ELEMENTARY TEACHERS PAST EXPERIENCES: A NARRATIVE STUDY
OF THE PAST PERSONAL AND PROFESSIONAL
EXPERIENCES OF ELEMENTARY TEACHERS
WHO USE SCIENCE TO TEACH
MATH AND READING

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Abstract

This qualitative study investigated the experiences of four elementary teachers who have elected to use science to teach math and reading/language arts in an attempt to identify what motivates them to do so. Identifying what experiences have motivated these teachers to go against the gain and teach elementary science in this current era of high-stakes tests is of the upmost importance given that science is being eliminated from the elementary curriculum and it is during the elementary years that students’ nurture and develop their interest in science. Additionally, the United States is failing to produce enough college graduates in STEM areas to fill the thousands of STEM jobs each year. Through a review of the literature, the past trends and current trends of elementary science education were explored as well as teacher training. Furthermore, the literature reviewed inquiry teaching which is considered to be the most effective teaching method when teaching science at any level. Using John Dewey’s Interest and Effort Relationship Theory and the Self-Determination Motivation Theory to guide this study, there were five prominent themes which emerged from the reconstructed stories of the four teachers: positive experiences with science, neutral/negative experiences with science, seeks meaningful professional development, influence and support from others, and regret/wants to do more.

Key terms: elementary science education, elementary science teaching, elementary teachers, teachers’ motivation
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Chapter 1: Introduction

Problem and Significance

“Our Nation is at risk. Our once unchallenged preeminence in commerce, industry, science, and technological innovation is being overtaken by competitors throughout the world” (National Commission on Excellence in Education, 1983, p. 1). These are the first two sentences of the 1983 report entitled *A Nation At Risk* which continues on to state “the educational foundations of our society are presently being eroded by a rising tide of mediocrity that threatens our very future as a Nation and a people” (p. 1). Until the National Commission on Excellence in Education published this report, Americans were satisfied with their public education system. This report cited the education officials, school leaders, as well as the American public for growing complacent with the education system (U.S. Department of Education, 2008). Since the release of this eye-opening report, elected officials, school leaders, and teachers have been hard at work developing and implementing state standards (U.S. Department of Education, 2008). States lengthened the school year and increased graduation requirements (Mondale & Patton, 2001) as they also grew increasingly reliant on standardized tests as they attempted to demonstrate to the public that the schools were showing improvement. The development of state content standards and tests continued under the discretion of individual states up until the passage of the *No Child Left Behind Act of 2001* (U.S. Department of Education, 2008).

The *No Child Left Behind Act of 2001* was passed by a bipartisan majority “as an effort to demolish the soft bigotry of low expectations, especially for poor and minority students” (Brint, 2006, p. 260) and signed into law by President George W. Bush in January 2002 (Dee & Jacob, 2011). Under No Child Left Behind (NCLB), schools were to make adequate yearly progress (AYP) in the areas of reading and mathematics with all students scoring proficient by the 2013-
2014 school year (Dee & Jacob, 2011). In an attempt to ensure that all schools strive to achieve AYP in reading and mathematics, NCLB placed penalties such as curriculum realignments for schools who failed to meet AYP for two consecutive years and possible state takeovers of schools who failed to meet AYP for five consecutive years (Dee & Jacob, 2011; Jennings & Rentner, 2006).

The purpose of NCLB was to improve the quality of instruction in all public schools in the U.S. especially in schools who serve high poverty populations. Since the possible penalty or penalties for schools who fail to meet AYP are so severe for the schools, many elementary schools have narrowed the curriculum by increasing time spent teaching reading and mathematics. To increase the amount of time spent teaching reading and mathematics, schools removed or decreased instruction in important but non-tested areas such as science, social studies, and the arts (Dee & Jacob, 2011; Jennings & Rentner, 2006). Schools who serve high poverty populations are more likely to have made such cuts to non-tested areas then schools who serve low poverty populations (Jennings & Rentner, 2006). Due to a vast majority of schools, including those who serve students most targeted by NCLB, decreasing or eliminating science content from the elementary curriculum, Congress passed an amendment to NCLB that would require students to be tested in the area of science beginning in the 2007-2008 school year. However, science was not added to the AYP calculation (Jennings & Rentner, 2006; Miller, 2010).

A major problem with the new requirement is that it increased the number of state tests that each elementary student would be required to complete each year while in grades 3-8. The new requirement did nothing to increase time spent teaching science or the quality of science instruction since the amendment failed to include student performance in science in a school’s
AYP. Because science scores are not included in the AYP calculation, schools continue to lack an incentive to change their practices; therefore, many elementary schools continue to only focus on reading and mathematics.

As standardized tests are used more and more as a measure of how well teachers are performing, teachers find themselves being more controlling of their students as more and more of the teachers’ autonomy is being removed by state and federal policy (Deci, Vallerand, Pelletier, & Ryan, 1991). This will be damaging to the future of the nation as teachers lose their intrinsic motivation to teach, and school children lose their intrinsic motivation to want to learn. Perhaps it will be even more damaging to areas such as science which is already being removed from elementary curriculums across the nation. As science is left out of the elementary curriculum in an increasing number of elementary schools despite the continued trends and subsequent posting of diminished elementary science achievement (Marx & Harris, 2006; Quennan, 2011), more and more school children will gradually lose their natural interest in science. When this occurs, who will be the nation’s future scientists, engineers, medical doctors, and elementary and high school science teachers? Adults of the future will lack the interest, knowledge, and the intrinsic motivation to work in science related fields. Thus, it is important that elementary teachers who are intrinsically motivated to teach elementary science be studied and the new found knowledge be used to grow this special population of teachers.

There have been numerous studies concerning the self-efficacy of elementary teachers in the area of science content knowledge as well as in teaching science content to elementary students. A study conducted by Cantrell, Young, and Moore (2003) found that the amount of science courses taken do affect a teacher’s self-efficacy in teaching elementary science. Furthermore, an elementary teacher can have a low self-efficacy in teaching science but have a
high self-efficacy overall. Researchers have also studied how the attitudes of elementary teachers toward science, in particular negative attitudes, affect students’ attitudes toward science (Schoon & Boone, 1998).

When searching for studies in which characteristics of elementary teachers who teach science were studied, there were only two studies found. However, there was one study found in which the past experiences regarding science of preservice elementary teachers where studied where a few preservice teachers were thought to be likely to teach elementary science once they become practicing teachers.

The first study in which the characteristics of elementary teachers who teach science were studied was a qualitative study conducted by Ramey-Gassert, Shroyer, and Staver (1996) in which they studied the factors that influence self-efficacy of elementary teachers in science. This study even included how the constraints that society places on gender appropriate tasks have affected the participating teachers in their decisions to complete college science courses and in their decisions regarding their approaches to teaching elementary science. The second study was conducted by Carlone, Haun-Frank, and Kimmel (2010), and it occurred during this time of high-stakes testing with the emphasis being placed on elementary reading and math. This study was primarily concerned with what drove these elementary teachers to go against the current educational reforms and their administration as they continued to teach science to elementary students. In the study in which only preservice elementary teachers were studied, it was discovered that an important predictor in whether a person is interested in science and plans to teach science is how memorable their science experiences were in elementary school as well as in other experiences that occurred outside of school involving science (Bulunuz & Jarrett, 2010).
As mentioned, there have been many studies that have investigated how attitudes toward science in elementary by teachers affect student attitude toward science as well as how teacher-efficacy in the area of science affects the willingness of elementary teachers to teach science. Only the Carlone et al. (2010) study could be found when looking for studies that have investigated positive characteristics of elementary teachers who teach science willingly. This study took place in rural, suburban, and urban school districts and involved thirteen teachers. Furthermore, only the Cantrell et al. (2003) study could be found when searching for studies that investigated past experiences, and its focus was only directed toward the number of high school and college science courses successfully completed. Additionally, the Bulunuz and Jarrett (2010) study was the only study found that investigated the experiences of elementary science teachers in and out of school science experiences on the likely hood that teachers would teach science to elementary students. A major limitation of this last mentioned study is that preservice elementary teachers were studied and not practicing elementary teachers.

A qualitative study detailing the past personal and professional experiences of elementary teachers who incorporate science into their math and science instruction would aid many individuals including current and future elementary teachers, colleges of education, and most importantly, current and future elementary students.

The elementary students would not only benefit by learning science and its processes in elementary, but they could benefit by beginning to prepare for a career in a science related field. This is extremely important given that the field of science continues to grow and continues to need a large number of qualified people. The nation will also benefit as a whole by having a workforce that is better prepared to meet the scientific and technological demands of a global world and global economy.
Significance

Since 1990, the number of degrees earned at U.S. colleges and universities in engineering by U.S. citizens in engineering has dropped eight percent while degrees in math and science have dropped nearly 20 percent. Within the same time frame, jobs that require such degrees have risen nearly five percent per year and continue to increase (National Science Board, 2004). In three decades the United States has fallen from third in the world to 17th in the number of science degrees earned by American students. In 2003, Asian students earned 1.2 million science and engineering degrees. European students earned 830,000 while American students only earned 400,000 degrees in science and engineering (Friedman, 2006).

