for her grandparents. The purpose of this scene was twofold. First, it informed the reader, that Kathy viewed her parents as older. In fact our parents were all in their thirties at the time of our births. Second, it sets-up a connection between family and school through parental involvement.

The story then fast-forwards to Kathy’s first day of high school. I did not include specific references to elementary school in this piece, because participants’ recollections at this age level did not include formal science learning. Twila talked about good teachers being creative, having stuff for the children to do, and caring about the students. She also emphasized her love of and interest in reading. Sarah shared a story about sitting in class and watching the sky turn green prior to a rainstorm accompanied with intense lightening. She expressed her curiosity in this event and acknowledged that she was totally oblivious to the teacher during this time. In my interview, I admitted that the only memory I had of any type of formal science learning prior to high school took place when I was in the seventh or eighth grade. Our small school building had a basement room that could be used as a science lab. I remember going to this lab where some of the students played with mercury when the teacher wasn’t looking.

The gym scene was used to communicate several important points. Kathy’s high school class contained approximately 100 students. This school would be considered small by today’s standards. This type of high school atmosphere reminds us that there is an opportunity for a social connection with
the other students and the teachers. They become part of one’s extended family. Twila told a story that speaks to this closeness. She talked about the “open classroom” being prevalent during her high school years. As a result, she felt that she received personal attention. Her teachers would help her find books on subjects that interested her, or they would send for books from the college library to share with her.

This scene also revealed the expectations regarding math and science associated with school in this small town community. As Kathy examines her class schedule, she realizes that there is not as much choice within the schedule as she had anticipated. She recognizes that math and science are required courses. Twila and I recall school math and science courses as a normal part of everyone’s school experience. It was just something everyone did. Sarah remembers there was a big push to do math and science in high school because of the launching of Sputnik. The importance of math and science in this school is further evidenced as the teachers are introduced. There are several math and science options offered at each grade level, while the other disciplines have few or no choices. Within the math and science disciplines, you will also notice that all the teachers are male. I mentioned this within the scene subtly to portray our collective memory. We didn’t recognize this as being common or important.

Our involvement in extracurricular activities is explicated in the vignette when Kathy scrutinizes her schedule. She finds that PE is required; and extracurricular activities in the form of band, choir, or sports round out her choices. In reality, Twila participated in sports while Sarah and I played in the
I also used this scene as an opportunity to portray the high school as a microcosm of the town. The high school was the place where intellectual growth took place. It was also the place where we had opportunities to improve our social skills, expand our interests, and develop our talents. In addition, organizations such as 4-H and Girl Scouts enabled us to increase our life skills.

In the second vignette, we get an inkling of the value placed on education by Kathy’s family as she learns how to fix a sink, and dad calls her a “budding scientist”. In this vignette, the theme is further solidified in several events related to formal schooling. Kathy reminisces about her early kindergarten experience sharing that she wanted to do well. She also recalls her mother coming to the school to support her when she had a problem. Kathy worries about her parents showing up at the high school and talking to all of her teachers. This last description highlights how involved Kathy’s parents were in her education during adolescence.

Kathy’s parents also insisted that she was going to college. This sentiment was shared by all of our families. Twila’s mother wanted her to have the education that she had been denied. Her father had received a full scholarship to study veterinary medicine, but his father’s sudden death and family responsibilities kept him from going to college. He maintained that all of his daughters would have a college education. He recognized that times were changing, and women were no longer being taken care of by men. Sarah’s father had an engineering degree. He also insisted that she go to college even though he didn’t want his wife to work outside the home. Neither of my parents
had attended college. As children growing up in the Depression Era, higher education was out of reach for most and not even considered. Conversations that I had with my mother revealed that she viewed herself as “smart enough” to go to college, while my dad considered himself lucky to make it through high school. I have no memory of any formal discussions about whether or not I would attend college. I only recall that for as long as I can remember it was expected.

It is not surprising to me that the data revealed a high value placed on education, since this study is set in the context of science education. One would assume that three persons pursuing PhD’s in education place a value on education. I think I was most surprised at how this priority evolved throughout our life experiences in formal schooling and informal living experiences. I was also surprised at the degree of parental influence on our educations and choices, as well as, the congruency I found between the home and formal school atmospheres derived from the data.

The following quotes are a sample of the data used to derive the finding related to a “high value placed on education”.

Sarah

- I remember when I was in junior high; my father had a huge argument with my algebra teacher. She insisted my answer to the problem was wrong. I went home and told Daddy. I said, “Dad you know that problem you helped me with last night? My algebra teacher says that answer’s wrong.” He went in to see her and found out that she had not done the order of operations correctly. Instead of doing my dear aunt
sally (multiply, divide, add, and subtract), she was doing the operations in the order they appeared in the problem. There were no parentheses to group things, and she didn’t know about order of operations. I have since remembered all about the order of operations. It is not a problem. …I have a full-blown example in my head….but he [dad] was furious. The answer that was in the answer key in the back of the teacher’s book had been wrong. The operations had been done in the order they appeared, so the answer in the book was wrong. “Well it was in the book,” the teacher said, “How could it be wrong?” We all know about that.

Twila

- You entered first grade through academic testing. This is something my mother did which was probably truly brilliant. They did academic testing, and a lot of the tests were puzzles. Not only did I finish very quickly, but they were all right….they brought my mother in and said, “This doesn’t make any sense. No five-year-old kid can do these puzzles.” My mother said,” Well she loves doing puzzles. She does them all the time. Give her another test, and we’ll [teacher and mother] watch her more closely.” They did, and I essentially did the same thing. They said, “Well we just don’t believe the test results.” And my mother then said, “Then you may never test her again.” So I never had another test, until I took my ACT test for college.
Cyndy

- I was excited. I was only eight years old, and I was going across the country in a car for three weeks to one of those places I had only read about [Florida]! As we drove along, I peered out the window, savoring every view and stop. Back in the car, books, paper, and pencils spread across the seat as my brother and I did our homework.

- When we returned from our trip, mom proudly shared our slides, photos, and memorabilia with family and friends. We were invited to share our "slides" at school. It was educational you know! The teachers thought it would be a good experience for all the children; just like the travelogues every Monday night at the high school gym.

*Vignette Four-The High School Years*

I soon settled into the rhythm of work and play known as high school that was occasionally punctuated with a holiday or special event. The years seemed to fly by. Nothing really distinguished one year from the next. An occasional visit from my parents to a teacher helped keep us on track. After all, I would be going to college and if dad had his way I would be a scientist no less. Afternoons were filled with practices for school events and evenings meant family chores, homework, and relaxation in the form of daydreams of the future that was to come.

I particularly enjoyed science with Mr. Nobles. Although he was demanding, he was also very good at explaining complex topics. I always felt a sense of accomplishment in his classes. He had an encouraging smile and his

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stories seemed to make science flow flawlessly from home to school. Once he even made a reference to soil acidity and told how the farmers might taste the soil to determine whether or not it in fact was acidic.

“That makes sense,” I thought since I had witnessed this firsthand, “so that’s what acidic means in terms of chemical composition.”

There were other stories too. He would tell us about botulism and illness caused by a bacterium. I had previously heard my mother and the home economics teacher use this term when discussing canning the seasonal produce.

Of course, I enjoyed other classes as well. Math classes, especially my senior year, became miniature intellectual marathons. I took it upon myself to upstage David who most everyone considered to be a true math genius although I did not find him to be so. I think Mr. Coles, although he never spoke it directly, actually enjoyed watching me routinely prevail when David and I engaged in intellectual jousting. However, it wasn’t Mr. Coles’ approval that drove me forward, but the stimulation of the game. It wasn’t just math and science that held my interest. I enjoyed band, PE, sports and all the social activities that came with those extracurricular activities along with the idea of freedom associated with a driver’s license.

It seemed all too soon when graduation day arrived laced with promise and a feeling of anticipation. As I looked around the gym I noted the nearly 100 students gowned and ready for the ceremony to begin, the small number of teachers that had guided my learning, and mom and dad sitting proudly in the audience. The ceremony opened with the customary convocation followed by the
principal’s introductory speech. The tradition continued with the presentation of
the valedictory and salutatory addresses and awards both academic and athletic. 
These presentations culminated with a parade of eager students one by one
crossing the stage to receive a diploma and a handshake. My parents beamed
with pride as my name was called. After each student had received a diploma the
class was introduced and the audience clapped their approval. After a short
announcement graduation was complete and the Plantersville High School gym
quickly emptied.

After the ceremony, the day was filled with more festivities and merriment.
Relatives, friends, and neighbors joined together to wish me well. Thoughtful
mementos both practical and inspiring would require a thank you both spoken
and written. Punch and cake were served while reminiscences of other such
celebrations took place. The day ended on a happy note as the guests echoing
their congratulations began to leave.

My parents reminded me that with hard work anything was possible and
repeated the refrain that I had come to expect, “I think you will make a fine
scientist someday. “

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The fourth vignette continues to develop three themes discussed earlier:
the “small town background” theme, “learning science as a normal part of life”
theme, and the “high value placed on education” theme. It also highlights two
new themes: the “belief in a balanced approach to life”, and the “belief that girls
can do school math and science”.

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A “balanced approach to life” is portrayed in several ways. First, Kathy finds a “rhythm” in her school experience that includes work and play. She begins to understand that school is more than an academic institution. It is also a place in which she feels part of a community and receives support much like she does in her family, both immediate and extended. Within this vignette I chose to highlight the home and family congruency through the graduation scene and the following party. This finding was revealed in the data as childhood memories and current adult practices. All the participants told stories about doing chores and playing outside as children. Twila specifically talked about having to work in the fields for long hours, but her family also insisting that the children should play outside. Sarah also shared similar stories in which she might help with peach picking and pie making, but she found time to climb trees with her brother as well. Another piece of her story included the yearly vacation to the Jersey shore for the entire family. My story is much like the others in that weekends were set aside for relaxation. Family picnics, shopping in the nearby stores, or embroidering a quilt were common practice. The weeklong vacation to the lake for fishing was also a much-anticipated annual event. We have acted on this belief as adults, evidenced by our work schedules. We all “work to live” not “live to work”. We think it is important to take time to develop relationships, relax in order to rejuvenate, and have fun

The following quotes are samples of the data used to derive the finding related to a balanced approach to life:
Sarah

- I have learned not to confuse my job with my life…. I just refuse to be totally caught up in that building over there [college]….I want to have friends….I want to be able to say that I know my children. I know my grandchildren. I have a house and a yard that is respectable. I’ve done some interesting craft projects. I have friends in Florida. I have friends here. I have friends in Utah. I want to be able to say that I still have those friends.

Twila

- My family liked to play with words, and they also believed you should play outside. Even in wintertime we played outside. We worked hard, because it was a farm. We had some wonderful chores like picking rocks. Everybody wanted to go do that. You had to pick the stones and rocks up out of the field before you could run the planter over the field, or you would ruin the planter.

- I went one summer [to college], but mostly I did not. Mostly I went fall and spring. Most of the times I went home in the summer and helped out my father.

- If you will notice, there is no computer in my house. I will not be working.

Cyndy

- We’d [Cyndy, her dad, and her brother] go in the boat, and we’d catch fish. Once a year, Uncle Joe and dad would take all the kids, all the
cousins, anybody who wanted to go, down to the riverbank. We'd fish and then we'd cook all the fish. We'd have a big cook out. …I guess the fishing that I remember most is when my brother and I would go with my dad….We went to the river, and the grass was really high. It was taller than I was high. We'd walk through that grass where you couldn’t even see our heads. We'd sit down in the grass and make a little nest. Now and then I'd come out. I'd throw the old cane pole in and try to catch a fish. We entertained ourselves. It was sort of like dad took us away on Sunday, so Mom could rest. I had a lot of special stuff I did with mom too, but I remember just a lot of going with dad into the woods and that kind of stuff.

- I have been known to say, "I am a Libra. Therefore, I believe in balance in all things."

The final theme found in this vignette is the belief that girls can do school math and science. Kathy’s experiences in science and math classes were positive ones as she felt a “sense of accomplishment” in chemistry class and “upstaged” David in intellectual marathons in math class. We also find that Kathy considers her chemistry teacher to be a “good” teacher. She refers to his ability to explain complex topics and be encouraging. While she didn’t seek approval from her math teacher, she still excelled and enjoyed the intellectual stimulation. I chose to portray the science and math teachers in this manner to reflect the participants stated feelings about their high school math and science teachers. Twila and I recalled feeling supported and encouraged by our teachers, while
Sarah said that she did not remember being encouraged nor discouraged by her teachers.