The scientists and engineers who were inspired and motivated by the threat of Sputnik in 1957 and by JFK’s promise that the United States would win the space race by being the first to put a man on the moon and do so by the end of the 1960s are now retirement age (Friedman, 2006). Between the low numbers of young people deciding to enter STEM (Science, Technology, Engineering, and Mathematics) professions and the number of people retiring from STEM careers, there is a major shortage of STEM professionals in both the private sector as well as in the government sector. For example, in 2005, the number of people working for NASA who were between the ages of 20 and 30 was only one third of the number of employees who were between the ages of 60 and 70 (Loston, Steffen, & McGee, 2005). Additionally, the shortage of American-born STEM professionals is so severe that in March 2008 Microsoft founder Bill Gates testified before the House Committee on Science and Technology in an effort to increase the number of H-1B visas issued each year. In his testimony, Gates attempted to convince Congress to increase the number of H-1B visas issued each year as approximately 60 percent of students majoring in computer science in the United States are foreign-born, and
companies such as Microsoft are experiencing difficulties in finding qualified people to hire (Wood, 2008).

In the past, the United States has been a world superpower because its people were inventors and logical thinkers (Bybee & Fuchs, 2006; Friedman, 2006). If the U.S. is to continue as a world superpower, it will have to find a way to prepare all of its children to be inventors and logical thinkers and reverse the trends that are leading to the shortage of STEM professionals (Bybee & Fuchs, 2006). If the United States fails to do so, it will find that it is no longer a world superpower (Bybee & Fuchs, 2006; Friedman, 2006).

Some people believe that the nation must increase the number of children who can read and write and who can perform the basic math skills before the nation begins to improve science education at all grade levels. However, waiting for reading and math scores to improve before making improvements in science education could be a very costly mistake, especially given that most of the people who entered the science and engineering workforce in 2004, made the decision to do so when they were in early middle school if not elementary school which was at least fourteen years prior to their entering the workforce (Friedman, 2006).

Studies have shown that students often lose interest in science by the fourth grade, especially when their elementary educations have failed to nurture and support their interest in science (Mertz, 2008). Furthermore, what can be considered developmentally appropriate is not determined by age, but by what the student has already had the opportunity to learn (Duschl, Schweingruber, & Shouse, 2007) especially given that science is cumulative in that it builds on previous knowledge. What this means is that students make such career decisions at an early age and if they are not interested in science and/or engineering at a young age, then they most likely will not enter either field. Additionally, if elementary students are not receiving quality science
instruction that fosters interest in science, they will not have a solid foundation in science to be built upon in the middle school and high school grades (DeJarnette, 2012).

Since students lose interest in science by fourth grade, it is imperative that elementary students in the lower grades receive adequate science instruction so that there is not a shortage of people in the science and engineering workforce later on. When such shortages do occur, the problem may take at least 14 years before the problem really can begin to be corrected. By that point, schools may not be able to reverse the trend (Friedman, 2006). Additionally, instead of the decade that it took to improve science education following the Russian launch of Sputnik in 1957, many people fear that it will take at least a half of a century to improve science education, so that students are receiving the science education that they need and that they deserve (Bybee & Fuchs, 2006). Thus, it is extremely important for elementary students to receive a quality elementary science education that fosters their interest in science and that can be built upon in later years.

Positionality Statement

As a secondary science teacher who holds a Bachelor’s of Science degree in Biological Sciences as well as a Bachelor’s of Science degree in Agriculture Ecology and who teaches a wide range of secondary science courses, I often find myself wondering what teachers in the elementary and middle school grades are teaching. I find myself wondering what they are teaching in the lower grades more and more as I find myself having to teach more and more science content as well as helping students develop skills that they should have learned and developed in lower grades. I have come to the conclusion that I can either point fingers or I can make an honest attempt to do something to improve the current situation.
Although performing tasks that help elementary teachers in my district improve in their teaching of science could be an excellent place to begin, I desire to make a change that could lead to permanent changes not only in my district but in my state which potentially could spread across the nation. I am not interested in placing a band-aid on a huge, gaping wound.

I also must admit that as an elementary student myself during the 1980s, I was fortunate enough to be taught by teachers who thought science was important, who knew science and who enjoyed science themselves. I remember taking field trips to the school playground or to the lake that was located near my elementary school when we were learning about the environment and state park rangers bringing in animals and/or items to help teach a science concept. I remember sitting with the rest of my third grade class and watching in disbelief as the space shuttle Challenger burst into flames shortly after launch and then broke apart on the television screen in front of me. We were able to watch the shuttle launch as it was part of the science unit that we were studying at the time.

I must also admit that I was raised in a very agrarian state as the daughter of a cattle rancher and wheat farmer. From the time I was old enough to help in some way on the farm, my parents and grandparents had me helping sow and harvest the wheat crop as well as helping process and manage cattle. I also assisted in repairing and operating farm machinery and in building many miles of fence. I grew up dreaming of a career in large animal veterinary medicine, and I pursued that dream until I was unable to achieve that dream due to medical reasons.

I learned quite a bit of science as an elementary student both in and out of the classroom and I find myself in disbelief over the science concepts and processes that I find myself teaching to high school students. Many of these concepts I remember learning as a fourth or fifth grader.
I learned science concepts and processes in upper elementary school because the foundation had been laid by my early elementary teachers. These same concepts are now being taught at the secondary level.

**Research Question**

The purpose of this study is to investigate the past personal and professional experiences (childhood experiences involving science, experiences with influential people as they relate to science, preservice training including the student-teaching experience, and chosen professional development) that have led participants to incorporate science into their elementary math and reading instruction.

Using Dewey’s 1913 Interest and Effort Relationship Theory and the Self-Determination Motivation Theory to frame the study, the following question was investigated.

What past personal and professional experiences have led participants to incorporate science into their elementary math and reading instruction?

**Theoretical Framework**

John Dewey’s Interest and Effort Relationship Theory and the Self-Determination Motivation Theory are the two theories selected to guide this study. Dewey believed curiosity is innate to children, and as children grew their natural curiosity and interaction with the world around them led to particular interests. Dewey also believed that due to the traditional teacher-centered instruction very often found in classrooms, children gradually lose interests in many areas of which they were once curious (Dewey, 1913/2012).

Dewey defined interest as “not some one thing; it is a name for the fact that a course of action, an occupation, or pursuit absorbs powers of an individual in a thorough going way” (Dewey, 1913/2012, p. 65). For Dewey an interest is also an emotion as he demonstrated when
he wrote “interest, in the emotional sense of the word, is the evidence of the way in which the self is engaged, occupied, taken up with, concerned in, absorbed by, carried away by, this objective subject-matter” (Dewey, 1913/2012, p. 90). Additionally, Dewey believed that a task only becomes a task for a child when the child has no interest. If the child had an interest in the assigned task, the child would find completing the task to be seemingly effortless. However, if the child does not find the task of interest, it is only after being under compulsion that the child would apply effort to the task (Dewey, 1913/2012). According to Dewey, learning that takes place under compulsion is mechanical and lacks mental purpose and worth while learning that occurs because of interest has a great amount of meaning and worth to the individual (Schiefele, 1991).

The second theory used to guide this study is the Self-Determination Motivation Theory as it supports Dewey’s Interest and Effort Relationship Theory. According to the Self-Determination Motivation Theory, there are two major types of motivation that effect individual behavior: intrinsic and extrinsic (Moran, Deifendorff, Kim, & Liu, 2012). Intrinsic motivation is from within one’s self and is due to an inherent inclination or interest while extrinsic motivation comes as one works to receive a reward or to avoid a consequence. Furthermore, extrinsic motivation can be broken down into four types: external, introjected, identified, and integrated. The four types of extrinsic motivation have varying levels of autonomy (Appendix A) (Moran et al., 2012).

The Self-Determination Motivation Theory differs from other motivation theories in that it supports the belief that there are basic psychological needs that must be met for ideal psychological growth and well-being. The basic psychological needs that must be met are the needs for competence, relatedness, and autonomy (Deci & Ryan, 2000; Deci et al., 1991). Under
the Self-Determination Motivation Theory, competence is the ability to achieve desired outcomes, the feelings of effectiveness, and mastery of one’s environment. Relatedness refers to the closeness and connection in which one feels to one’s everyday connections while autonomy refers to being in control of one’s own actions or making decisions for one’s self according to one’s interest (Deci & Ryan, 2000; Deci et al., 1991).

When motivation is autonomous whether it is in the form of intrinsic motivation, identified motivation, or integrated motivation, the individual experiences a self-endorsement of their actions (Deci & Ryan, 2008). Additionally, if it is autonomous motivation, the individual is either interested, sees value in the activity, and/or they are able to internalize the reasons for engaging in the activity. Thus, the outcome of the activity is maximized (Deci & Ryan, 2008; Deci et al., 1991; Milyavskaya & Koestner, 2011; Moran et al., 2012; Vallerand, Pelletier, & Koestner, 2008; Vansteenkiste, Lens, & Deci, 2006). Moreover, autonomous motivation is not only linked to greater achievement and positive affect, but autonomous motivation is also linked to greater persistence, effort, and well-being (Frederick-Recascino, 2002 as cited in Moran et al., 2012; Koestner & Losier, 2002 as cited in Moran et al., 2012).