The competition between Kathy and David was also used as a way to introduce the gender issues often associated with school math and science. This seemed of minor importance to the participants in this study as revealed by the data. Twila said that no one had led her to believe that she couldn’t do science and math in school. She also said that you just worked harder if you were a girl or if you were poor. Sarah based her experiences with boys on her relationship with her brother. She knew she was smarter than her brother, so she assumed she was smarter than other boys as well. Her school experiences also supported that belief. I don’t ever remember considering gender differences as a reason, excuse, or rationalization for my success or failure in a science class. In my experience equal numbers of boys and girls were successful in these classes.

Later in the scene, we find Kathy making connections between science she learned in her daily life and school science. I chose to represent this connection through two events. First, Kathy connects acidity as part of chemistry class to acidity as part of farming. Second, she connects botulism mentioned in biology and home economics classes to botulism described in canning, a home event. Kathy is building her understanding of how school based science relates not only to other school based science disguised within another discipline, but also how it relates to her daily life and its implications for her life. I chose to present this connection as occurring at the high school level. I vaguely remember making a connection to biology and chemistry topics and science associated with
cooking in home economics’ class. Twila and Sarah recalled making the connection, but could not place it within a particular time frame. Since the three of us remembered very little about middle school, I placed this connection in high school. However, it could have been much earlier. We did agree that by the time we graduated from high school, we had made this connection.

At the end of the vignette, Kathy’s parents remind her of their expectations as she graduates from the local public high school. She is not only going to college, but she is expected to be a scientist. I found this to be an important point derived from my data. Twila’s parents were both very involved in her education as described earlier. Her father was adamant about his daughters going to college, although he didn’t hold the same expectation for his son. Twila remembers her mother wanting her to become a medical doctor, but she thinks her mother would still be proud that she has a PhD. Sarah’s father, an engineer himself, envisioned the growing technology fields as good career opportunities. He wanted Sarah to pursue a career in a computer related industry. My father wanted me to be a medical doctor, although he was notorious for not visiting a doctor when he was ill. I would tell him that I would probably go broke if I became a doctor, because all of my patients would be like him.

The following quotes are a sample of the data from which the finding related to the belief that “girls can do school math and science” was derived:

Sarah

- Well when I was little my favorite part [of school] was reading, but then in high school my favorite part was to prove that I could do math as
well as all the boys in class. We always said that the girls who couldn’t
do math wore tight sweaters. That was the time when you wore your
sweater turned around backward and buttoned up the back. You wore
padded bras. We always said she got good grades, because she looks
good in a sweater. She couldn’t really do the math. So it was my
job….it was always between the two of us as to who had a better proof
to the geometry problem or a better way to work out the problem.

- I took every science course that I could get….Tenth grade I had
  biology. Twelfth grade I had chemistry and advanced biology.

- And of course we lived out in the country, so we thought everybody
  pretty much knew about the birds and bees and how a steer got to be
  a steer until one girl in our advanced biology asked what they did with
  the little girl steers. And that was pretty much the end of class for the
day.

Twila

- …new math started and nobody including the teacher understood it [in
  Michigan]. That was the year that I started traveling to Arizona for half
  a year with my mother….Interestingly the teachers in Arizona did
  understand the new math. When I came back…. I was in sixth grade
  and I understood the greater than and less than symbols. I could get
  them all right and all those kinds of things. The teachers were always
  amazed, because they still hadn’t figured it out. I remember looking at
them and saying, “It’s really easy. The smaller number goes at the little end.’

○ You’re a girl in science. So what! Now you work twice as hard.
No body ever gave me the idea that because I was a girl or because I was a poor child that I shouldn't be able to think and perform in these areas, nobody.

Cyndy

○ I took biology my freshman year, and I had Mr. Nobles. He was just wonderful with science. We studied all those invertebrates, all those animals that were in the ocean, all those things that we didn't have in our area. I just got really fascinated with all of those animals and decided I wanted to be a marine biologist. I was good in science. I took chemistry, physics, and biology. I was good in science. I decided early on that's what I wanted to do

○ But it never occurred to me that that it wasn’t OK for girls to do these things….like we were less than the guys or whatever. I always felt that I was an equal and people weren’t really separating me out because I was female. I didn’t really ever feel that.

Vignette Five-Road to Teaching

The next few months were a flurry of activity ever increasing in pace as we transitioned into the Dog Days of Summer. There was paperwork to complete and checks to send; clothes and essentials to be gathered; chores to do; and fun to be had as I counted down the days until the fall semester began. While I was
very excited about the proposition of attending college, I was not really sure what to expect. I had heard some tales of college from previous high school graduates who were commissioned to speak to the current senior class about what lie ahead. I had also heard more personal stories from a few of my relatives who had attended college. Even the student guidance counselor had rambled on recounting episodes from time to time as we sat pouring over college catalogues hundreds of pages thick. While these stories gave me something to think about, I was still convinced that my college experience would be totally unique. My college experience, whether I lived at home or moved thousands of miles away, would surely offer life changing adventures and opportunities.

I was not disappointed as I transitioned from protected high school senior to confused college freshman although growth at times was painful as I tried to stretch myself beyond that box called “small town”. Choosing courses that first semester reminded me of my freshman year in high school. While there was an appearance of more flexibility within the schedule, the number of required courses significantly reduced the choice of electives that appeared as clusters on the scheduling forms. I ended up taking the required English, math, and science to which I added an elective from the fine arts and social sciences.

With my schedule set, the real learning began. Adjusting to a schedule in which every hour of the day was not planned provided opportunities for me to discover a level of freedom yet untested. Of course waiting until the last minute to read hundreds of pages of text did not always serve me well, but I persevered learning from my mistakes and triumphs alike. This was a time of personal
growth in which I revisited those lessons learned in childhood and those beliefs instilled in me through experiences both at home and in my community. It was during this time also that I spent some time searching for and decided upon a major. I settled on biology in the male dominated natural sciences. With that decision came the inevitable chemistry minor, but I was confident that I could handle it.

Early on the professors reminded us of how many of our comrades would fail in their pursuit.

“Look to your left and look to your right,” he would say. “By the end of the semester those seats will more than likely be empty.”

I found this an interesting concept but never felt directly threatened, since failure was not an option for me. It was during this time that I built a support group consisting of classmates some of who would soon became friends. We spent hours together persevering through endless lectures filled with scientific terminology and labs held in windowless rooms strong with odors associated with long dead pickled creatures. Outside of class we used studying as a pretense to gather although on occasion we actually did cram for the inevitable midterm and final exams that were standard fair in the science department.

Home and family were never far from my mind as I navigated my way to graduation day. It was now time to use all of the scientific knowledge I had acquired and move into the world of work. I quickly found a job in my chosen field with a little help from one of my college professors. While the work was satisfying and used my talents, I was always on the look out for an opportunity. Maybe I
could do something more lucrative, stable, worthwhile, or rewarding. My searching phase just happened to coincide with the advent of alternate route certification programs in education. These programs designed to attract more people to the teaching profession offered flexible schedules and reasonable time commitments resulting in at least a teaching certificate and at best the added bonus of a master’s degree. In addition an attractive financial assistance package was attached to one such program offered at the nearby university. I decided to take advantage of this opportunity and enroll in the program. I was sure that I could teach elementary students especially after the story my aunt had recently told me.

“Nancy came home so upset from school last week,” Aunt Mary pronounced, “It seems that her teacher didn’t know that plants had boy and girl parts. What silliness! You would think that a teacher would know what these children learn working in the garden.”

I agreed and set off on a new life path one that in retrospect seems well planned but in reality was nothing more than a collection of well-timed events, opportunities, and decisions that took me to my next life phase-teaching.

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The fifth vignette describes Kathy’s college experience and career preparation, early work experience, and transition to teaching. It also introduces the theme related to taking advantage of opportunities.

In this vignette we’re reminded that Kathy comes from a small town in which she found congruency between her family and community experiences,
expectations, and beliefs. She is now a young adult who values education as evidenced by her pursuit of a college degree. She is also confident that she can succeed in school math and science as she has chosen to major in biology. Kathy’s choice of a college major and minor mimics the experience of the research participants. All of us have undergraduate degrees in a natural science. Twila’s program emphasized botany/horticulture while mine emphasized marine biology. Sarah did not indicate a specialty area associated with her biology degree. The three of us also minored in chemistry. We agreed that our minor was not chosen but rather mandated as prescribed by the program in which we were enrolled. Kathy also recognizes that she has chosen a field dominated by males. This also mimics the participants’ experiences. Sarah does not recall having any female professors in the sciences, but believes that there were some within the department. Twila remembers a few women in botany and horticulture but none in biology. I knew of two female professors in the biology department. They both taught genetics. I found the female professor that I had for genetics to be very masculine in her demeanor.

As Kathy “successfully navigates” her way to graduation, we find that she secures a job in a science field. This reflects the direct experiences of the participants in this study. Twila worked as a grower in greenhouses doing a variety of tasks associated with horticulture. Sarah took a job at Dupont indexing biological and mechanical patents. In this job she was responsible for identifying key words and writing twenty-five word abstracts to accompany the patents. I had several jobs in science related fields including: marine ecology lab technician;
bench chemist for an environmental testing company; and county inspector in charge of water sampling, sewer system checks, and restaurant inspections.

In this vignette, Kathy has already taken advantage of the opportunity to go to college. She completed her course of study, graduated, and found employment. She now takes advantage of another opportunity, to change careers. Kathy was not unhappy with her current job, but she was always searching. This is reflective of the participants in this study. Sarah had expressed an interest in teaching when she was an undergraduate. The requirements to enter the college of education and the time commitments involved however dissuaded her from pursuing a degree in education. Life circumstances that made it difficult for her to find a job in a science field along with the appearance of alternate route certification programs refueled her interest in pursuing a teaching degree. Twila said two events initiated her interest in teaching elementary students: 1) her niece coming home from school in the fifth grade and informing her that plants didn’t have “girl and boy” parts, and 2) leading all the school group tours at the greenhouse where she worked. She also mentions that the timing was right with the appearance of the alternate route certification programs. I had also considered getting a minor in education when I was in college, but like Sarah, I did not want to make the extra time commitment. I decided to go into teaching, because I also found it difficult to find a job in a science related field, and I thought teaching was a career that I could do in any geographic location as opposed to a marine biology related job that I would
probably only find in a coastal state. The opportunity to take enroll in an alternate route certification program also affected my decision.

In this vignette, Kathy weighs her options for a second career. She is attracted to the alternate route certification program because of the flexible schedule, short time commitment, and financial assistance available. When choosing a certification and masters’ program, study participants also considered these features. Twila and I completed programs that led to a certificate only, while Sarah’s program culminated in a certificate and an M.Ed. To obtain an M.Ed., Twila and I completed traditional programs. We also concurred that financial benefits associated with our graduate level courses were a primary incentive for completing our education programs.

I have discussed several instances within the vignette in which Kathy takes advantage of opportunities. I think this theme illustrates our approach to life and how we make decisions. We view any experience as an opportunity to learn even if the outcome is other than anticipated. When taking advantage of an opportunity we are aware one exists, become receptive to the opportunity, and act upon it. Although the data did not elucidate the distinctive qualities of the opportunities that caused us to act upon them, I suspect that we chose to take advantage of opportunities that more easily fit within the belief and value systems we had developed earlier in life. We did choose to take advantage of opportunities that led us to science and education careers. The data does support a high value placed on education within our lives and the belief that we could do science was instilled early.
The following are a sample of the quotes from which the finding related to “taking advantage of opportunities” is derived.

Sarah

- He said what do you know about fifth grade? I said, “I taught it three or four years.” He said, “Can you be here Tuesday afternoon for an interview?” This is Monday morning. Do you mean tomorrow? Ya, school starts next week. O.K. Fine. It turns out they had a fifth grade teacher whose husband all of a sudden got transferred, and she’d resigned on Sunday night. So I was back in small town America, except this time in the middle of Florida ….What an experience that was! I taught there six years.

Twila

- When you look at it in retrospect, it does look like what I was doing was very well planned. It really was a lot of serendipity and right things in the right place at the right time.

- I was teaching in Tylerville at a place called St. Mary’s. The big teacher layoffs in Michigan began a year and half later. When I was talking to the personnel people they were telling us it was going to be eleven years before we were called back. I went to visit one of my sisters, who was living in Florida. The rest is history. I started teaching in Florida. I taught basically fifth grade and some science to the sixth, seventh, and eighth graders.
Cyndy

I signed up to take the national teacher’s exam and the biology specialty area test. When I finished my exam, the test for the elementary teaching specialty was in the room next door. I heard the proctor say that they had some extra tests, which was highly unusual. I approached the desk and inquired as to whether I could take the test. They were more than willing to take my money. How fortunate I was to be there that day as it was the last time that the elementary education test was being offered through an alternate route. I passed the test in the 86th percentile.

Vignette Six - Elementary School Teaching

The school was abuzz as teachers ran to and from the copy machine with stacks of papers in their hands. Half finished bulletin boards, last minute mopping, and frequent phone ringing signaled the beginning of a new school year. I now felt like a seasoned professional as I began my third year teaching at Lincoln Elementary. A quick hello was the extent of any casual conversation, as we raced to complete our decorating, organizing, and planning that was squeezed between official school wide meetings.