When motivation is controlled, the individual feels pressure to think, feel, or behave in certain ways due to the motivating force being from outside of one’s self. If the controlled motivation is external motivation, the individual often performs the task to receive a reward or to avoid some type of punishment. If the controlled motivation is introjected, the individual is motivated because they are seeking approval, avoiding shame, or their ego is involved. The outcomes of tasks performed due to controlled motivation are not as great as those achieved through autonomous motivation due in part to the lack of interest and effort experienced by the person (Deci & Ryan, 2008).
When thinking of these two theories in terms of the personal and professional experiences of elementary teachers who chose to teach elementary science, one must remember that these teachers are people who were once small children. Did these teachers develop a strong curiosity in science that grew into a strong interest as they grew and developed into adults like Dewey would lead one to believe? If so, why did they not lose some of this interest in science as they progressed through school and endured teacher-centered instruction as well as faced possible gender stereotyping? Additionally, what events occurred in childhood helped to further these teachers interest in science outside of school? What was it about their environment that allowed these teachers to feel competent in science, to relate to their environment, to feel as though they are in total control in the area of science that they are intrinsically motivated to teach elementary science even though they are experiencing extrinsic pressure to leave science out of the curriculum? According to the self-determination theory, autonomous motivation comes from within when the three basic psychological needs are met. Furthermore, when the needs are satisfied, additional energy is gained to keep the autonomous motivation occurring (Ryan & Deci, 2008). As these elementary teachers are under increasing extrinsic pressure to leave science out of the curriculum, how do they continue to meet their basic psychological needs, so they can continue to gain the necessary energy for their intrinsic motivation? These and other questions that revolve around the elementary teachers and what leads them to be motivated to teach elementary science was used to guide the interviews as this study looked to understand the past personal and professional experiences of these teachers.

Research Design

According to Connelly and Clandinin (1990) humans are “storytelling organisms who, individually and socially, lead storied lives” (p. 2). Therefore, narrative studies are a way to
investigate how humans experience the world (Connelly & Clandinin, 1990). By investigating the human experience through narrative research methods, the researcher is able to develop an understanding of the participants, their feelings, and their experiences within the participants’ environment (Clandinin, Pushor, & Orr, 2007). A qualitative narrative approach was chosen for this study that looked to investigate and then understand the lived experiences and their impact on elementary teachers who have elected to include science in their elementary curriculum although there is external pressure to leave science out of the curriculum. Interviews are widely used in narrative research to collect data from participants (Creswell, 2012) since interviews allow the researcher to obtain oral histories from the participants (Leedy & Ormrod, 2005).

This study relied greatly on the oral histories of the participants as it looked to identify the factors in the participants past that separate them from other elementary teachers.

This study was analyzed using a constructivist paradigm. The constructivist paradigm holds that humans look to develop an understanding of the world of which they live, and many of these understandings are subjective meanings that are directed toward particular objects (Creswell, 2007). Additionally, these subjective meanings are varied from person to person, and the researcher must seek to find the complexities in these meanings instead of seeking to place them into categories (Creswell, 2007; Pontorotto, 2005). This paradigm is appropriate for this study that looked to understand the experiences that have led elementary teachers to teach elementary science by incorporating math and reading instruction into their science instruction rather than leaving science out of their curriculum.

**Data Collection**

In narrative research, the researcher often asks the participants to retell lived events through the use of interviews (Fraenkel, Wallen, & Hyun, 2012). The retelling of events by the
participants is best performed by conducting interviews (Creswell, 2012) and asking the participants to “reconstruct his or her experiences within the topic” (Seidman, 2006, p. 15). This study relied heavily on semi-structured interviews and used a modified version of Seidman’s (2006) three-interview protocol. In the original version, Seidman’s three-interview protocol calls for the conduction of three different interviews with each participant over the course of nine days to three weeks. The purpose of the first interview is for the researcher to place the experiences of the participants relating to the research topic into context. The purpose of the second interview is for the participant to reconstruct their topic related experiences while the purpose of the third interview is for the participant to reflect on such experiences. Although Seidman recommends that researchers do not deviate from the three-interview protocol, he states that researchers can modify the protocol as long as they allow the participants to reconstruct and reflect upon the topic related experiences (Seidman, 2006).

Since the participants are busy teachers, and the researcher is also a busy teacher who had to travel a long distance to conduct the interviews, the three-interview protocol was modified to include only two semi-structured interviews. The purpose of the first interview was for the researcher to place the experiences of the participants into context as well as for the participants to reconstruct their experiences. The second interview was conducted to allow the participants to reflect on the experiences. In order to facilitate the process of placing the related experiences into context and reconstructing the experiences, the participants were asked to fill in a timeline. This type of interview protocol was appropriate for this study as it allowed both the participant and the researcher to place the experiences into context, reconstruct the experience, and reflect on the experience.
Other forms of data collection included field notes and science lesson plans. Both forms of data collection are recommended and discussed by Connelly and Clandinin (1990) as valuable means to collect meaningful data in a narrative study. The field notes were recorded by the researcher, and these notes and the participants’ science lesson plans were used to aid the researcher in developing an understanding of how the participants understand the integration of math, reading and science as well as to develop an understanding of how each participant performs the task.

Data Analysis

To analyze the data collected though this study, the narrative configuration process was used. Polkinghorne (1995) states that the narrative configuration process “employs a thematic thread to lay out happenings as parts of an unfolding movement that culminates in an outcome” (p. 5). The thematic thread of which Polkinghorne speaks of is often termed a “plot.” Within the plot, the events are laid out and the contribution of each event and its influence on the topic being studied is understood (Polkinghorne, 1995). Plots are often used in narrative research to mark off a portion of a timeline in which events are connected together as contributors to a particular outcome. The narrative configuration process was used to analyze data due to the functions of the plot. The plot functions to:

1. delimit a temporal range which marks the beginning and end of the story,
2. provide criteria for the selection of events to be included in the story,
3. temporally order events into an unfolding movement culminating in a conclusion, and
4. clarifying or making explicit the meaning events have as contributors to the story as a unified whole (Polkinghorne, 1995, p. 7).
To ensure accuracy of the stories, each participant was asked to proofread their stories and notify the researcher on multiple occasions of any inconsistencies. Additionally, field note entries recorded by the researcher served as “active recordings” and were used alongside the participants’ stories to ensure a balance between the two perspectives (Connelly & Clandinin 1990).

Limitations of the Study

A major limitation of this study is the limitation that comes with all narrative studies. Since this study is narrative and relies heavily on the memory and storytelling of events that may have occurred in the participants’ distant past and the experience is not directly observable, it is possible that events could be remembered incorrectly or told incorrectly without the researcher being able to identify such problems (Polkinghorne, 2005). A second major limitation is researcher bias. The researcher attempted to keep bias out of the study by using journaling and member checking methods to ensure accuracy of data. However, it is not always possible to keep researcher bias completely out of the study. Limitations that are unique to this study are data was collected from only four individual elementary teachers, and all participants are women from the south central portion of the United States where it is still primarily rural and agriculture remains a large industry. Due to the limitations of this study, it will be difficult for the findings to be generalized for other environments such as large urban areas.

Content and Organization of the Thesis

This doctoral thesis contains five chapters. In chapter one, the problem of practice and its significance, the statement of the problem as well as a description of the theoretical framework and explanation of the limitations of this study are included. Chapter two contains the literature review which focuses on past trends in education and current trends in elementary education, the reasons as to why elementary teachers do not like to teach elementary science, and the reasons
why science is being left out of the elementary curriculum as well as inquiry learning which is the effective method in teaching science on all levels. The third chapter holds the methodology of the study. In this chapter, an explanation of the methods of data collection, analysis, and ethical considerations that pertain to this particular study is found. In chapter four, the findings from this study are found. Chapter five holds the discussion of the research findings and concludes with a discussion of the implications for educational practice.
Chapter 2: Literature Review

Elementary Science Education

Elementary science education has mainly been considered a passing trend and has never really been able to find a permanent position in elementary education (Century, Rudnick, & Freeman, 2008). There are several reasons as to why elementary science education has had difficulties in taking hold in elementary schools across the United States. The main reasons include teachers not feeling confident in science content knowledge, teachers not feeling confident in their training to teach science, teachers not having an interest in science, and last but not least, the – No Child Left Behind Act of 2001 which places great emphasis on math and reading (Allen, 2006). This emphasis being placed on math and reading has led many schools to greatly decrease the amount of time spent teaching science. For some schools, the time for science instruction has been cut to zero (Queenan, 2011). Additionally, some elementary educators have long held the belief that young children simply cannot learn science; (Akerson & Donnelly, 2010; Quigley, Pongsanon, Akerson, 2010) therefore, elementary schools usually lack science equipment and fail to include science supplies and curriculum in the budget (Stamp & O’Brien, 2005).

Elementary science instruction has not only had difficulties finding a permanent position in the nation’s elementary schools, but the amount of time spent teaching science has continued to decline significantly over the past few decades (Morton, Dalton, & National Center for Education Statistics, 2007). The fact that elementary science instruction has struggled to catch on in elementary schools coupled with the decrease in time spent on elementary science instruction is creating a problem for the future of the United States. The U.S. needs a workforce of people who are self-reliant, logical thinkers who can problem solve and be inventors and
innovators. Furthermore, many feel that the key to developing such a workforce lies in strengthening science, technology, engineering, and math (STEM) competencies in every K-12 student (Thomasian, 2011).

**Research Question**

Science education in the nation’s elementary schools is on the decline for many reasons. This trend is alarming given that science was not really ever taught much in elementary in the first place, and now that it is on the decline, many elementary students are not being taught science at all. There are a few elementary teachers across the nation that believe science is important in elementary, and they teach science even though their school administrators instruct them not to do so (Carlone et al., 2010). Just what is it about these teachers that lead them to place enough importance on science education that they continue to teach science under the current conditions? This question has led to the research question of “What past personal and professional experiences (childhood experiences involving science, experiences with influential people as they relate to science, preservice training including the student-teaching experience, and chosen professional development) have led participates to incorporate science into their elementary math and reading instruction?”

To explore this question, one must first understand the past trends in education as well as the current trends in elementary science education. Furthermore, to understand why it is difficult for elementary teachers to teach science effectively, one must know and understand the most effective teaching methods when science instruction does occur. This literature review will first look at the past trends in education before looking at the current trends in elementary science. Once the trends have been discussed, this literature review will look at the effective teaching
method used by those who teach science to elementary students. The literature review will then conclude by discussing why it matters if elementary students are taught science.

**Trends**

**Past Trends in Teacher Preparation**

According to Pestalozzi (1894), the purpose of education is to prepare individuals to use all abilities that were given to them by the Creator, so they can improve life and take their proper place in the world. Unfortunately, a proper education has not always been available for women. Traditionally, women have been the caretakers of the family because of their childbearing abilities. It has long been thought that women should learn, but that they should only learn ideas that are considered suitable or proper for women, and these ideas must be planned in relation to man (Rousseau & Foxley, 1972). Even in the early days of the United States, the role of a woman was to be only the family caretaker, and she only needed enough education to make a good wife and mother as was demonstrated by the proposed structure of common schools by then secretary of state Thomas Jefferson (Mondale & Patton, 2001).

During the mid-1800s, Horace Mann who was the secretary of education for the state of Massachusetts, and at that time, the only person across the nation in any position of this type, argued for the education of young girls (Mondale & Patton, 2001). What Mann’s argument did was allow girls to attend common schools and receive at least an eighth grade education. Women for the most part where still prohibited from attending the nation’s colleges and universities (Fraser, 2007).

Educating young children had long been a position held by young men in the transitional period of life between graduating college and beginning their careers in their chosen profession. These men were not trained to teach. They just happened to be in need of employment (Fraser,
The teaching profession would remain a male profession until women such as Emma Willard and Catharine Beecher began to make the argument that teaching should be a woman’s profession since it was an extension of motherhood (Fraser, 2007; Mondale & Patton, 2001).

Catharine Beecher began opening schools to prepare women for teaching during the 1830s before sending the trained women westward to teach on the western frontier (Mondale & Patton, 2001). State ran and funded teachers’ institutes, and normal schools began to spring up, first, in New England and then across the country as Americans continued to settle westward. As the institutes and normal schools developed, many were open only to women, thus allowing many women to find a career in teaching. History finds the effectiveness of the teachers’ institutes and normal schools debatable since students could drop in and out without necessarily completing a full year’s training (Fraser, 2007).

Students of normal schools and teachers’ institutes were not only allowed to drop in and out of their coursework throughout the year, but they were able to obtain teaching jobs without completing training in many areas of the country. For many normal schools, the courses that pertained to the sciences were taught as advanced courses in a teacher’s third, fourth, or fifth year of training. Many teachers never reached such coursework, and in fact, in many normal schools, less than five percent of students completed the advanced coursework (Fraser, 2007).

As normal schools gave way to colleges and universities, teacher training became more specialized. With the development of the specializations such as school administration, educational psychology, educational sociology, etc, experts and professors increasingly sought to make teaching a true profession (Fraser, 2007; Ravitch, 2003). Sometime around 1915, this drive to make teaching a profession led to professors of pedagogy and professors of liberal arts
parting ways, thus separating normal schools from liberal arts and sciences and leading to teachers being trained in pedagogy and not content (Ravitch, 2003).

When elementary teachers who have primarily been female for the past century (Fraser, 2007) have taken science courses either during their high school years or during their teacher training, they have found science courses irrelevant especially since the majority of pictures and problems in science textbooks tend to be of males (Blickenstaff, 2005; McCarthy, 2009). Many have also found a ‘chilly climate’ in their science courses where instructors tend to be male. The male instructors tend to give the male students more attention, and women find the instructors unapproachable (Blickenstaff, 2005). Additionally, many women have had difficulties completing science courses due in part to an inherent masculine worldview in scientific epistemology (Blickenstaff, 2005) and traditional gender roles in society (Blickenstaff, 2005; Ramey-Gassert et al., 1996). When one considers all of the barriers that have been placed on women in the past, it is no wonder that elementary teachers who have traditionally been women for the past century have not been known to teach a great amount of science.

Current Trends in Elementary Science Education

There are many alarming trends in elementary science education. The first is the amount of time spent teaching science to elementary students is on the decline (Morton et al., 2007). The second alarming trend is teachers not only lack an interest in teaching science, but they are not trained to do so even if they so desire (Allen, 2006; Darling-Hammond, 1997; Kindfield & Singer-Gabella, 2010; Levy et al., 2008). Third, the No Child Left Behind Act of 2001 has only contributed to many elementary schools further decreasing the amount of time spent teaching science or ceased to teach it altogether (Allen, 2006; Miller, 2010).
Decay in Time

Currently, there is a great need to improve the quality of science instruction that elementary students are receiving in the United States. Unfortunately, quality is not all that needs to improve. Quantity or the amount of science instruction that elementary students are receiving needs to vastly increase. In the 1987-1988 school year, teachers of grades one through four reported spending 2.6 hours a week teaching science. By the 2003-2004 school year, that number had dropped to 2.3 hours a week (Morton et al., 2007). Although this .3 hours a week decrease does not sound too significant at first, it is actually quite significant. If one assumes that the average school year is 36 weeks, and that the average elementary student received just 2.3 hours a week of science instruction in 2003-2004 compared to the 2.6 hours students received in 1987-1988, the students in 2003-2004 received on average 10.8 fewer hours of science instruction than their counterparts in 1987-1988. This decrease equates to nearly a loss of five weeks of science instruction in just one school year. If one assumes that this trend remained constant, a student in the first grade in the 2003-2004 school year received 20 fewer weeks of science instruction while in grades one through four then a student who was in the first grade during the 1987-1988 school year.

Why time spent teaching elementary science is significantly less than other subjects

There are several reasons why the amount of time spent teaching science in elementary school is significantly less than the time spent on other subjects. First, elementary teachers typically do not personally enjoy science. They either found science difficult themselves while in school and/or they simply do not have much interest in science (Allen, 2006; Darling-Hammond, 1997; Kindfield & Singer-Gabella, 2010; Levy et al., 2008). Second, elementary teachers are really not trained to teach science nor do they have a high degree of science
understanding (Darling-Hammond, 1997; Kindfield & Singer-Gabella, 2010; Levy et al., 2008). Most colleges of education only require elementary education majors to complete a few science courses if they require any science courses above what is required by the university in a student’s general education. For many, the science courses that they do take do not help them in understanding science due to the way in which they are taught. Many elementary teachers graduate college with the ability to recall several unrelated facts and rules but unable to understand the underlying processes; therefore, they find it difficult to teach science (Kindfield & Singer-Gabella, 2010).

Elementary education majors are also not taught how to teach science effectively. Allen (2006) quoted science education professor Alan Colburn of California State University who summed up the first two reasons why elementary teachers do not enjoy teaching science when he stated that elementary teachers “don’t like science, they don’t feel confident in their knowledge of science, and they don’t know how to teach science effectively” (p. 5). The problem of teachers not feeling confident in their science content knowledge and their lack of training in how to teach science is further compounded by the fact that state science standards often overwhelm teachers because they are topic based information that includes mainly disconnected facts, formulas, and procedures (Allen, 2006).

An additional reason as to why elementary teachers do not like to teach science, especially those who teach the younger elementary grades, is the idea that young children cannot understand science (Akerson & Donnelly, 2010; Quigley et al., 2010). Many older studies concluded that young children simply do not have the ability to understand the complex processes of science. However, there are more recent studies that show that young children can learn science (Akerson & Donnelly, 2010; Mertz, 2008) and even “develop a rich view of
science, and actually use science to investigate their own questions through appropriate instruction and scaffolding by more experienced others” (Akerson & Donnelly, 2010, p. 118). In other words, many studies have shown that the notion that young children cannot learn science is simply not true. They can learn science and use the science concepts to investigate their own questions if they are appropriately taught science and its processes.

The fourth and final reason as to why the amount of time spent teaching science in elementary school has decreased is due to the No Child Left Behind Act (NCLB) of 2001 (Allen, 2006; Miller, 2010). Under No Child Left Behind, students are to be tested every year in reading and math using standards-based tests, and the results are to be published (Center on Education Policy, 2006; Mondale & Patton, 2001). Under the instruction of school district administrations across the nation, elementary teachers have reduced science instructional time to allow for more time spent teaching math and reading (Griffith & Scharmann, 2008). Math and reading tests scores have been of the up most importance for elementary schools due to these tests results being used in determining if the school meets AYP (Adequate Yearly Progress) for the school year. Meeting AYP is extremely important for a school district due to the fact that a school district’s funding is tied to the district meeting AYP each year (Griffith & Scharmann, 2008; Owens, 2009). Unfortunately, the message that is being sent to schools and the general public by excluding science from AYP calculations is that science is not important (Milner, Sondergeld, Demir, Johnson, & Czerniak, 2012).