“So much to do, so little time, “ I thought to myself, “Another school year ready to begin, what fun!”

As I was intently scrutinizing poster placement on the rear wall of my classroom, I was interrupted by a voice from behind.
“Hello, I’m Debbie Bauman. I’m the new fifth grade teacher. I wanted to introduce myself, since we’ll be grade level partners.”

“Nice to meet you! Come in. How is your first day of initiation?” I asked laughingly.

Debbie smiled and said, “To tell the truth, I am a little overwhelmed trying to fit everything into the schedule and learn everything I need to know.”

“You’ll be fine,” I reassured.

“Is this your first teaching job?” I inquired.

“Yes,” answered Debbie seeming a little unsure.

“Well, we’ve all had one of those!” I said.

“Did you get your degree locally?” I asked.

Debbie nodded, “Yes, I did an alternative certification program.”

“So did I,” I responded.

Debbie started to relax as she walked around the room surveying my handiwork.

“I like your room,” she said. “You have lots of interesting things. I really like your shell and leaf collections.”

Laughing I said, “I guess that’s why I got an undergraduate degree in science. I find all of that stuff fascinating.”

“How did you end up in elementary school?” she asked. “ Couldn’t you teach high school students?”

“I could, but I don’t want to teach the older students. I would rather teach children than content,” I said.
Debbie looked at me with a puzzled face as I continued, "I like the younger students. They’re so curious and ready to try anything. So when I graduated, I started looking for a job, but I was told that elementary teaching positions in this area are difficult to find. But, as always, an opportunity presented itself. A friend of mine called me one day and said there was an opening here. I came right over, talked with the principal, and the rest is history."

"Well, I’m glad you’re here. I’m not sure I can teach science. It just seems confusing with all of those terms," said Debbie.

"Science is really just about exploring in nature. It is really great for the students we have here, since we get a variety of ability levels." I reassured, "We take trips to the playground. They study insects, trees, and whatever else they can find."

"I never really thought of science in that way," Debbie reflected, "I used to spend hours in the tree behind our house watching the squirrels build nests and those little black ants march up the trunk."

"See, you can do science." I said, "If you ever want to learn more, I volunteer at the arboretum down the street. I’d be glad to show you around. If you like it, you could volunteer too. They also have summer jobs available, and they’re always looking for teachers to fill those positions."

Before Debbie could reply, we were interrupted by the arrival of the school principal. Ms. Reynolds while short in stature, being all of five feet two inches tall, commanded attention as she appeared with her flaming red hair balanced atop of
her head in a somewhat untidy bun. Her two-piece purple silk suit and pointy-toed shoes were reminders that the formal school year was underway.

“Oh, I see you’ve met Debbie,” she said as she entered the room turning her attention to me.

“I just wanted to come by and congratulate you, Kathy,” she said. “Not only do you have a high parental approval rating on our school evaluations, but your students also did very well on the standardized tests taken last spring. I think you had the highest scores in science. I’m really not surprised, since the students are always doing experiments and seem so happy. You know this year you are eligible for the outstanding teacher award.”

“I’ll consider applying,” I said reluctantly.

“I know you don’t like to take time away from your teaching to fill out all the paperwork, but you really should,” Ms. Reynolds cajoled, “Just think about it.”

As Ms. Reynolds and Debbie left the room I continued sticking posters to the wall leveling them with a critical eye.

“I guess I am a good elementary teacher,” I thought to myself.

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The sixth vignette extends the “taking advantage of opportunities” theme, tells us about Kathy’s early teaching experience, and introduces the “good elementary teacher” belief.

I chose to convey several general likenesses through a dialogue between Kathy and another teacher. In this conversation, we find out that Kathy teaches fifth grade. This represents the actual experience of the study participants. Twila
taught fifth and sixth graders at the elementary level. She also taught middle and high school students. Sarah taught fifth graders. I taught fourth and fifth graders at the elementary level and high school students as well. I did not find it unusual that we taught at the upper elementary level. In my experience, alternative route certification graduates were often placed in the upper grades even though they were certified to teach K-6. I also found that administrators and teachers were happy to have elementary teachers with science backgrounds to teach their fourth through sixth grade science. Administrators felt that most of their teachers lacked science content knowledge. The teachers lacked confidence to teach the science, and many of them preferred not to teach it at all.

The study participants also expressed their preference for teaching at the elementary level. Twila’s certification program was a pilot program being tested for a cohort. The majority of students graduating from this program received elementary teaching certificates. However, Twila completed an additional secondary methods course that then allowed her to earn a dual level certification. Her preference for teaching elementary students was soon ignored as a result of two events: administrators becoming aware of her science background, and the critical need for science teachers. Sarah ensured that she would only teach at the elementary level by purposefully limiting her certification. I also have a dual level certification, but I specifically sought out and remained in elementary teaching positions while teaching in the K-12 enterprise.

Within Kathy and Debbie’s conversation we also learn that Kathy volunteers at the local arboretum. Within my data, I found that Sarah and I had
similar volunteer experiences associated with organizations. We both volunteered in science related settings. I helped at the local marine aquarium, while Sarah assisted at an environmental education center. We both volunteered at our churches. Twila’s volunteer experience seemed to be more of a personal nature. She spoke about helping out a neighbor in need, and I observed her volunteering at her church. I found this interesting, because I think that Twila probably volunteers more often than she recognizes. To her it is part of one’s life and not something that you would label as extraordinary or unusual. As a result of these findings I chose to include volunteering as a commonality, but I did not emphasize it within the narrative.

Kathy also works at the arboretum in the summertime. This information represents the participants’ involvement in the informal education enterprise. All of us worked in summer camps associated with water science. This finding, together with our elementary teaching experience and science backgrounds, represents uniqueness within the science education enterprise. It was even more surprising then that the three research participants shared these characteristics.

The main theme introduced in this vignette is the belief that we were good elementary teachers. I first began thinking about this when I was formulating my research question and had a conversation with my outside reviewer. When I was trying to explain what I was interested in doing, she immediately assumed that I was talking about three people who had been exemplary elementary teachers. I began to think about this and asked myself what kind of evidence would support this assumption. I thought that I was a good elementary teacher. I based this
belief on several key pieces of evidence: my principal wanted me to apply for an
elementary science teaching award; my students earned high scores on the
science sections of the SAT tests; my students did well at the regional science
fair, and other teachers would come to me for help with their science lessons. My
data revealed that Twila’s principals encouraged and believed in her. Her
students also did well on standardized tests. In addition, Twila measured her
success by the level of her students’ happiness and their willingness to attend
her class when they might be absent from others. Sarah received a teaching
award, was asked to sit on several school committees, and also helped other
teachers at her school. In addition to these findings, we were also successful with
students of varying abilities. Twila recalls having nonreaders that were reading by
year’s end. Sarah remembers being responsible for “all” the children’s learning.
When she started teaching there were few if any special needs programs in
place. I taught in elementary schools where additional help for students was
provided through pullout programs. In this case students received extra help for
30 minutes twice a week. Most of the programs focused on reading.

The following quotes represent a sample of the data from which I derived
this finding related to the belief that we were good elementary teachers:

Sarah

o Apparently the Florida association of teachers thought I was good
  enough to make me Florida Elementary Science Teacher of the year in
  1994 or 5. I’d have to look it up. That’s pretty good validation. Kids
  remembered my science classes…
One of the best compliments I ever got was from the science supervisor. We had adopted new textbooks. I was on the textbook adoption committee and this one teacher was complaining about having this set of textbooks in her building. She didn’t much care for them…but I know Sarah has them over in her building. Of course the science supervisor said to her, and when was the last time Sarah used a textbook? Well, I took that as a really high compliment.

When you had a teacher who was doing the job right, your discipline problems dropped to zero. I had very few referrals, especially during those last three years I was teaching.

Twila

There are multiple things that I use when I think about good teaching. One is that my students always came to class when they could, including days when they were absent in other people’s classrooms. Students seemed to be mostly happy when they were in my classroom. The vast majority of times my students did very well on end of the year or standardized types of tests. I had children who went from being 10-year-old nonreaders to being readers, so there are a lot of measures that you can look for. I think those are some of the ones I look for.

Every principal that I ever had thought that I was a very good teacher. Even the very first principal that I had thought that I was a good teacher, and I was a first-year teacher. She knew that I would grow
and become better, but she also understood that I was a first-year teacher.

Cyndy

- My principal asked me to fill out the paperwork for Mississippi's outstanding elementary science teacher after only teaching for three years. Other teachers would come to me and ask for help with science content or exercises. I also organized the school science fair and developed a system for conducting science fairs that was adopted and adapted by several schools.

- When Eisenhower monies were available, the third principal I worked for gave me money to complete my master's degree. This money was not offered to any other teacher.

- I reviewed the science SAT scores for my students every year. My students had the highest composite SAT scores in science every year that I taught. Since I had data from three schools it did not seem to be school population specific.

Vignette Seven-Elementary Classroom

As the days progressed, the children became accustomed to the morning rituals of standing in line prior to the bell, filing quietly into the school, putting projects and papers in the appropriate places, and sharpening pencils in preparation for the coming day. In my room, small groups of both boys and girls also chatted amongst collections of odd and intriguing items emanating from every available space, math and science centers, and a reading corner disguised
as a beach picnic area complete with lawn chair, picnic basket filled with books, beach towels, and a palm tree. Others checked the bulletin board for their daily jobs. Clusters of desks that would seat four students were arranged sporadically around the remaining floor space. Trinkets scattered across desktops, special pens, immaculate workspaces, or the crumpled remains of yesterday’s homework betrayed the owners. The teacher’s desk nearly unrecognizable under a myriad of books, papers, and miscellaneous items that seemed to be reclaimed from the recycle bin was tucked into a far corner of the room.

I surveyed the scene breathing a sigh of satisfaction as I ticked off students’ names in my head and counted lunch money that had been sealed in white envelopes for safe keeping.

“We truly have a community of learners here in which we care for each other,” I thought as I watched Jane and David help Sarah carefully place her items on the shelf. Will and Penny were taking charge of the daily schedule moving nametags into the appropriate slots. Others gathered around as Jamie tried to manipulate paperclips at the science center. No one was alone.

“One can’t help being drawn into these children’s lives,” I contemplated, “with all of their varying personalities and abilities. I wouldn’t have it any other way as long as it’s balanced. Remember balance in all things.”

My momentary musing was interrupted by the sound of the final bell. Students scattered quickly taking their seats. They listened quietly without prodding to the short daily announcements. The pledge of allegiance brought students to their feet as we began our day.
“O.K., let’s do our morning ‘check up’, I said as students returned to their seats.

“It’s Jamie’s turn to start,” said David, “since she was last yesterday.” Jamie smiled as she told us about her new puppy, a basset hound with ears so long they swept the floor. When she finished sharing her story, Jamie chose Amanda to go next. As the students continued taking turns, I observed their behaviors and made mental notes. After everyone had shared, it was time to experiment with tops.

The students were fairly self-directed as they collected supplies brought from home and decided on “experimental labs” consisting of floor space claimed by each previously chosen group. I watched as students cluttered the floor with experimental equipment and materials consisting mostly of recyclables and other easily obtainable items followed by the ceremonial choosing of jobs within the groups.

“Don’t forget to begin with a testable question,” I reminded them even though I knew it was unnecessary.

As the students experimented, I moved from group to group occasionally stopping to listen, insert a question or make a comment. I might ask the students why they thought something was happening, or how they would test an idea. My brain was filled with mental notes concerning the students’ thinking and social interactions; after all, my goal was to develop critical thinkers that could communicate their findings.
I was interrupted by a question from Debbie who was standing in the doorway.

“Ms. Schultz, where are you?” questioned Debbie from across the hall. “Every time I come by here, I see children sitting on the floor or things flying in the air. I usually can’t find you. How do you get these children to work together?”

“It’s easy,” I replied, “Just have them do things. That’s how they learn. Everyone is good at something, so they all contribute. Oh, you also have to have high expectations and believe that they can do it.”

Our conversation was cut short by a student’s voice rising above the low hum normally heard during experiments.

“Ah, I get it!” cried Jamie.

From across the room, I heard a defeated David.

“I can’t do this,” he moaned.

“Sure you can,” I encouraged.

I resumed my rounds like a seasoned doctor guiding eager interns until the lesson ended. The day continued with similar experiences connecting all our lessons whether they were in science, mathematics, language arts, or social studies and placing them in a real-world context. The day ended with the building of “balanced” sculptures constructed from recyclables and requiring students to use what they had learned during their top experiments.