Under No Child Left Behind, subjects such as science have not only been treated as being unimportant, but the overall elementary curriculum has been narrowed (Griffith & Scharmann, 2008). Ontario Canada has recently undergone a similar reform to NCLB in which the primary focus was placed on math and reading. Unlike schools in the United States, schools in Ontario
did not narrow their curriculum; instead they broadened their curriculum to include subjects such as science, social studies, physical education, and the arts. This broadening of the curriculum has allowed teachers to engage in rich teaching for meaning and has greatly improved both student learning and teacher moral (Levin, 2012).

**The Value of Teacher Preparation and Support**

*Teacher Preparation*

The amount of expertise and experience that a teacher possesses has been found to be the single most important contributing factor in the success of students followed by a smaller teacher-to-student ratio. In fact, teacher expertise and experience was found to account for 90 percent of the variance in student reading and mathematics scores (Darling-Hammond, 1997). One could assume that this would also apply for all content areas.

Teacher expertise is extremely important, but when science content is concerned, colleges and universities usually do not properly prepare elementary education majors in the area of science. In the few science courses that are required of elementary education majors, the preservice teachers learn facts and formulas otherwise known as the mechanisms of science, but they do not develop an understanding of science (Kindfield & Singer-Gabella, 2010). Many teachers realize this once they begin teaching, but they do not know how to improve the situation for themselves (Allen, 2006). This feeling of unpreparedness is expressed by elementary teachers not only concerning their content knowledge of science but their content knowledge in most subject areas. Many elementary teachers feel they learned very little in their college courses that they could actually use in the classroom. They feel what they learned in college that was useful was learned during their student-teaching and not during their days sitting and taking notes in a lecture hall (Darling-Hammond, 2006).
In a study by Plourde (2002) that investigated preservice elementary teachers’ personal efficacy beliefs and outcome expectancy beliefs in science teaching, it was found that there were five major sources that have led to a lack of efficacy beliefs and outcome expectancy beliefs in science teaching. These five sources are:

- a lack of practical work, personal involvement, and hands-on manipulation in science related activities in elementary, secondary, and tertiary education;
- a dependence of science courses on textbooks and lectures,
- the dispassionate association with science teachers/instructors;
- a focus on formalized tests with no performance assessments; and
- the lethargical attitude towards the teaching of science by inservice/mentor teachers (Plourde, 2002, p. 257).

**Support from school districts**

When elementary teachers are asked in which area or areas do they feel that they need the most professional development, they overwhelmingly answer that they need the most help in the area of science (Weiss, Banilower, McMahon, & Smith, 2001). Many school districts are aware of the problems faced by elementary teachers in effectively teaching science. Some of the school districts that have not completely removed science instruction from their elementary curriculum have hired science curriculum specialists and/or provided high quality grade and content specific professional development. The science curriculum specialists support elementary teachers by providing expertise in science content and by helping them design and implement science curriculum in their classrooms. These methods of support for elementary teachers can be quite affective (Miller, 2010).
Unfortunately, approximately half of the nation’s elementary students do not receive the benefit of science curriculum specialists supporting their elementary teachers. This is because nearly half of the nation’s students attend school in a small or medium sized school district (National Center for Education Statistics, 2004). A small or medium sized school district will have an enrollment of less than 10,000 students, and these school districts account for nearly 90 percent of the nation’s schools (National Center for Education Statistics, 2004). The students in these schools usually do not receive the benefit of science curriculum specialists because their school district simply cannot afford a specialist. This is especially true for the smaller districts (Miller, 2010). The small and medium sized school districts usually cannot afford specialists due to increased costs of transportation. When fuel costs are high, the small and medium sized districts’ budgets can be devastated because transporting students long distances from home to school and back home is the norm. These school districts often find any school improvement difficult, especially since they are very often located in rural areas that once were predominately agricultural and manufacturing economies which have declined in recent years. The decline has led to decreasing populations and tax bases. Because the populations are decreasing and the tax bases are declining, these schools often have “low fiscal capacity, fewer management support services, greater per pupil costs, higher numbers of teachers teaching outside their specialty area, less competitive salaries and benefits, less specialized space and equipment, less availability of planning support services, and fewer evaluation support services” (Harmon, Gordanier, Henry, & George, 2007, p. 8).

Specialized professional development has been used by many schools to support their teachers such as elementary teachers teaching science. However, for many small and medium school districts, this is not an option due to the low numbers of teachers who teach a particular
grade or subject as well as the costs associated with such professional development. For the nation’s smallest districts, it is not uncommon to find that there is only one teacher per grade or subject. It is also not uncommon to find teachers teaching multiple subject areas even on the secondary level (Blanton & Harmon, 2005; Harmon et al., 2007).

**An Effective Form of Science Teaching**

The National Research Council (1996) defines a scientifically literate individual as someone who “can ask, find, or determine answers to questions derived from curiosity about everyday experiences and who can describe, explain, and predict natural phenomena” (p. 22). There are multiple explanations as to why K-12 students are not developing scientific literacy like many think they should (Loston et al., 2005).

Of the many reasons cited in the literature as to why students are not developing into critical thinkers who are scientifically literate, the two reasons that stand out the most and are given the most blame for the lack of critical thinkers are teacher content knowledge and teachers not instructing students using the most effective teaching methods (Loston et al., 2005). According to Ingersoll (2003), many teachers across the nation, who teach science either on the elementary level or on the secondary level, are lacking in their content knowledge; therefore, they struggle with curriculum goals. Additionally, many teachers today still teach like they were taught. They still use old contemporary science teaching methods that have historically focused on mastering as many concepts as possible and not so much on the processes of actually performing science (Kattoula, Verma, & Martin-Hansen, 2009). Many teachers still heavily rely on lectures and worksheets, so students are not able to see a relationship between what is taught in science and the actual application of it (Yang, 2010).
To help aid teachers and schools in producing scientifically literate graduates, NASA and the National Science Education Standards both promote as well as believe in the use of inquiry teaching (Loston et al., 2005). Additionally, studies have shown that when elementary students are taught science through inquiry, that math, reading, and writing skills improve (Griffith & Scharmann, 2008). However, this promotion of inquiry learning is not without problems. To properly use inquiry learning, a teacher must be strong in content knowledge and able to set and meet curriculum goals as well as be able to design true inquiry lessons. The ability to design true inquiry lessons comes with having a great deal of content knowledge as well as an understanding of how students best learn.

**What is Inquiry Based Learning?**

Inquiry based learning may be defined several different ways with no particular definition being more correct than the others. The first definition of inquiry based learning is by Rooks and Maker (2009) who define inquiry based learning as an approach that involves the learners in actively experiencing the natural world first hand. A second definition by Burns (2005) states inquiry based learning is learning that involves learning activities that allow students to discover concepts and to make sense of the natural world by themselves instead of relying on teachers and textbooks for interpretations.

A third definition of inquiry based learning comes from Fragnoli. Fragnoli (2005) defines inquiry based learning a little bit differently from the first two by stating it as a way to passionately pull apart ideas and put them back together. Fragnoli further defines inquiry based learning as a more engaging way to teach content than the teacher requiring only rote memorization of minute facts.
Finally, a fourth and final definition to be presented is provided by the National Research Council (1996). The National Science Education Standards define inquiry based learning as a comprehensive teaching method in which students’ understanding of science is developed by actively combining scientific knowledge with reasoning and thinking skills. Many feel that it is the reasoning and thinking skills that are underdeveloped in the contemporary classroom (Kattoula et al., 2009).

According to the National Research Council (2000), there are five essential features of science inquiry. They are the learner engages in scientifically oriented questions, the learner gives priority to evidence in responding to questions, the learner formulates explanations from evidence, the learner connects explanations to scientific knowledge and finally, the learner communicates and justifies explanations. There are many variations to each of the features depending on how much the teacher or material gives directions and how much the students must find for themselves. However, the National Research Council (1996) specifically defines inquiry learning as being "mind-on" experiences while it defines hands-on activities as just physical activities that do not necessarily require the mind.

Today, many teachers miss the "mind-on" point which shows their lack of understanding of how students learn. They believe that any type of lab is an example of inquiry because the students are up moving around and performing tasks using their hands and not sitting and listening to the teacher present a lecture or just sitting and filling out worksheets. What they fail to see is that the cookbook labs are very often limited in scope and focused on mechanical procedures rather than depth of understanding (Wood, 2009).

Many teachers are unable to realize just how limited in scope cookbook labs are because they lack the knowledge in their own content area. They themselves do not know the content much above
what they are attempting to teach the students, thus making teaching through inquiry difficult for these teachers even if they do understand how students develop and learn.

*Why inquiry based learning?*

Current literature on inquiry teaching and learning lists four significant findings that support the use of inquiry based learning. The first finding is that students develop better understanding and concept retention. In other words, they not only get the material, but they remember the material after the passing of time. The second finding is that students are better able to transfer knowledge to new problems as well as to real world situations. Third, students experience an increase in intrinsic motivation in science, and fourth and finally, the self directed learning skills of students have been found to improve (Loston et al., 2005).