After the final bell, I fell into my typical after school routine that included a short reassuring conversation with a parent, a brief exchange with another teacher, and a cordial greeting to the janitor as I settled into grading papers and
arranging materials for the following day. An hour and a half later, I closed and locked my door and headed for home. On my way out, I met Ms. Reynolds as she went from door to door for a final check.

“I came by your room today,” she said, “but I didn’t want to interrupt.”

I just smiled and shrugged my shoulders.

“I really think you should complete that teacher award application,” she coaxed, “or at least sometime in the future consider teaching other teachers what you do.”

“I’ll consider it,” I answered as I hurried out the door waving my arms in the air as if to dismiss her request.

Driving home I anticipated the weekend ahead.

“I think I’ll start with my daily jog, scrounge up some supper, and relax with my novel,” I thought to myself, “I only have two appointments on my calendar: lunch with friends on Saturday followed by an evening choir practice.”

As I formulated plans in my head, Ms. Reynolds words returned.

“I probably could teach other teachers,” I reflected, “I could trade my M.Ed. in for a Ph.D.”

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Vignette seven focuses on three beliefs associated with teaching and learning: students learn through experience, good teachers act as facilitators using their creativity to develop communities of learners in which critical thinkers are supported, and attention to the affective domain is critical in teaching and learning.
These findings resulted primarily from a search focused on key words and phrases found within the data and elicited from probes dealing with teaching and learning. Some of these findings were also synthesized from stories told by the participants. These beliefs about teaching and learning are not grade specific, but represent the participants' beliefs about good teachers and important aspects of teaching and learning environments throughout the K-16+ enterprise. Within the vignette, these beliefs are presented in the context of an elementary classroom. I chose to portray these findings in this particular setting, because our first teaching experiences in formal education took place in elementary schools.

Therefore the first belief concerning the importance of learning through experience is conveyed as students prepare to experiment with tops using materials they had brought from home. It is further reinforced as Debbie questions Kathy concerning the effectiveness of having children work in groups. This belief is further emphasized as Kathy has students create balanced sculptures as part of an art and science lesson. I chose to revisit this belief throughout the vignette in order to communicate the strength of this belief revealed by the data. In addition, our experiential learning belief extends beyond classrooms situations to those taking place in natural, human enhanced, and human made settings.

The following quotes are a sample of the data from which this finding related to “experiential learning" was derived:
Sarah

- There is lots of stuff you can do just in schoolyards. In my last school before I became a fulltime student, they had a nice big schoolyard. We could go out there and measure stuff and do outside experiments. We could go into the courtyard and do bubbleology, studying bubbles and how they work. If you checked my classroom, you might not even find us there.

- Sometimes in the science education classroom, they’re out in the hall racing balloon cars up and down. Sometimes they’re playing with bubbles. They’re doing all kinds of things. It’s like the ideal school classroom. People are doing things, talking, sharing ideas, not so much sitting and listening….It’s about the learning. It’s not about the delivery.

Twila

- I think the younger the child, the more important it is for a teacher to just let the child play and experience. I think the child is more important than the teacher. We should not try to impose ideas on them. I think young children are very, very good observers. Teachers of these children can work with them through any modality that they want to from drawing to dance to speaking etc. in order to draw out these observations. I think children can do much much more than we give them credit for. …This is a teacher who likes to have lots of things out and about in the classroom and isn’t afraid to go out the door or out
the window or wherever to introduce the child to the stuff, lots and lots of stuff.

- I know for a fact that they need to be teaching science, and they need to be doing it in a manner that is consistent with science. I also know that the vast majority of them due to believe structures fear and other factors are going to basically teach it like a big reading lesson from a textbook.

- And my niece was at the age where she wanted to know how seeds got made. And so I went outside, and we got some flowers. We looked at the flowers, and we looked at the flower parts. We took them apart and did a bunch of stuff with them, so she could see how flowers were made.

Cyndy

- I tried to incorporate a lot of doing and fun into whatever we did.

- I also did lots of hands-on minds on activities that stretched student’s thinking and helped them develop as critical thinkers.

- I did big themes on the ocean. We would create jellyfish from paper plates and hang them from the ceiling. We transformed the whole classroom into an underwater habitat. We had big crepe paper streamers hanging down. We had a kelp forest in one corner, and we had the coral reef in another corner.

- I was always doing things with the children, and the other teachers would ask me how I could get so and so to do work. He won't do any
work for me…. my answer was if you have them do something they’re fine. So I always knew you had to have children do something

The second belief reflects four behaviors that we think good teachers possess. These include: acting as facilitators, being creative, developing communities of learners, and supporting critical thinking. These behaviors are recognizable throughout the vignette. Kathy acts as a facilitator or guide for her students. She has designed her classroom so the students are in charge of many of the activities, while she quietly oversees their movement from the back of the room. She also becomes a partner in the learning process as she moves from group to group asking questions. This portrayal represents the two aspects of facilitation evident in the data. Kathy’s creativity is also present in two forms within the vignette. Kathy has provided learning centers that attract the students’ attention, and she has developed transdisciplinary learning opportunities that include the use of recyclables and incorporate art. This portrayal reflects the range of meanings attached to creativity as found in the data. Creativity for us may mean making use of community resources, approaching a lesson from a new perspective, or finding unique ways to help students learn. Building a community of learners is conveyed by the activities taking place in the classroom. Students are working in groups, taking turns, learning about and helping each other. The students and Kathy are also exhibiting supportive behaviors. This description interwoven throughout the vignette represents our belief in building a community as an important foundation upon which learning rests. Within a safe place to practice, students are able to move beyond their perceived limitations.
We also believe that good teachers should strive to develop critical thinkers. This belief is apparent in Kathy’s questioning techniques and lesson goals. We believe that providing opportunities for critical thinkers will help us develop the scientifically literate populace that our world needs.

The following quotes are a sample of the data from which the “teacher as facilitator” finding was derived.

Sarah

- Well first of all the desks would be arranged in small groups not in rows. They [visitors] would see children going about their business doing what they need to do. The children would be self-directed learners. They [visitors] might have a hard time finding me, the teacher as facilitator. Very often I’m sitting with a group. I’m working with a group. They [visitors] would look in the front of the room and there’s probably nobody there except some kids or something. They [visitors] might even have a hard time deciding which is the front.

- Purposeful noise…. If you’re used to traditional classrooms, you’d probably find that it’s noisier. I was always and forever getting in trouble for having noisy classes. It didn’t bother me. They [students] were doing stuff and getting excited about it…

Twila

- This person [ideal teacher] would also have multiple means of helping with analogies and models. They [ideal teachers] would question you. They would get you to use your reasoning powers or to use your
critical thinking, if you like that better. They would keep you curious and stay curious themselves. They would always be on a quest to see that there was a next level. They would always be looking to the next generation to do more. They would stay open minded enough to see differences in nuances that may actually mean something.

- I had a sixth-grade teacher when I was in Smithtown, Arizona, who was one of those very creative… understood children and teachers. She was very helpful with getting me on tracking and keeping me on track. She made sure that I stayed attentive. Then when I was in high school, I would say the two science teachers that I had were the two teachers that probably kept me going. And at no point did they ever stop me or try to stop me from going ahead. They always made sure that no matter what, I had lots of things to do. They would even help me get books from colleges across the state or whatever to keep me interested. I think they figured out that I could easily be one of those high school dropouts, because I was bored to death.

Cyndy

- So the perfect professor would be a facilitator rather than a lecturer. They would provide opportunities for the students to be comfortable, so they could learn. She [ideal professor] would provide opportunities for there to be a community of learners within the classroom. That doesn’t mean the students aren’t challenged or don’t become frustrated. There is a fine line there. Students have to move into unknown territory in
order to learn and with that they will become frustrated. The perfect professor would be there and be supportive, but also give them opportunities to develop as autonomous learners. The ideal professor would help them begin to recognize they can do this on their own. They don’t need the professor’s approval and then if their project doesn’t look like everybody else’s that it’s OK.

The third belief represented in this vignette is the importance of the affective domain in teaching and learning. Kathy begins the school day with a “check up” session in which students can share events of a personal nature. This sets the tone for the classroom experience and heightens Kathy’s awareness of situations that may arise during the day. I chose to portray this theme as an event that started the day to convey the participants’ belief that learning is limited by the emotional state of the student. We believe that if we regard our students as cognitive beings alone, we will not be successful as teachers. Participants in this study used words such as humanistic, caring, and emotional connection to reflect teacher qualities that addressed the affective domain. This belief is evident throughout the data in childhood memories, school recollections involving both children and adult learners, and the participants’ student experiences.

The following quotes are a sample of the data from which the “attention to the affective domain” finding was derived:

Sarah

○ When you’re working with little people, caring is probably the most important one [characteristic of a good teacher], I would think. Well if
you care, you will find ways to make the learning happen. And also I think if you care enough, you will be paying attention to what’s going on in your class to promote an optimum learning environment for everybody.

- They’ll [Sarah’s students] tell me about other professors, the one’s they have complaints against. I’ve even had students drop by my office and tell me “rah rah rah”. I’m having such a terrible time with and then go on about how arrogant one professor is or how picky another one is. I’m like too bad you feel that way. Just kind of reflecting back. They must feel comfortable being in my presence certainly comfortable enough to say things…

- It seems a shame to me to be teaching college level students and not really be interested in them as people. One of the things I find about teaching my students is the relationships I form with some of them. I have one who went off to France to student teach and the other day I got an email that she was back in the states and was going to be in Arizona. She was taking a teaching position in Arizona. I emailed her back and said congratulations.

Twila

- I don’t ever remember giving up on a child. I can remember any number of children saying things to me like I can’t do that. My general response to them was, “Of course you can, maybe you have to work
harder.’ Interestingly most of the time they would try again, and they would go back after it.

- I kept saying that I like being in the classroom. I like working with the kids. They said, ”That’s even more reason why you should be doing it [teaching teachers]. There are many people doing it [teaching] who don’t even like kids.”

- He [good high school science teacher] hadn’t been teaching too long when I had him, but he taught 35 years. He taught a long, long time. He was a good teacher. He kept up with the times, but I don’t think he ever went beyond his bachelors. I don’t think he ever made any effort to go beyond his bachelors. He made an effort to know his students.

- Professor Lowell was one of my favorite professors in horticulture. He always wanted me to do independent studies with him. He would give me bench space. We would run research tests…. He talked to you like you knew what you were doing. He always talked to you like you had good ideas….and when I was working in greenhouses after I graduated; he still came and visited me to see how I was doing.

Cyndy

- There is almost always a teacher that influenced them [preservice elementary teachers], and it had something to do with caring or connection with that teacher.
I had kids come to my class who were on drugs, who would threaten to throw tables and chairs around the room. Thank God the gang members picked them up, and took them away.

I think it had more to do with the way I interacted with the students rather than the content itself….being honest, fair, approachable, and caring.

It's [ideal teacher] definitely a teacher that cares about their students; has that personal connection to the student; teaches to the mind, body, and spirit; is interested in all aspects of the student and not just intellectually.

I really think that it's almost more important for the teacher to have those personal qualities they use to connect with the student rather than it is for them to be the person who had the best grades….I just almost think personal connection, emotional connection, is more important than content knowledge.

Vignette Eight-Teacher Education

Once the idea was planted in my head, I began to review my options for getting a PhD. Decisions had to be made. Balancing work, family, and school would be no little feat. Stretching my budget would also require some ingenuity. Of course I couldn’t go just anywhere to school. Financial aid, flexible schedule, and location became some of the driving criteria. After researching several options, the University of South Florida seemed to be the only choice.
Once I decided on a program of study, I found a mentor in the science education department. She would guide me through the labyrinth of resocialization from teacher practitioner to researcher. In retrospect, I was probably drawn to her because she shared my philosophy of teacher as partner in the learning process, learning by doing, and mutual respect between student and teacher that had become embedded in my belief system. As a result there were opportunities within my course of study to practice what I had learned while teaching science methods classes for preservice teachers.

I found these experiences not unlike teaching my fifth graders at Lincoln Elementary. Students still learned in the same way and still required intellectual stimulation approached from a humanistic viewpoint. Therefore I continued to use a student-centered approach to my teaching acting as a facilitator and providing opportunities for exploration and experimentation. I would build a community through small collaborative groups and provide support as students experimented and reflected. In a typical class the undergraduates might be seen laughing and comparing the results of paper bridge design or timing the speed of balloon cars racing down the hall before we met to debrief.

As I evolved in my university teaching practice my philosophy changed only slightly. I had always believed instructors teaching science methods should have some understanding of how science works and the nature of science, but I also began to recognize the importance of field experience and an understanding of how people learned. I tried to help students become aware of inquiry as the process through which learning takes place not just science learning. Although
this approach was sometimes met with resistance, I persisted. Throughout this
time, I never lost my love of teaching and planned to make it a priority in my
career. As graduation approached I reviewed job postings focusing on institutions
geared more toward teaching than research.