Inquiry based learning is believed to be successful for various reasons. One reason is that it allows students to learn using a very similar process which scientists use in research (Leonard & Penick, 2009). In a classroom in which inquiry based learning is the norm, this process often looks very similar to a learning cycle that any excellent teacher would use who really understands how students learn and develop.

In the learning cycle, there are three major phases. Phase one is known as the exploration phase in which the students are allowed to learn through their involvement and actions. The goal of this phase is to allow students to apply previous knowledge, develop interests, as well as initiate and maintain curiosity toward the materials in front of them. The second phase is concept introduction. The goal of this phase is to relate directly to the exploration phase and to clarify concepts that are essential to the lesson. The third and final phase is concept application, and its goal is to have students relate the newly learned concepts to their everyday world (Trowbridge, Bybee, & Powell, 2000).
In Trowbridge et al. (2000), Anton Lawson proposes three types of learning cycles: descriptive, empirical-inductive, and hypothetical-deductive. These three learning cycles which use inquiry based learning, differ in the degrees in which students gather data and develop conclusions. He also says that an advantage of using the learning cycle is it allows the students to express their previous knowledge and most importantly their misconceptions. In inquiry based learning, students are like scientists in that they use what is commonly known as the scientific process to observe, identify, explore, and explain occurrences in nature. Again, teachers who lack content knowledge and knowledge of how learners learn will experience a great deal of difficulty trying to use inquiry based learning (National Research Council, 2000).

A second reason for the success of inquiry based learning is that it actively engages each student in a positive interdependence (mutual dependence on one another), face-to-face promotive interaction (interaction that allows all group members to grow in understanding), individual accountability, interpersonal and small group skills, and group processing (occurs when all members of the group work together in developing conclusions) which in turn develops positive student attitudes towards learning (Mohamed, 2008).

A third reason for the success of inquiry based learning, like many teaching methods that allow groups of students to work together, is that it helps students who are visually impaired, gifted or both (Rooks & Maker, 2009). Inquiry based learning helps the visually impaired and gifted students because it allows them to work with general education students who can provide them support. Inquiry based learning also allows the students with disabilities to demonstrate their strengths. It gives the student a way to verbally express thoughts through reduced vocabulary demands, graphic organizers, and multiple representations of materials. The student can develop higher level thinking skills by the use of structured questioning techniques, and it allows the student
to build upon prior knowledge and experiences to create new knowledge (National Research Council, 2000; Rooks & Maker, 2009).

The third reason as to why inquiry based learning is successful is significant when it is considered that there are approximately 93,600 students with a visual impairment and 55,200 who are legally blind in U.S. schools each year not to mention the number of students with disabilities other than visual impairments who also greatly benefit (Rooks & Maker, 2009).

A fourth reason that inquiry based learning is successful is that it can easily incorporate technology through the use of such devices as computers. Incorporating computers can help inexperienced learners break down tasks into easy to manage tasks, replace the natural world through simulation, provide analytic tools, and support collaboration among learners (van Joolingen et al., 2007).

A fifth and final reason that inquiry based learning is successful is that it helps more concrete thinkers in finding things out for themselves. In the more traditional forms of teaching, students can complete assignments with little to no thinking and thus never really develop critical thinking skills as well as a real sense of understanding of concepts. However, when inquiry based learning is used, the concrete thinkers are pushed to develop questions to investigate, figure out how to answer the questions, decide what to observe as well as how to interpret the meaning or meanings behind the obtained data (Colburn, 2008).

**Types of Inquiry**

There are three types of inquiry which differ by the amount of student involvement at the planning stage (Zion & Sadeh, 2007). The most common type of inquiry is structured inquiry. In structured inquiry, the teacher states the problem, formulates the question and hypothesis as well as develops the working plan. The students implement the plan, gather the data, and draw
conclusions. The second type of inquiry is guided inquiry. In this type of inquiry, the teacher poses the problem and then the students determine the processes and solutions. The third and final type of inquiry is open inquiry. In open inquiry, the students state the problem, formulate the hypotheses, and develop procedures as well as follow through with the procedure and collect the data (Zion, Cohen, & Amir, 2007).

In selecting the appropriate type of inquiry based learning to use for a particular lesson, a teacher must use his or her content knowledge and curriculum goals. An important aspect of using the teacher's knowledge of the content is how difficult is the material to be taught. If it is difficult material then structured inquiry may be the most appropriate type to use. However, if the material is somewhat easy, a teacher might need to use either guided or open inquiry. The teacher must have a clear understanding of the curriculum to determine the degree of difficulty of the material to be taught. Additionally, when a teacher is determining which type of inquiry to use, he or she must use his or her knowledge concerning the learners in the class and how diverse their learning needs are. If the teacher has a class of students who have very few learning difficulties then guided or open inquiry may be appropriate depending on the difficulty of the material. However, if the teacher is teaching a group of students who have several learning difficulties, then structured inquiry might be the most appropriate.

Finally, when a teacher is determining which type of inquiry to use, she must also consider how students learn and develop. A teacher may need to break the lesson down into smaller lessons to be covered over a few days instead of trying to teach the entire lesson in one day. The students will not be able to learn the material to the depth that they need or they will struggle to learn the material if too much is given to them at one time.
**Factors that Influence Success of Inquiry**

There are four major factors that help to determine the effectiveness of inquiry based learning. The first factor which is most likely the biggest factor is the teacher and her content knowledge. This is considered to be the most important factor because one cannot teach what one does not know (Sanders, 2004). Also, how can a teacher develop curriculum goals if the teacher does not know where the curriculum is headed and where the class should finish?

A second factor is the support the teacher receives from administration as well as from parents (Sanders, 2004). Many parents and students oppose inquiry based learning because it differs from traditional learning, and parents and students alike have a tendency to focus more on grades then on actual learning (Robertson, 2007).

A third factor in determining the effectiveness of inquiry based learning is the teacher's confidence in her ability to guide students through the inquiry learning process. This relates back to the teacher's self-efficacy in her ability to help the students truly understand the material. If she has a great amount of confidence in her knowledge of learners, how they learn, and in her ability to guide students through the process, then she most likely will be successful as long as she has the content knowledge to do so. However, if the teacher does not feel very confident in her ability to guide students through the process, then more times than not, the endeavor will not be successful even when the teacher has a great deal of content knowledge.

The fourth and final factor that determines the success of inquiry based learning is how well the teacher can handle the feeling of having little to no control over the students. The teacher’s ability to handle a classroom full of students who are all performing various tasks is a part of classroom management. If a teacher lacks knowledge in how to manage a classroom, she is going to feel uncomfortable with so much activity going on at once. However, if the teacher is able to manage
the classroom in such a way that it does not get too noisy and in a way that she can easily bring the attention of the students back to herself, then the teacher can be successful at inquiry learning (Zion et al., 2007).
Chapter 3: Methodology

Overview of Methodology

This study investigated both the personal and professional experiences of elementary teachers who have elected to teach science to elementary students by incorporating math and reading instruction into their science instruction although there is external pressure to leave science out of the curriculum. The data gathered from the participants will illustrate what type of experiences has led to the participants placing such a high value on elementary science education. The data will also illustrate how teacher training programs need to make improvements in teacher preparation, so that more elementary teachers feel they can be successful in teaching elementary science and will be motivated to do so once they become practicing teachers. The aim of this study was to investigate the past personal and professional experiences (childhood experiences involving science, experiences with influential people as they relate to science, preservice training including the student-teaching experience, and chosen professional development) that have led participants to incorporate science into their elementary math and reading instruction. To understand how the past personal and professional experiences of elementary teachers who use science to teach math and reading to elementary students influenced them to do so; this study focused on the individual experiences of the participants. These experiences included events that occurred as far back as the participants’ early childhood and progressed forward to include experiences that have only recently occurred.

This study investigated the following question:

What past personal and professional experiences have led participants to incorporate science into their elementary math and reading instruction?

Conducting a qualitative narrative study was the best approach for this study because it
allowed the researcher to “situate individual stories within participants’ personal experiences (their jobs, their homes), their culture (racial or ethnic), and their historical contexts (time and place)” (Creswell, 2007, p. 56). Additionally, the qualitative narrative approach allowed the researcher to analyze the participants’ stories and retell them in a way that makes sense within the context of the study.

The research paradigm that was used in this study is a constructivism paradigm. The main goal of the constructivism paradigm is to rely on the participants’ views of a particular situation as much as possible. Furthermore, the meanings of these interpretations are believed to have both a social and a historical aspect, thus the interpretations are formed through the interactions between the participants and the cultural norms as well as the historical norms in their daily lives (Creswell, 2007).

This study used the constructivist paradigm impart due to its reliance on the researcher making sense of the meanings of which the study participants have about the world from their experiences. These experiences and how they are perceived are thought to be effected by both cultural norms and historical norms placed on elementary teachers currently as well as in the teachers’ past; this is especially true since most elementary teachers are women. Using the Interest and Effort Relationship Theory of Dewey and the Self-Determination Motivation Theory, this study explored the events that have occurred throughout the lives of the participants from life as a young toddler into adulthood and looked at how the participants interpreted these events. This study also explored how these interpretations have led to the participants’ motivation to teach elementary science.
Research Design

Qualitative research by its very nature is inductive and richly descriptive (Merriam, 2002c). In qualitative research, truth is regarded as being subjective instead of objective, and it recognizes that a phenomenon cannot be broken into multiple variables to be studied independently of one another (Ryan, Coughlan, & Cronin, 2007). Additionally, “the world, or reality, is not the fixed, single, agreed upon, or measurable phenomenon that it is assumed to be in positivist, quantitative research” (Merriam, 2002c, p. 3).

Qualitative research was selected for this study in which the past personal and professional experiences of elementary science teachers was studied due to its recognition that the participants’ experiences, feelings, and attitudes are not variables to be studied separately (Ryan et al., 2007) but instead, they are interacting factors that influence a person’s understanding of the world (Merriam, 2002a). Understanding the past personal and professional experiences of elementary teachers is a complex issue that required empowering the participants’ to tell their stories while not being concerned about the outcomes (Creswell, 2007) nor being concerned about individual variables.

Qualitative research has multiple philosophical stances. Of the philosophical stances that exist in qualitative research, an interpretive design was selected for this study. In interpretive qualitative research, the researcher is the primary instrument for data collection and data analysis which allows the researcher to develop an understanding of how the participants have constructed meaning from their experiences (Merriam, 2002a) through the conducting of interviews and the pattern, category, and theme building from the “bottom up” (Creswell, 2007, p. 38).
Due to the very nature of how a person develops interests, interacts with their interests, and develops their life to reflect their interests, a quantitative research design just simply would not work. There simply is not a way to measure such experiences using numbers. Instead the experiences and how they have been interrupted and allowed to influence a person’s motivation to react with their interests over the course of time has to be studied subjectively or in other words, they have to be interrupted by the researcher.

The subjective nature of an interpreted qualitative research design can be both an advantage and a disadvantage. Being subjective was an advantage in this study in that it allowed the researcher to gain a rich understanding of the experiences as well as how the participants have interpreted them and allowed them to influence their motivation to incorporate science into their elementary curriculum. The subjective nature was a disadvantage in that the researcher had to guard against allowing her own biases to effect decisions while assessing the data and developing conclusions.

**Research Approach**

Narrative research “strives to preserve the complexity of what it means to be human and to locate its observations of people and phenomena in society, history, and time” (Josselson, 2006, p. 3). Narrative research was also the approach chosen for this study. The narrative approach was most appropriate for this study as it seeks to understand the experiences that have led the participants to teach elementary science. Many of these experiences relate to the participants’ past experiences which include experiences affected by boundaries often inflicted by society on a person based on their gender. It is important to remember that most elementary teachers in the United States are women, and many women have been turned off of science by their experiences in the classroom with teachers as well as experiences with family and friends.
Although each individual is unique and has a unique past, the narrative research approach seeks to understand “the patterns that cohere among individuals, and the aspects of lived experience that differentiate” (Josselson, 2006, p. 5). Since events in an individual’s past cannot be recreated, it is very common for narrative researchers to conduct interviews to gain an understanding of each participant’s past and to help develop their story (Merriam, 2009). To understand the past of the participants’ so that it can be reconstructed and the data analyzed, interviews; field notes; science lesson plans of the participants; and a journal kept by the researcher was used.

**Participants**

In qualitative research, sample selection has a large impact on the quality of the research; therefore, sampling in qualitative research is both selective as well as purposeful (Coyne, 1997). According to Creswell (2007), narrative studies are best “for capturing the detailed stories or life experiences of a single life or the lives of a small number of individuals” (p. 55). Additionally, Creswell (2007) recommends the inclusion of only a few individuals in narrative studies; therefore, four elementary teachers who teach elementary science were included.

By keeping the number of participants in the study small, the researcher was able to dive deep into the stories of each participant in order to reconstruct and analyze the experiences. Participants were elementary teachers who have participated in ToPPS (Teachers of Physics and Physical Science). ToPPS is a program hosted by the Physics Department at Northwestern Oklahoma State University with most of the instruction being provided by PTRAs (Physics Teachers’ Resource Agents) provided by AAPT (American Association of Physics Teachers). Although this program was actually designed for physics and physical science teachers, there have been elementary teachers who have chosen to take part in the program. Many of these
teachers incorporate the topics from ToPPS into their elementary teaching. All participating teachers hold a degree in elementary education and teach in a public elementary school.

When considering the type of sampling to be used in this study to determine which elementary science teachers would be included as study participants, it was important to remember that participants should be selected because they can “provide substantial contributions to filling out the structure and character of the experience under investigation,” (Polkinghorne, 2005, p. 139) and not because they meet representative requirements (Polkinghorne, 2005). When selecting which ToPPS participants to recruit for the study, the researcher contacted the director of the program and university physics professor for his recommendations as to which teachers he felt would provide the most substantial contributions to the study. The director of the program was an excellent resource for this because he has worked with these teachers personally as they have been involved in the ToPPS program.

**Recruitment and Access**

Once the researcher received the approval from Northeastern’s Internal Review Board to conduct the study, the researcher contacted the director of ToPPS for his recommendations. Once he gave his recommendations, the researcher sent an email to the recommended teachers. This email contained the recruitment letter (Appendix B) and a copy of the consent form (Appendix C). A deadline for willing teachers to respond by email was included.

Once the deadline passed, each willing teacher was contacted by email to establish a time and place for the initial interview on one of the dates in which the researcher had already set aside for interviews. The time and date for the researcher to observe the participant teaching a science lesson and for the second interview was also established through email.
**Data Collection**

The key to narrative research is the first person accounts of lived experiences (Merriam, 2009). These first person accounts are the stories of the participants, and these stories are gathered through interviews (Connelly & Clandinin, 1990). In conducting the interviews, the researcher used a modified version of Seidman’s (2006) three interview protocol. For Seidman (2006) the goal of an interview is to have the participants recreate their experiences that are related to the topic understudy. According to Seidman’s three interview protocol, the purpose of the first interview is for the researcher to place the experience of the participant into context. Then, when the second interview occurs, the researcher is to concentrate on the details of the experience. Then finally in the third interview, the researcher is to have the participant reflect on the meaning of the experience.

Due to schedule constraints of the participants and the researcher as well as the distance of which the researcher had to travel, Seidman’s three interview protocol was modified to include only two interviews. Seidman agrees that at times a researcher may have reason to reconstruct the three interview protocol. Seidman just reminds researchers that they must preserve the logic and benefit of the three interview protocol when modifying the three interview protocol (Seidman, 2006).

The main role of the researcher in narrative research is to be a coproducer of the narrative by asking the participant to tell them their story about the topic (Kvale & Brinkmann, 2009). To aid the participants in thinking about their story and to help the researcher place the experience of the participant into context and concentrate on the details of the experience during the first interview, the participants were asked to fill in a timeline that focused on the life, education, and professional development of the participants (Appendix D). They were asked to bring a copy of
the timeline with them to the initial interview for the researcher to keep and for the participant to use as an aid in recalling details.

Each one of the two interviews with each participant lasted around forty five minutes. Seidman (2006) recommends that each interview should last approximately forty five minutes to an hour. If it is shorter then forty five minutes, then an understanding of the context of the experience may not be gained by the researcher. If it is longer than an hour, the participant may grow weary. Additionally, each initial interview consisted of six broad questions (Appendix E). Auerbach and Silverstein (2003) recommends six questions because if more than six questions are used, the participants grow exhausted and not enough data is gathered if less than six are used. Additionally, each of the six questions were broad to allow the researcher to concentrate on what the participant was saying and inquire about details of the story that provided rich contributions (Merriam, 2009).

Each participant was asked to bring a copy of the timeline with them to the first interview. Once the study was explained and the participant’s questions answered and the consent form was signed, the first interview began with the participant being asked to discuss the events they had written on the timeline. Since the purpose of the first interview was to help the researcher place the experience of the participant into context and to understand the details of the experience, the questions asked during this interview aided the participant in reconstructing their experiences as well as describing how the past experiences have impacted the present.

Connelly and Clandinin (1990) recommends field notes of shared experiences between the participant and the researcher be used to collect data in narrative studies. After the first interview occurred and before the second interview, the researcher spent time in each participant’s classroom observing and recording notes in a field journal as the participant taught
a science lesson. The participant was asked to provide the researcher with a copy of the lesson and/or the plan for the science lesson that is being taught while the researcher was present. The participant was allowed to bring the science lesson plan to the first interview, or they could have given it to the researcher on the day of the observation.

The second interview was conducted following the classroom observation. During this interview, the researcher asked questions that filled in any gaps of the story (Appendix F). These questions pertained to the experience described in the first interview as well as to what may have or may not have been observed during the classroom visit. During this interview, the participant had the opportunity to reflect on their responses and describe how the experiences of the past have impacted the present. Kvale and Brinkmann (2009) recommends that narrative researchers use questions that begin with “Can you tell me about ..,” or “Please tell me about…” and that they become the listener, “abstaining from interruptions, occasionally posing questions for clarification, and assisting the interviewee in continuing to tell his or her story” (p. 155).