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The final vignette presents three findings: belief that university science
educators should have science content knowledge, belief that preservice
teachers should have opportunities to practice, and belief in a constructivist
approach to teaching and learning. I have also chosen to end the vignette with
two similarities that extend the high value placed on education theme. They
include: love of teaching, and search for a career in an institution geared more
toward teaching than research.

The first two beliefs are stated directly within the scene as Kathy
reminisces about her teaching experiences. I chose to present the first belief
concerning the importance of a science educator’s “science content knowledge”
as one that Kathy developed in the past, although she cannot recall the
timeframe. This belief is one that is shared within the science education
community as evidenced by the requirements for admission to graduate
programs. It also reflects the qualifications of the majority of science educators
who are members of professional associations for university science educators.

The quotes that follow are a sample of the data from which this finding
was derived:
Sarah

- A real science educator should have also spent some time doing science, and knowing what science is about. They could have an undergraduate degree in science. I really think that may be the way to do it. You would have an undergraduate degree in science and then spent some time in science… but you need to have a lot of science. A science educator should have a lot of science in their background. They should also be interested in science. To just be interested in the education is foolishness, because science gets old. It’s one of those fields where you really have to keep up with what’s going….It doesn’t necessarily mean that you have to know about chemistry or know about biology or that you have to know about the environment. You certainly should have a smattering of each of those.

Twila

- They [science teacher educator] would understand enough of the core of science to be able to converse about the major concepts. I'm not talking about little piddly facts or factoids. I am talking about understanding what is in electricity. I'm talking about understanding what a zero or a one is in anything like electricity or engineering. Computers are all the same thing. They're all on and off switches. We have multiple ways of creating those [switches] with electricity and magnetism predominately. Those are big ideas. So when you're
talking about something electrical that [switches] has to be involved somewhere.

Cyndy

- I also think by being in science and having a science background….
- recognizing that doing science is actually how we do everything, or doing inquiry is actually how we learn anything. Those steps that they use in methods of science are just an inquiry: asking a question, developing a plan, making observations…. We do science when we learn anything. If we can get that across to people, then I think people won’t be as afraid to teach science.

The second belief, regarding the importance of opportunities to practice within the teacher education program, is presented as a more recent development to reflect the growth of the participants during their PhD programs. It also reflects how the participants developed connections between their elementary teaching and college teaching experiences. At the elementary level opportunities to practice took the form of experiential learning. At the college level the participants continued to provide these opportunities and extended opportunities for practice to field experiences when possible. This finding also revealed itself as direct statements made by the participants.

The following quotes are a sample of the data from which the finding related to the “importance of opportunities to practice” was derived:
Sarah

- Certainly I never have in mind the ideal classroom with the sage on the stage and the little faces eagerly hanging on every word. Well, A that doesn’t happen, and B it’s not a good model….occasionally that’s a good way to deliver information. They should have read the stuff ahead of time and then come to class to practice and participate….sometimes they’re playing with bubbles. They’re doing all kinds of things….

- Inquiry is the kind of thing that if you want to know what it is, you have to do it. You just can’t learn it. It’s not a book learning thing that you then have to put into practice. You just have to get out there and do it.

Twila

- I think there should be a lab designed for them [preservice teachers], and the labs should actually match what's going on in the classroom. Heaven forbid! I think there should be a second lab that actually teaches them how to take and transfer this [science] information and put it into the classroom where they're likely to be teaching in the future. I think there should probably be a follow up course after all this is done. They should have a practical course where they actually use the materials and their knowledge to practice. They would have to figure out what's going on with the kids that are put in front of them. They would have to figure out how to make it work for that group of children. This model is significantly different from what I see right now.
Everything is separate. Everything is compartmentalized. They don't use the science. They forget the science. They get an attitude about the science. I do think there are ways to do things that they [science teacher educators] wouldn't have to create any of those issues.

Cyndy

○ I also think that the perfect science educator for these students [preservice elementary teachers] probably would be very attuned to their students needs. Their courses would grow, adapt, develop, and change from semester to semester. How the course changed would depend on what types of students were in their classes. They may have some specific objectives for the course, but there would be a few objectives that could be met in a variety of ways. There would be opportunities for the students to practice, develop, and learn through doing instead of through lecture and sitting.

The final belief derived from this study is the participants’ belief in a constructivist approach to teaching and learning. I chose to represent this finding as Kathy recognizes the importance of understanding “how people learn” in her teaching practice. I also indirectly alluded to it in the final two vignettes through the following: the teacher’s instructional technique and the structure of the learning opportunities. I chose to present the constructivist approach to teaching finding in this manner for two reasons: the multiple meanings that are ascribed to the term constructivism, and the form of the data from which the finding was derived. Within the interview data, the participants gave numerous accounts of
the types of strategies a constructivist teacher may use in the classroom, but I was still not clear about the meaning they attached to the term. I requested additional information from the participants for clarification. As a result, they each sent me a paper that described their interpretation of the term. From these two data sources, I concluded that we believe a constructivist approach to teaching is learner centered. In this model the learner is actively engaged in knowledge construction through a process of destructuring and restructuring (Fosnot & Perry, 2005). This process may be evidenced by the “I get it” moments often expressed by students. In other words we believe that students are not empty vessels that need to be filled up, but rather knowing beings who will incorporate new experiences into their existing schemata in order to create meaning.

The following quotes are a sample of the data used from which the finding related to the belief in a “constructivist approach” was derived:

Sarah

- You ask them [preservice teachers] questions, like how did that work for you or what do you think about that, as opposed to jumping in there and making comments about what they’re doing. I really like to ask them questions and have them tell me what they’re thinking. They know how it went….and then try to help them come up with resources and suggestions as to how they could improve things. I try to remind them that it’s always about improvement.

- I used a lot of AIMS materials and a lot of other materials that have what some might call worksheets. I prefer to call them data collection
sheets. They have instruction sheets. They have data collection sheets, so there’s a lot of data collection. I think I would put more emphasis on what they learned from that data…. not just activity for activity’s sake. There would probably be more lead in. It’s hard, because of time constraints. I would do more asking why are we doing this, and what did you learn when you did this? That’s where the real learning comes in. What did we learn from this activity? I think there would be more of that kind of explicit metacognition for students.

Twila

- I truly believe that every human being can learn something somehow. It is my job to figure out how they can learn it and make that situation appear so that they have the opportunity. I am quite constructivist. I really believe that people build their own knowledge. I think the child is the worker in the model and not the teacher. If you’re going home with a headache and they aren’t, something’s wrong. I’m very much a humanist in approach; I think that it’s best to use a positive human regard in what I consider tactfulness. I think you get a lot more results. The old colloquial phrase from my neighborhood is you catch more flies with honey than vinegar…. Probably some of my favorite things are “of course you can”, “how do you know”, “what’s you’re evidence”.

Cyndy

- So I basically use a constructivist approach, and I try to base the lesson on their prior knowledge. Then I go from there and get them to
explore. What students come back and say to me is that this class is different than any other class they’ve ever taken. It's even different than the ones they're taking now. They say a lot of people talked to them about constructivism and the constructivist approach, but nobody taught that way. And so this is entirely different, and it's an entirely different way of thinking. A lot of the people seem to like it better, because they feel like it's less threatening. It's not just a paper and pencil test. It's not just memorization. They're thinking about what they're doing, reasoning it out, and recognizing there's more than one way to do things.

At the end of the vignette, Kathy reflects on her love of teaching and her desire to work in an institution geared more toward teaching than research. I chose to include these similarities at the end of the narrative to provide an endpoint for this study. The three participants are at three different levels in their careers. Twila is now a tenured full professor and has been at the same institution for 14 years. Sarah is an assistant professor in her third year as a faculty member. I am just beginning my journey. I will be interested to find out if Sarah and I will be as tenacious as Twila with regard to our love of teaching.

The following quotes are a sample of the data from which this finding was derived:

Sarah

- I wanted an institution where I was going to be comfortable doing what I do which is teach. I didn’t want to go to a place where research was
going to be the goal, and you did teaching to support your research habit. I do the research only because it supports my teaching habit and that’s what they require….I was looking for an institution that was interested in students and teaching students how to become good science teachers. That is why I did this in the first place.

Twila

- I really wanted an institution that was more geared toward teaching than research. I really didn't like the atmosphere at Big Town University. I didn't think it was conducive to much of anything….My third criteria [for choosing a college] would have been that there was something interesting that I was going to be doing when I got to the college. I ultimately chose College A, because they literally wanted me to assist in building the science and math for teachers program that I now direct.

- I have always loved teaching. I used to think of research as a necessary evil. Now my view has changed because of the population I work with….still love teaching.

Cyndy

- From the very beginning, I was looking for a program in which I could develop my talents and skills. I really wanted to teach future teachers. I wanted to help them understand what I had learned in my classroom. I wanted them to have the successes and fun with science that I had.
As I have gone through the PhD program, I realized that it was a resocialization process. I was becoming a researcher versus a practitioner. I knew that intellectually when I began, but I didn’t realize what a struggle it would be for me. The more I learned the more I feared that I would not be able to communicate with the very people that I wanted to teach. I feared that I was now the “other” and could no longer understand their viewpoint.

**Impact of Mentor Professor**

A final point I would like to address is the impact of the mentor professor. I chose not to list this as a finding at the beginning of the chapter for two reasons: 1) sharing a mentor professor was a secondary criteria that I used when selecting the sample population, and 2) suggesting that the impact of the mentor professor was the same for all of us would be difficult to assess within the context of this study. The three participants built relationships with the mentor in very different circumstances. First, the university does not represent a static system, but rather a dynamic one that operates in complex ways on several levels simultaneously. Since the three participants attended the university at various times, the context of the relationship was different. Second, the personal relationship between the mentor and mentee was impacted by, among other factors, the environment in which the relationship developed and the characteristics of the individuals involved.

So if one asked whether the mentor professor influenced us, we would agree that she did. How could she not? Every experience that we have changes
us in some way. If I were to describe the general nature of the influence, I would use the words of the mentor professor that corroborate the data in my study.

Mentor Professor

- I like to think that I was able to take what was already a nucleus inside each of you, that to a greater or lesser extent was not supported by your educational experiences previously or the system in which you lived previously, and help you bring it to the surface….bolster those [qualities, skill, and abilities] to the point where they become your dominant way of functioning and thinking….giving you the confidence….giving you the tools to expand.

To describe the influence of the mentor professor with regard to our growth within the educational enterprise, I would use the words of the participants and the mentor professor. Twila recounted the mentor’s influence in the area of research as helping her develop an understanding of what it means to engage in qualitative research. Sarah and myself, while also having conducted qualitative research guided by the mentor professor focused our responses on her influences concerning our teaching practice.

The following quotes are a sample of the data that explicate this understanding:

Sarah

- My students sometimes tend to think that they are the ones teaching the class. I think that’s the biggest thing [impact of the mentor
professor], and the other thing is that I am much more constructivist than I would have been.

- There would now be much more stuff going on, but still it [previous teaching style] was pretty constructivist in nature.

**Twila**

- I don't know if it's just because I had her [mentor professor so much, but Beth was really pretty much the best one [professor] that I had. At least she challenged us to think. At least she challenged some ideas. She pushed some envelopes....that whole notion of asking questions. Is there something to research here? How do you go about researching it?....Beth was the one who introduced me to the whole notion of research in the schools.

**Cyndy**

I don't think my philosophy has changed so much. I'm thinking about philosophy at a couple different levels. First, I'm thinking about it as an elementary school teacher and then as a university educator. I think my philosophy is still the same, but I think I now know more about what my philosophy is. Maybe I was doing it intuitively, but now I have words to put with it.

**Mentor Professor**

- I can't really remember the teaching styles that each of you had to start with.... Twila is not particularly structured. Sarah has a lot of structure....I don't have a sense of structuring with you [Cyndy]. In
other words I would say that here’s what you do and here’s how you do it [demonstrating with hands]. Then you take what I do and weave it into what you do. With Sarah I would say here are the things I do and here are the things she does [demonstrating with hands]. She’s used her ability to make a box to structure and put my stuff inside the box. … With Twila, I don’t remember because so much of what I developed was developed in conjunction with her. I don’t really know what she had by herself initially.

Summary

The findings in this chapter were presented as a narrative in an attempt to relate them in an appropriate, interesting, and informative format (Merriam, 1998). As such, the narrative contains both description and interpretation. In order to distinguish between the two, I included a discussion section following each vignette. These discussions identify the findings, describe their representation within the vignette, elucidate my reasoning for the representation, and provide a sample of the supporting data.
Chapter V- Conclusions

Introduction

The purpose of this research was to explore what values, beliefs, and experiences three science teacher educators with elementary teaching experience have in common and how these commonalities influence their thinking about teaching preservice elementary teachers. I have chosen to begin this chapter with an assertions section based on the recommendations for writing up qualitative research according to Merriam (1998) as follows:

It is my intent to provide information that allows the readers to reconsider their knowledge of the case or even modify existing generalizations about such cases. Nevertheless, having presented a body of relatively uninterpreted observations, I will summarize what I feel I understand about the case and how my generalizations about the case have changed conceptually or in level of confidence (Stake, 1995, p. 123).

This section is followed by three others which include: implications of the study, directions for further research, and a summary.

Assertions

When I began this study, I was trying to determine what values, beliefs, and experiences the three participants had in common. The following narrative represents these commonalities in the form of a composite individual named Kathy.
Kathy grew up in a small town. When I say small, I mean a town of 2500 residents or fewer. Some people would consider this place a mere village. In this town you would find a handful of stores, churches, and taverns along with an elementary, middle, and high school. These schools would be in close proximity to each other and the campuses may even be indistinguishable. The high school would hold no more than 600 students in all four grades. As you look beyond the town proper, you would find farms, woods, ponds, and all manner of natural habitats; places where Kathy spent many hours playing as a child. It was during these times, whether alone or with family members, that Kathy learned science as a normal part of life although she was too young to recognize it as such.

Kathy was a member of a nuclear family consisting of a mother, father, and brother. Her brother, at times would be her only playmate. Other times she might be found with her two close friends. She would also have an extended family consisting of aunts, uncles, and cousins who would provide support even if they didn’t live in the same geographic locale. In Kathy’s life strong female role models, such as her mother and Aunt Betty, provided examples of influential women both within and beyond the immediate family structure. The family also provided examples of responsibility as each member went about their daily lives working and helping neighbors. Her family members also exemplified a balanced approach to life as they set aside time for spiritual growth and relaxation.

Kathy began her formal schooling in kindergarten. Her parents, who placed a high value on education, also expected her to attend college and major in a science field. In her elementary years, she continued to play outside and
developed a passion for reading. She easily transitioned into high school where everyone took math and science classes. Male teachers taught these classes, but Kathy did not think this was unusual or important. Kathy always believed that she would succeed in these courses, and she did. During this time, she continued to receive support from her parents. Her high school science teachers, while maybe not always encouraging her did not discourage her. By the time she graduated from high school she had made the connection between personal and school science. Her high school experience did not entirely consist of academic pursuits, but also included opportunities to extend her interests and talents through extracurricular activities.

Kathy did indeed attend college, major in a natural science, and had a successful experience working in a science related field. Throughout Kathy’s life, she remained opened to opportunities. When one presented itself in the form of an alternate route certification program, she took advantage of it. She weighed her options and enrolled in the program. As a result, she began her second career in education, as an elementary teacher. She excelled as an elementary teacher having positive and rewarding experiences. During this time she also developed a teaching philosophy that included a belief in experiential learning. She also believed that effective teachers were facilitators who acted as partners in the learning process and who used their creativity to build a community of learners in which critical thinking was supported. She continued to love teaching, furthered her education, and extended her teaching experience to informal education.
As Kathy developed as a teacher, she was encouraged to pursue a PhD, so she could educate other teachers. After weighing work and family responsibilities and encouraged by financial support offered by the university, Kathy enrolled in a program at a nearby university. Throughout her course of study she had opportunities to teach preservice elementary teachers. She particularly enjoyed working with this group of students, because she felt she understood them and had valuable incites to offer in the form of real world experiences. She recognized that her students were not empty vessels waiting to be filled, but rather complex human beings who constructed knowledge within the context of their lived experience. Within these classes she also continued to care about her students and treated them as members of her extended family.

Initially I found the information available about science teacher educators to be primarily limited to demographic data (Jablon, 2002). Beyond this I found only two studies focused on science teacher educator characteristics, and these studies applied to individual cases (Chacon, 2002; D. C. Rice & Roychoudhury, 2003). Literature about or information focused specifically on science teacher educators with elementary teaching experience was even more difficult to access, because we represent only 10% of the science teacher educator population (Jablon, 2002). For me, findings here in extend our knowledge base concerning the qualifications and characteristics of science teacher educators and can be used as a baseline for further study.

In addition to revealing the commonalities of the participants, I was also interested in how these similarities influenced our thinking about teaching
preservice elementary teachers. I concluded two of the findings directly address this question. The first finding is our past positive experiences as elementary teachers. As former elementary teachers, we were successful in school atmospheres characterized by personal and professional closeness. Within these environments, teachers teach “students” (Hargreaves, 2000). This is in contrast to the experiences of the majority of science teacher educators who have secondary or post secondary teaching experience (Jablon, 2002). They are accustomed to thriving in institutions where emotions are considered impositions. (Hargreaves, 2000). Contrast in teaching experience is one factor that contributes to misunderstandings between the science teacher educator and preservice elementary teachers (Wright et al., 2004). Elementary teaching experience alleviates some of these misunderstandings and gives us more credibility with the preservice elementary teachers (Martin, 1985). This perception of improved credibility lessens one of the barriers to becoming an effective science teacher educator for preservice elementary teachers.

The second finding here in is our belief in the importance of attention to the affective domain in the teaching and learning process. We consider students as complex human beings who construct knowledge, not as empty brains divorced from their physical and emotional states. We recognize that more effective teachers exhibit “caring” behaviors when interacting with their students (Thompson et al., 1998). We also recognize that preservice elementary teachers represent a distinct culture with regard to their beliefs about teaching and learning science. The majority of these students come into the teacher education
programs feeling inadequate and lacking confidence in their ability to teach science (McGinnis, et. al., 2002; Watters and Ginns, 2000). By attending to the affective dimension of learning, science teacher educators have an opportunity to alleviate some of these negative feelings resulting in more self-efficacious elementary teachers. It makes sense then that more self-efficacious teachers would have increased confidence in their abilities to teach science and would be more motivated to do so.

I also believe that the attention to the affective domain evident in our teaching practice is an outgrowth of our lived experiences and the belief systems initiated in childhood and extended during our adolescence. The belief literature supports this assumption indicating the earlier the belief is formed the more resistant it becomes to change (Pajares, 1992). For me, it makes sense that these beliefs would influence my teaching practice, because I cannot separate my personal identity from my role as a teacher (Berci, 2002).

Implications of the Study

This study extends the existing limited literature base with regard to what we know about the qualifications and characteristics of science teacher educators. It therefore, has the potential to encourage science teacher educators to broaden their research endeavors to include self-studies and studies of other science teacher educators. With this change in perspective, comes the opportunity to develop a better understanding of the complex teacher student relationship that is an integral part of effective teaching and learning. The study also has the potential to raise questions concerning the importance and
appropriateness of attending to the emotional aspects of learning within college classrooms causing some science teacher educators to rethink their class structure. Findings from this study may also be used as the foundation of an instrument designed to gather information about science teacher educators, so we gain a better understanding of what qualifications and characteristics science teacher educators currently possess. We may also be able to identify areas that appear to be critical in developing effective science teacher educators and use these as departure points for additional research.

Every year there are numerous positions advertised for science teacher educators that remain open. By in large, these positions require teaching preservice elementary teachers and seek applicants with elementary teaching experience (Barrow et al., 2005). PhD programs, however, for science teacher educators are currently not designed to attract applicants with these qualifications. They are still geared toward individuals with secondary teaching experience and an undergraduate level degree in a natural science. Therefore, faculty and graduate assistants, who are assigned to teach preservice elementary teachers, often do not possess the affinity for or abilities to communicate with this population. Hence, this study has potential to encourage changes in applicant recruitment and program design that may resolve these issues. Recruitment procedures may be refocused to attract applicants with science backgrounds and elementary teaching experience. One viable applicant pool is the alternate certification programs intended to attract career change people with science backgrounds. Another applicant pool, often not considered,
is elementary education majors. Many elementary education programs now include specialty area requirements amounting to a minor in one subject area. A person could graduate from one of these programs, complete a masters’ degree, and engage in inservice opportunities geared toward science. Consequently this person could conceivably accumulate a level of content knowledge accepted by the science education community. Existing science education programs may also be redesigned to reflect the changing needs of current graduate students by offering them opportunities to develop the skills and abilities necessary to effectively teacher preservice elementary teachers. The programs could also be redesigned to meet the needs of incoming students with elementary teaching experience by requiring cognates in science.

In addition this study has the potential to influence the way we think about retaining quality science teacher educators in the university system. As students graduate from programs and enter the university system, they are resocialized from practitioners to researchers. In the current system, it is easy to lose sight of the importance of the impact of the science teacher educator as practitioner. The system as it is now designed rewards university educators focused on research rather than teaching. Considering the importance of the student teacher relationship, it makes sense to rethink promotion and tenure requirements to attract and maintain quality teachers at the university level.

Directions for Future Research

As I come to the end of this study, I realize that it has raised many more questions than it has answered. I can think of numerous directions for future
research, but I will only share a few of them here. I would like to continue this research, employing the same methodology, to a sample population similar to the one in this study. I would be interested in extending this study to a larger sample of science teacher educators with elementary teaching experience to determine if they had experiences, beliefs, and values similar to the study participants. I would also like to expand the study to science teacher educators without elementary teaching experience, and compare their results to their counterparts with elementary teaching experience. In addition, it would be interesting to focus on a subset of the data across the science teacher enterprise such as common experience, or common beliefs. I also think each finding by itself could be studied more in-depth.

Post Script

As I reflect upon this research process, several things come to mind concerning the methodology that I chose. I was continually reminded of the importance of the “researcher’s” lens as it impacted the entire process from beginning to end. I was also reminded of the importance of sharing with my readers my thoughts and intentions, so the process and conclusions could become visible to them. I did not find the roles of researcher and participant to be difficult to reconcile as qualitative studies incorporate the perspective of the researcher. I also took precautions in the form of data triangulation, member checking, and input from three outside sources to help balance my viewpoints throughout the study. For me, being a participant as well as the researcher seemed to enrich the study allowing for a more collaborative effort. I would say
that I would not want to undertake such a study without having a prior relationship with the participants or having an extended time period in which to collect data. Knowing the participants for five years definitely allowed me to gather in-depth data in a short amount of time, because the participants were less guarded. I also had prior knowledge to build upon. One thing that did surprise me was the importance of being flexible concerning the data gathering techniques and matching those with the researchers’ level of expertise and the participants’ predispositions. For instance, it had been suggested that I use an open interviewing technique and ask the participants one question. How did you get here (where you are today)? I found that technique did not work for my participants or me. The question seemed to be overwhelming and stifled responses. The semi-structured interview with guiding probes elicited much richer stories focused on the topics pertinent to this study. The participants seemed much more comfortable and the interview became more conversational in tone.

Summary

I would like to end with a closing story adapted from the work of Loren Eiseley (1978). This anecdote summarizes why I think this study is important.

Once upon a time, there was an old woman who would spend her mornings walking along the beach at the ocean’s edge. One day, as she was walking along just after sunrise, she saw in the distance the figure of a young woman. This woman seemed to be dancing. The old woman smiled to herself as
she hurried to catch up to this “beach dancer”. As she got closer to the young woman, she realized that she was not dancing at all. She was bending down to pick up small objects that were covering the beach. One by one she was throwing the objects back into the ocean.

As the old woman drew closer, she called out, “Good morning! May I ask what you are doing?”

The young woman paused for a moment and replied, “I’m throwing starfish back into the ocean.”

The old woman surprised by the response, asked, “Why are you throwing starfish into the ocean?”

The young woman replied, “The sun is getting higher and the tide is going out. If I don’t throw them into the ocean, they will die.”

Upon hearing this, the old woman remarked, “There are miles and miles of beach and there are starfish along every mile! How can you possibly make a difference?”

The young woman turned, bent down, and picked up another starfish. As she threw it into the ocean, she said, “It made a difference for that one.”
References


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Retrieved November 15, 2005 from

http://www.educ.sfu.ca/narstsite/publications/


Appendices
Appendix A: Informed Consent Document

Informed Consent
Social and Behavioral Sciences
University of South Florida

Information for People Who Take Part in Research Studies

The following information is being presented to help you decide whether or not you want to take part in a minimal risk research study. Please read this carefully. If you do not understand anything, ask the person in charge of the study.

Title of Study: A Study of Three Science Teacher Educators with Elementary Teaching Experience: What Do We Bring to Science Teacher Education?

Principal Investigator: Cynthia S. Leard

Study Location(s): participant’s residence or via phone

You are being asked to participate because you are a science teacher educator with elementary teaching experience; you have earned or are pursuing a degree at USF; and you had/have a female, full professor mentor in the science education department at USF.

General Information about the Research Study

The purpose of this research study is to find out what factors the participants have in common that shape the way they approach teaching preservice elementary science teachers. Data will be collected by asking the participants demographic information and probing questions about science and education to elicit life history information. The initial interview will be conducted in person and recorded using audio and video devices. Follow up interviews may be conducted by phone. As data is analyzed, it may be necessary to look at other types of data. Participants may be asked to take a Myer’s Briggs Personality Profile or other similar assessment. They may also be asked to supply documents such as course syllabi for preservice elementary teacher classes that they teach or have taught.

Plan of Study

This study will require approximately 40 hours of your time. I will visit you at your place of residence for the initial data collection. I will ask you demographic questions followed by probes concerning science and education in your life history. The first visit will be audio and video taped.

Follow up interviews will be conducted via phone unless the data indicates otherwise. The follow-up interviews may be audio recorded or notes may be taken.

It is anticipated that I will make no more than two personal visits with you during the study, and I will have no more than three additional contacts with you for information during the study. Most study visits will take about three to five days (averaging five hours per day). Some may be shorter. If it is necessary to conduct data using a personality profile instrument, the administration of the test will take place as required by a certified counselor at a time and in a location convenient for you.

Payment for Participation

You will not be paid for your participation in this study.

IRB Form: 2006011900119
Benefits of Being a Part of this Research Study

It is not known if you will get any benefits by taking part in this study. However, your participation may increase our overall knowledge about science teacher educators with elementary teaching experience.

Risks of Being a Part of this Research Study

There are no known risks in taking part in this study.

Confidentiality of Your Records

Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel, employees of the Department of Health and Human Services, and the USF Institutional Review Board, its staff, and other individuals acting on behalf of USF, may inspect the records from this research project.

The results of this study may be published. However, the data obtained from you will be combined with data from others in the publication. The published results will not include your name or any other information that would personally identify you in any way.

Your name will be coded and only the principal investigator will have access to non-coded data. Coded data will be made available to study participants and outside reviewers involved in the project. Data will be kept in electronic form on the principal investigator’s home computer which is password protected. No one else has access to the computer. Any documents, portable electronic files, or tapes will be kept in locked storage in the principal investigator’s home office.

Volunteering to Be Part of this Research Study

Your decision to participate in this research study is completely voluntary. You are free to participate in this research study or to withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive, if you stop taking part in the study.

What other choices do you have if you decide not to take part?

If you decide not to take part in this study, that is okay. There are no other choices for participation connected with this study.

Questions and Contacts

- If you have any questions about this research study, contact Cyndy Leard at 727-521-5640. If you have questions about your rights as a person who is taking part in a research study, you may contact the Division of Research Compliance of the University of South Florida at (813) 974-5638.
Appendix A: (Continued)

Consent to Take Part in This Research Study

By signing this form I agree that:

- I have fully read or have had read and explained to me this informed consent form describing this research project.
- I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.
- I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.
- I have been given a signed copy of this informed consent form, which is mine to keep.

____________________________  ______________________________  ____________
Signature of Participant      Printed Name of Participant      Date

Investigator Statement

I have carefully explained to the subject the nature of the above research study. I hereby certify that to the best of my knowledge the subject signing this consent form understands the nature, demands, risks, and benefits involved in participating in this study.

____________________________  ______________________________  ____________
Signature of Investigator      Printed Name of Investigator      Date
Appendix B: Life History

As a child growing up in rural Wisconsin, in the middle of dairy country where family farms dotted the gently rolling landscape, I found adventure in the day to day happenings of a small town with approximately 1100 inhabitants. I particularly remember my grade school years when the long days of summer offered time for exploration. I spent hours under the apple trees in our backyard creating daisy chains, drinking kool-aid, and reading books. On my more adventurous outings, I would go fishing with my dad. As we traipsed along riverbanks high with green growing grass my head would barely be visible. Once we found a "good" spot as pronounced by my Dad, I would sink down into the grass making myself a private hideaway hidden from view. There I would explore the grasses, bugs, and muck that surrounded me occasionally emerging to hold the end of an old cane pole or watch my Dad pull in a "nice" one and throw it into his old fishing satchel.

As these lazy days of summer gave way to my favorite season of autumn, we would ready for school. This meant a trip to the nearest city approximately forty-five miles away. My mother, brother, and I would rise early and be on our way by eight o’clock. No time to waste. We had to be there when the stores opened at nine sharp. As we drove into the downtown area, I thought of Macy’s, Penney’s, the corner cafeteria (where we always stopped for lunch and vegetable soup), Kresge’s Five and Dime, and Walker’s Shoes. These stately brick and rock buildings were always on our list of places to shop. The day was spent buying those much needed school clothes, dresses and skirts for me and
pants and shirts for my brother. New winter coats (always one made of fake fur
with a hood for me) and pairs of shoes, one for church and one for school
rounded out the list of purchases. The day would then come to a close as we
drove home and laid out all of our treasures for dad to see.

As the first day of school approached, I was excited. I liked school. I was
good at it. I liked to learn about all the far away places especially those tropical
areas where palm trees swayed and dolphins swam. I dreamt of sandy beaches
and felt inextricably drawn to the ocean. I spent countless hours playing school.
Drawing on my chalkboard and teaching my dolls about these wonderful places
that I hoped someday to visit. And then something extraordinary happened.
Something that doesn't happen in small town middle America, but it happened to
me! My dad announced that we were going on a vacation to Florida! How could
that be? We had only spent vacations in Wisconsin at the lake, fishing. I was
excited! I'm only eight years old and I am going across the country, in a car, for
three weeks, to one of those places that I had only read about! As we drove
along, I peered out the window, savoring every view and stop. Back in the car,
books, paper, and pencils spread across the seat as my brother and I did our
homework. We saw cotton in Mississippi, oranges and alligators in Florida,
mermaids, beaches, fishing boats, shrimp, coconuts, and so much more! What
an adventure!

When we returned, mom proudly shared our slides, photos, and
memorabilia with family and friends. We were invited to share our "slides" at

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school. It was educational you know! The teachers thought that it would be a good experience for all the children, just like the travelogues every Monday night at the high school gym. These are my early memories of school. My memories stayed much the same as I entered high school, always positive, and looking forward to the next school year. As a freshman, we were graded and sorted, much like eggs. I was lucky enough to fall into the Grade A bin where I and other Grade A's were sent to biology class where we met Mr. Nodolf. Mr. Nodolf, the guru of all things scientific, chemistry and biology, with no nonsense. This would be a changing day. Up until this time all things scientific that I remember came from my family experiences. Knowing where and when to fish, what season fish would spawn, and when they would be heavy with eggs came from my father along with details of the habits of mud turtles, wild ducks, deer, and bear. The "how to's" of hunting for wild asparagus, the prized morel mushroom, and water cress came from my uncles. Stories of spring flowers, where and when they grew, and what to pick and not pick came from my mother along with medical remedies. I particularly remember my mother putting egg white on my brother's foot when he stepped on a pitchfork. It would draw out the infection she would explain, and she was right. Nights with lightning bug captures and days of gardening "how to's" round out the picture.

I fondly remember those days set In a typical 1960's classroom-black chalkboard (with real chalk), rows of black topped lab tables bolted to the floor, and metal stools for sitting (no spinning allowed). Across one wall were banks of
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windows that looked out toward the municipal swimming pool, the quaint houses, and rolling fields of hay. Along the opposite wall were glass front cabinets with rows of specimens carefully preserved. These pickled creatures that most students found disgusting fascinated me. I could hardly wait for the days when we observed these specimens and learned their names. I even spent extra time after school studying them. I realized that most of these animals came from the ocean, the ocean that I had seen as a child. I think it was at that moment that I decided to become a marine biologist. (Not a marine scientist and definitely not an oceanographer, but a marine biologist.)

I was interested in learning more about these creatures especially the invertebrates - sponges and jellyfish. Throughout my high school years I continued to think about biology and Mr. Nodolf. I began to develop a plan and talked with my guidance counselor about schools that had marine biology degrees. As graduation approached, I had decided to attend the University of Southern Mississippi in Hattiesburg, MS. It was a world away from everything that I knew, but seemed to offer the ideal program. USM was affiliated with the Gulf Coast Research Laboratory located on the Mississippi Gulf Coast where students majoring in marine biology would spend one summer semester. I could hardly wait to get started.

My entire college experience focused on science and my ultimate goal. I lived and breathed science and developed a group of friends who also had insatiable appetites for science. The road to my goal was not an easy one. As I
studied long hours, memorizing plant and animal characteristics I realized that
the education majors (in the room next door) were spending hours putting
together bulletin boards. I began to ask myself why I was taking all of these
rigorous courses when I could be putting together bulletin boards and probably
have a better chance of getting a job when I graduated. But my focus was
renewed as I spent a summer at the Gulf Coast Research Laboratory trekking
through salt marshes, collecting specimens in the bayou, and learning about sea
eels first hand aboard a research vessel. Yes! This was what fascinated me!

Back on the main campus I continued to learn more and excelled in my
course work. Ecology with Dr. Grantham (the department chair) brought new
adventures as we explored lake habitats. Genetics with recombinant gene theory
(and a lot of failing students) ignited my interest in all things microscopic. Dr.
Fish, instructor of oceanography and invertebrate zoology, became my mentor.
Dr. Grantham provided a senior year research opportunity. But all the while, I
kept thinking about those education majors. Then one day a friend of mine told
me that she was going to minor in education instead of the usual chemistry that
most biology majors were encouraged to take. Other students often talked about
the people who minored in education. They were considered less able than those
who minored in chemistry. I didn't really believe that because I had a friend who
decided to minor in education, so she could find a job when she graduated. I
enjoyed listening to her talk about the education courses, but I never considered
it for myself, as I didn't want to become an outcast. And so my undergraduate
career ended as I was voted the Outstanding Female Senior Biology Major, an award voted on by the department faculty. As I reflect on this experience, I realize that if I had taken education courses as a minor, I would not have received this award.

After college my life took many twists and turns, with purpose I believe. I worked in several science related jobs from copepod identifier, graduate research assistant, to bench chemist, and finally health inspector. With each passing experience, I gained knowledge and skills. As a young mother, I looked for opportunities to expand intellectually. I found the answer at the J. L Scott Marine Education Center where I became a volunteer in their school programs and worked as an educator during their Project Marine Discovery summer camp. With three years volunteer experience, and ten years worth of summer camps, I began to think about teaching as a career. I liked working with the students and staff. I was knowledgeable. I was a good teacher and organizer. It was something I could do that would fit into my children's schedule. Then enter fate! My husband lost his job for political reasons, and I was thrown into the world of work. I got a job as a long-term substitute in a high school.

This experience is not the storybook ending to my dreams of being an educator. This was more like a nightmare, similar to the "Dangerous Minds" television program without the happy ending each week. This school was the stereotypical inner city school where the gang members took control of the school grounds and the only learning taking place was in those "special"
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programs for high achievers that were housed in separate buildings. There was racial tension and fights almost every day. Many of the students came to school simply to get away from horrible home situations. Many of them did not have electricity or running water, some were abused and hungry, others were high on drugs. The school was looking for a substitute teacher, because a student with a baseball bat had chased the former teacher around the room.

After meeting with the principal, I took the job, because I had no choice. I would be teaching biology, anatomy and physiology, and consumer science. That meant that I would see every type of student the school had to offer from those that could not read to those that had skipped several grades. I felt that everyday was a struggle. It was spring semester and the school funds were slowly running out. Paper clips and chalk were not to be found, and copies were rationed to ridiculously low amounts. I started each day focusing on my teaching philosophy. Every day is a new day and what is in the past is in the past. I was there to teach these students and that I would do to the best of my ability providing variety, intellectual stimulation, and an environment conducive to learning. As the days went on, I built trust with most of my students. They appreciated the fact that I was trying to teach them something and took the time to provide them with a variety of resources such as movies, books, lab experiences, and notes. The gang members began to look out for me, as they would walk me to my car every afternoon, remove disruptive students from class, and act as group leaders on lab days. It was here that I also first used
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psychology as I tried to persuade a twenty three year old drug dealer that he really was interested in being in my class and not being disruptive. Although there were aspects of this job that were very rewarding, the lack of administrative support and concern caused me to give up this position. I never forgot the lessons that I learned during this time particularly those lessons concerning human beings and basic needs. It really is true that if you treat people with respect they will give respect in return.

Of course, I still needed a job and it wasn't long before another opportunity presented itself. This time I would be teaching chemistry, biology, and physics for a teacher who had become terminally ill. Again entering a high school, during the late spring semester was difficult. Students were ready to be out for summer break and the parade of substitutes had left them weary to say the least. This experience taught me that I did not want to teach in a public high school. The paperwork that consumed valuable teaching time was truly ridiculous. Attendance forms, tardy forms, racial counts, forms to be filled out for the school guidance counselors (I don't know what they were doing), and students leaving class for pictures, meetings, and dental appointments. These distractions took place everyday!

After these two experiences, it is difficult to believe but I still wanted to be a teacher. At that time Mississippi was introducing the alternate teacher certification program. I signed up to take the national teacher's exam and the biology specialty area test. When I finished my exam, the test for the elementary
teaching specialty was in the room next door. I heard the proctor say that they had some extra tests (which was highly unusual). I approached the desk and inquired if I could take the test. They were more than willing to take my money. How fortunate I was to be there that day as it was the last time that the elementary education test was be offered through an alternate route. I passed the test in the 86th percentile. Alternate route people were required to have a 66 percentile score while those from a preservice teacher education program only needed to score at the 34th percentile. I was on my way. I could choose to get my certification in elementary education or high school biology. This required taking three courses identified from the exam, procuring a teaching position, and a two-year internship. During this internship, the Mississippi Teaching Assessment Instrument had to be completed satisfactorily, and teaching needed to be assessed by the school principal, a peer teacher, and an outside expert. I finished my internship while teaching fourth grade.

During these and the following years, I continued to grow. My principal asked me to fill out the paperwork for Mississippi's outstanding elementary science teacher after only teaching for three years. Other teachers would come to me and ask for help with science content or exercises. I also organized the school science fair and developed a system for conducting science fairs that was adopted and adapted by several schools. I also conducted thematic units focused on the science curriculum in which students might visit the solar system or live in the ocean depths. During the time that I taught fourth, fifth, and sixth
graders I continued to develop my teaching philosophy. I would try to get
students to think by giving them opportunities to ask "Why" questions. It became
standard procedure in my classroom that students knew that they might be called
upon to defend their answer with a “Why do you think that question?” Sometimes
they would laugh and just say they didn’t know. Or sometimes they would say
that the book said so, then we would have a discussion about believing
everything that we read. Of course I really didn’t have any basis other than
intuition for what I was doing. Now that I look back, I see that I was building
student self-efficacy and helping them identify misconceptions or alternate
conceptions that we could address. I also did lots of hands-on minds-on activities
that stretched student’s thinking and helped them develop as critical thinkers.

I remember distinctly four incidents that reinforced for me that I was a
good science teacher. First, I organized the school science fairs in the three
elementary schools in which I taught. I would also work with students that had
been school winners to prepare their projects for the regional science fair. At that
time there were (and still are) many restrictions on what students could bring to
the science fair. For instance, some of the many restrictions included: no plants,
no soil, no animal parts, no water, no glass, no chemicals, no food, etc. The list
seemed inexhaustible. So for the school fairs, I told the students that they could
bring everything, but they would have to restrict animal studies and human
studies if they were interested in going to the regional fair. My philosophy
included getting children excited about science not dampening their interest by
reducing their projects to cardboard, paper, photos, and ink. Of course all of the restrictions were done in the name of insurance liability for the buildings in which science fairs took place. How sad! Anyway, as I reviewed the school regional winners in our district (the Catholic Diocese of Biloxi) I found that the school where I was located always had the highest number of winners. It seems that students were learning science. I did not do a longitudinal study of my students that I had after I left the school, but it seemed that those schools had more winners than they had in the past. Second, when Eisenhower monies were available the third principal I worked for gave me money to complete my master’s degree. This money was not offered to any other teacher. I began working toward my master’s degree and I finished 5 of the 10 required courses before we moved to Florida. Third, I was the only teacher in our district allowed to take students on science field trips across state lines. My students had many adventures at the New Orleans Zoo, the Aquarium of the Americas and the IMAX theatre associated with the aquarium. Fourth, I reviewed the science SAT scores for my students every year. My students had the highest composite SAT scores in science every year that I taught. Since I had data from three schools it did not seem to be school population specific.

As we left Mississippi for Florida, I left my teaching career behind. When I moved to Florida I applied to the state certification board for a teaching certificate for elementary school, middle school science, and high school biology. They would not even consider me for an elementary teaching certificate even though I
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had a standard professional certificate from Mississippi and had taught for six years. They wanted me to take undergraduate elementary education courses including art for elementary teachers, music for elementary teachers, science for elementary teachers, math for elementary teachers, and P. E. for elementary teachers. I thought this was a waste of time. They would give me a certificate in middle or high school science if I took methods for middle school teachers and methods for high school teachers. After considering my options, I decided that I would finish my master’s degree in Mississippi. I could finish my last 5 courses in one summer. Sure, I wouldn’t be doing anything but eating, sleeping, and breathing, education courses but it would be worth it. So I moved in with my friend in Biloxi and went to work. The course schedule was rigorous with classes four days a week. Two of those days I drove 90 miles to take courses in Hattiesburg then back to the coast to stay up all night reading and doing it all over again the next day. I completed all of my courses and took my qual exam in the fall semester with graduation in December.

In the meantime, I continued to be interested in teaching, but I needed a job. As I was perusing the paper one day, I came across a tiny add for outdoor educators with teaching experience. I called and got an interview for an outdoor educator position. I started as a part time employee and in less than three years became the fulltime curriculum developer and program director. This job opened up so many avenues of thinking for me. Teachers used a teambuilding perspective. It all adhered to the principles of how people learn and the
experiential education and character education movements. Here was the piece
that I had been missing in my teaching. I had been doing so many of these things
intuitively: setting up interdependent groups, valuing individual student
perspectives, providing opportunities for student voice and perspectives, etc. But
this outdoor education experience crystallized the pieces. The training was great
and professional development was an integral part of everything we did. The
worlds of psychology and sociology and how they affected teaching and learning
were opened to me. This was a great three years, but as life would have it, I was
beginning to feel the effects of carrying canoes and hiking on a daily basis. Time
to move on. Again the newspaper just must be my friend. I found an ad for a
curriculum writer for a middle school science education program at USF. What
luck! I knew someone at USF, so I gave her a call and found out about the job. I
deecided to apply and went to an interview. Looking back I know I wasn’t prepared
for the interview. I didn’t even bring writing samples with me, but I got the job. For
the next four years, I would write teacher packets to accompany the show and
begin to grow even more as an educator.

I initially became interested in pursuing a doctoral degree as a result of a
benefit provided by my employer (USF) and the realization that other staff
members with far less experience and abilities in education were taking
advantage of this benefit. Tuition up to six credit hours per semester would be
free for all course work, so I thought that I should take advantage of this
opportunity. I also missed classroom teaching and thought this would be a way
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for me to share all that I had learned while teaching with future teachers.
I began to consider the options available on the USF campus. Initially, I wanted
to pursue a doctorate in elementary education with an emphasis in science
education. I thought I could uniquely contribute to elementary science education,
because I had a science degree and had been a certified elementary teacher.
Unfortunately the only elementary degree offered emphasized reading. The
elementary education faculty discouraged me from pursuing that degree, since
my interest was in science education and I had only a limited number of reading
courses. Then I began to research the doctoral programs available in science
education. I specifically looked at two programs. One program was offered at the
University of Southern Mississippi and one was offered at the University of South
Florida. After weighing my options, I chose the one at USF largely due to the
tuition subsidy provided by my employer.

My first course was a Science, Technology, Society course taught by Dr.
Barbara S. Spector. It wasn't long before I realized that she "spoke my
language". We had similar philosophies of teaching and had shared experience
in organizational development. She became my major professor and we began to
work together. At the same time, Barbara was working with Sarah. Sarah was
pursuing a doctoral degree in instructional technology with a cognate in science
education. Sarah and I had an immediate rapport. As we began to share our
stories, we realized that we had something in common that other science
educators did not have. As Sarah put it, "You're the first person like me that I've
Appendix B: (Continued)

found in science education." That made me think about how we were alike, yet we were different from the many of the science education community. As we shared stories about our lives, I began to realize that we had similar life histories with respect to experiences, education, and philosophy. Both of us had bachelor's degrees in biology and master's degrees in education. We had both had a variety of jobs in science areas and were certified elementary teachers that loved marine biology and spent our summers working in marine science camps. We also had similar teaching philosophies grounded in constructivism (before we even knew what that meant).

As I began to work more with Barbara and Sarah, I attended science educator conferences. It was there that I became acquainted with another former student of Barbara's, Twila. Twila was very easy to talk to and her calm manner permeated her entire being. Her calm manner and empathy speak to her life ways and research interests. In speaking with Twila, I also found that she had a bachelor's degree in horticultural science and had a master's degree in education with a doctorate in science education. She had taught elementary school as well. It made me begin to question if these similar experiences were what drew me to these people. Again, I had been attracted to her teaching philosophy and her concern for preservice elementary teachers without knowing that we had similar experiences.

As I became more active in the science education enterprise attending conferences, writing papers, and taking courses, I began to think more about the
three of us. We were not the typical science educators found at these conferences. Most science educators have bachelor’s degrees in a natural science and have high school teaching experience. Their experience with elementary school students is limited to those with children or those with friends that have children. Many have not had experiences with elementary students until they became science education professors. They are also asked to teacher preservice elementary teachers (PETS) and those preservice elementary science teachers (PESTS)- I think these are good acronyms because it seems that many science educators look upon elementary teachers as less able than secondary teachers and actually treat them like PETS or PESTS. I also find that science educators who genuinely care about the elementary teacher are looking for resource people who can help them understand this group and their students. (O.K. so I am getting off the subject here, but it leads to why I think this is important.)

But, back to my story, over the next 4 years I took courses toward a doctorate in science education. I took one or two courses per semester, since I was working full time. I had many frustrating moments along the way, with hoop jumping for the department. Running around getting signatures, meeting deadlines, and tracking down elusive contact people. On my journey I took two courses that definitely impacted me. One course was an organizational development course. I was interested in this course, because my facilitator background and interest in sociology made me curious about organizational
development in the education enterprise. The one thing that I took away from this course was the idea that we are all part of the system. Every time we blame a system for a challenge we need to look to ourselves for the answer. The system won’t change without the “individual” taking responsibility for his or her input into the system. The second course was a qualitative design course with Dr. Ellis. This course was taught in the communications department. It opened up those doors that helped me understand that everything begins as a human endeavor. It brought home the idea of science as a social enterprise and it helped me discover the methodologies that I could use to share my research. It opened me up to story telling and narrative as ways to share qualitative research.

Throughout this journey I recognized a disconnect between the students in Ph.D. programs and the programs themselves. I talked to a lot of students (and overheard conversations) about where teaching fell in their framework of importance. Everyone that I talked to was interested in sharing their experiences with preservice teachers. They thought that teaching should be the primary focus of the graduate programs and not secondary to research. Most people would have preferred to have an Ed.D. Often they weren’t offered, or they were discouraged from getting one. Some of these people ended up dropping out of their programs, because the focus was on research. These students were exemplary teachers in their districts, and just wanted to help others become the same. This really speaks to the lack of connection of higher education with K-12 education. This is not to say that Ph.D. programs in education should not be
rigorous or should not contain research, but teaching should also be a priority. It seems that there should be some way to at least view and critique these students in action as part of graduation requirements.

Finally, I have reached the dissertation stage. I took a leave of absence from my job to focus on writing the dissertation. I definitely am not the same person as when I began. I have learned so much about education and in some instances I have learned nothing. I have learned that many things stay the same as they change. I have looked back in some instances with sadness finding that the education that I have received in many ways has distanced me from those who I wish to educate. I worry that I will no longer be able to relate to them. I sometimes fear that language will become our greatest barrier to communication as I now see things in much greater depth than I did before. It brings tears to my eyes to think that the part of me that wished to touch so many may have been hardened and destroyed through the process that should be designed to bring out the best attributes of the graduate student. And so it is that I now live by the mantra, “the world I grew up in no longer exists”. This world of mine changes day by day, minute to minute, and even now.
Appendix C: Interview Protocol

Demographic Questions (not asked in any particular order)

Name
City of Birth
Birth Date
Town where you grew up
Family background-ethnicity, etc. (Probe-tell a story that describes your family.)
Number of years as a science teacher educator

Probes (not asked in any particular order)

Describe your childhood
What did you know of the outside world?
Describe your educational path
Describe your career path
When and how did you first become interested in education?
What brought you to science education?
Why did you decide to become a science education professor over your other options?
Describe your best professor
Describe the perfect science education professor
What is your relationship like with the mentor professor?
Describe your elementary teaching experience
Tell me about your teaching philosophy
Appendix C: (Continued)

Describe a good elementary science teacher

What would it be like in a perfect world?
About the Author

Cyndy S. Leard earned a B.S. Degree in Marine Biology and a M.Ed. in Curriculum and Instruction from the University of Southern Mississippi. Her years of work experience as a professional scientist, K-12 educator, and informal education instructor and program director brought her to the University of South Florida’s College of Marine Science. She became the education specialist for Florida’s Center for Ocean Science Education Excellence and continued in this position while pursuing her Ph.D. at the University of South Florida.

While in the Ph.D. program at the University of South Florida, Ms. Leard was very active in the science education enterprise. She conducted science education research and presented papers at regional and national conferences. She also coauthored two book chapters and taught science methods courses for elementary teachers and marine biology graduate students.