At the conclusion of the second interview, the researcher thanked the participant for taking the time to participate in the study. By thanking the participant, the researcher concluded the interview as well as gave the participant an opportunity to comment on their participation.

Each interview was recorded using a digital voice recorder, a smartphone, and a Nexus 7. Fraenkel et al. (2012) recommend using a recorder of some type to ensure that the interview is captured in its entirety. Additionally, each interview took place at a location that was agreed upon by the participant and researcher. Fraenkel et al. (2012) supports the idea of conducting interviews in a location where the participant is free of distractions and will not feel intimidated since the conditions of the location can affect the responses of the participant and negatively affect the validity of the interview. Furthermore, notes relating to the participant’s behavior and
actions as well as the behavior and actions, biases, and decision making of the researcher were recorded in the field journal during both interviews and during the classroom observation.

The research protocol, as set forth by the Northeastern University Internal Review Board as well as the methodology of this study as it was approved by the university’s IRB, was strictly followed. Participants were not recruited until the methodology of this study had been approved, and once the study was approved, the researcher began to recruit participants, conduct the research, and analyze the data in the manner approved.

**Data Storage**

When conducting narrative research, it is easy for the amount of data collected to quickly become overwhelming if the data is not organized. To organize data in narrative studies, Creswell (2007) recommends computer files be backed up, only high quality recording devices are used to record interviews, a master list of information types gathered be developed, and the anonymity of the participants be protected by masking their names.

To protect the identities of the participants, each participant was assigned a number. The list with each participant’s name and assigned number was kept in a locked filing cabinet separate from all other study documents. Additionally, only the researcher knew what number had been assigned to each participant, and the assigned numbers were used with each document provided by the participant.

The science lesson plans, timelines, field journal, SD card containing the recordings of each interview, and hard copies of the interviews were kept in a locked filing cabinet. The electronic documents were kept in a password protected file on the researcher’s personal computer as well as on a flash drive. The flash drive was stored in the locked filing cabinet when not in use. Once the consent forms were signed, they were placed in the locked filing
cabinet during the study and will continue to be stored there for the three years following the study as required.

**Data Analysis**

In conducting narrative research, a researcher is looking to understand the “stories” of the participants and how the events of these stories have affected the participant in the present. Because the narrative configuration process uses a thematic thread or “plot” to layout the unfolding events that lead to the outcome, it was the process initially used to analyze the collected data and to reconstruct the stories of each participant.

In using the narrative configuration process to reconstruct the plot from the collected data, the researcher must:

1. delimit a temporal range which marks the beginning and end of the story,
2. provide criteria for the selection of events to be included in the story,
3. temporally order events into an unfolding movement culminating in a conclusion, and
4. clarify or make explicit the meaning events have as contributors to the story as a unified whole (Polkinghorne, 1995, p. 7).

After the story of each participant was reconstructed, a thematic coding process was used to further analyze data. A theme is a phase that identifies what a unit of data is about and/or what it means, (Saldana, 2009) and it functions as a way to categorize data into “an implicit topic that organizes a group of repeating ideas” (Auerbach & Silverstein, 2003, p. 38.) In thematic coding, the researcher reviews the interview transcripts looking for points in which the participants shared similar or identical ideas (Auerbach & Silverstein, 2003). There are six steps that must be followed when using thematic coding. In the first step, the researcher familiarizes themself with the data by reading the transcribed interviews several times looking for repeated
patterns and meaning. The researcher then generates the most relevant initial codes. Once the second step is completed, the researcher focuses on seeking to find the more broad themes that combine the initial codes. Once completed, the researcher reviews the themes looking to identify themes that are unnecessary and to create new themes as needed. In the fifth step, the researcher defines and names the themes while analyzing the data. Finally, the researcher produces the final story (Braun & Clarke, 2006). When the themes were created, a combination of inductive and deductive analysis methods was used.

In this study, the stories that were reconstructed relied heavily on the events that have occurred in the lives of the participants. Each participant is unique and came into the study with a unique story to tell as different events have shaped their lives and their understanding of the world. Therefore each story had to be analyzed individually as the researcher identified themes before the stories could be analyzed together. Because each story was told by the participants and through their eyes, the constructivist paradigm was employed as the data as analyzed.

**Ethical Considerations**

Anytime in which research is performed that involves humans as participants, it is of the upmost importance that the researcher ensures that none of the participants suffer as a result of their participation in the study. Because this study involved consenting adults who were telling their story, it was thought that harm would not come to the participants. To ensure that the participants suffered no repercussions, the researcher not only emailed a copy of the purpose of the study and the consent form to each participant prior to the interview, but the researcher also carefully discussed the purpose as well as the process with each participant individually. Once each participant understood the study and had asked any questions they had, they were then asked to sign the consent form. They were reminded that they could cease participation at any
point in time. Furthermore, all hard copies of interviews, field notes, participant provided lesson plans, and the SD card that contained the interviews were kept under a tight lock. The only other people allowed to see the documents other than the researcher was the researcher’s advisor or people appointed by the internal review board.

To protect the identities of the participants, the researcher assigned each participant a unique number. The list of participants and their assigned identification numbers were kept in a separate filing cabinet from the other documents. Only the researcher knows what number had been assigned to each participant and only researcher assigned identification numbers were used to identify documents provided by each participant.

**Trustworthiness**

“All research is concerned with producing valid and reliable knowledge in an ethical manner” (Merriam, 2009, p. 209). To ensure that a study is valid and reliable, Creswell (2007) describes four criteria that must be present in any study. They are credibility, authenticity, criticality, and integrity. For Creswell, credibility means that the results are an accurate account of the participants’ meaning. Authenticity occurs when multiple voices are allowed to be heard through the data while criticality means that all aspects of the research has been studied using a critical eye. The fourth and final criterion that must be met is concerned with the integrity of the researcher. Are they self-critical of their own investigation?

To ensure this study is of high quality and is a study in which professionals in applied fields would consider the results of this study to be of value, several validation strategies were employed.

The first strategy to be employed was the strategy of clarifying researcher bias. Because qualitative research is open to interpretation by the researcher, it is important that the researcher
clarifies his or her “past experiences, biases, prejudices, and orientations that have likely shaped the interpretation and approach to the study” (Creswell, 2007, p. 208). This strategy is important here for it aids others in understanding how the “researcher’s values and expectations influenced the conduct and conclusions of the study” (Merriam, 2009, p. 220).

A second strategy employed in this study was the strategy of adequate engagement in data collection. In qualitative research, there is always a question of how many participants should be included and how much data should be collected from each participant. For Merriam (2009) a good rule to obey is that the data must feel saturated. What Merriam means by the phase “feel saturated” is that the researcher has collected so much data that they begin to feel as though they continuously hear the same things over again. Once no new information is emerging from the data, the researcher has finally collected enough data.

The third strategy used in this study to ensure validation is considered by many to be the most critical strategy of trustworthiness, and that is member checking (Creswell, 2007). Member checking occurs when the researcher allows the participants to provide critical feedback concerning the data and interpretations (Merriam, 2009). In this study, member checking occurred at several different points. The first time member checking occurred was following the interviews once the interviews were transcribed by a professional transcriptionist. Once transcribed and received by the researcher, the file was sent via email to the participant whom provided the interview. The participant was asked to read the document to verify that what they meant is indeed what was transcribed. Once agreement was reached on the transcribed documents, the data was coded.

The second time the participants were asked to review documents containing the data they provided was following the analyzing of their particular story. Again, each participant was
asked to notify the researcher of any inconsistencies. The third and final time that the participants were asked to review documents was once the initial findings were written.

The fourth strategy of validation that was used is rich, thick description. When a rich, thick description strategy is used, the researcher writes in enough detail, so that the reader is able to determine if the findings are transferable in their situation (Creswell, 2007). This strategy was used extensively in this study in an attempt to aid readers in understanding the environment in which the participants live and work as well as the conditions in which they were raised since it was found that experiences from childhood have affected the teachers’ decisions to teach elementary science.

A fifth and final validation strategy that was used in this study is that of journaling. Krefting (1991) states that journaling is a method that can be employed by qualitative researchers to not only record their thoughts concerning interactions with participants but that journaling can be used to record questions and potential problems. During this study, the researcher used the journal to record field notes while observing participants teaching a science lesson, to record behaviors of participants during the interviews, the thoughts of the researcher, questions, concerns, decisions made that concern the study as well as for researcher reflection.

In summary, five strategies were used to ensure trustworthiness in this study. The first strategy used was researcher bias. The researcher of this study described all biases as they related to the study. The second strategy used was adequate engagement, which just simply means that the researcher collected data to the point of saturation. The third strategy used was perhaps the most important, and that is member checking. In member checking, the participants are allowed to verify the work of the researcher in an attempt to verify that the data is correct. Rich, thick description is the fourth strategy employed, and it required that the researcher use
descriptions in their writing that allows readers to determine transferability. Finally, the final strategy used was journaling. The journal was used to record all concerns, behaviors, questions, decisions, and reflections as they related to the study.
Chapter 4: Findings

The purpose of this chapter is to report and discuss the findings from the research collected through interviews, timelines, and classroom observations with four elementary teachers who elect to incorporate science instruction into their math and reading instruction. The chapter begins with a brief introduction to the study context and defines terms associated with the study. The second section provides a summary of the stories of each of the four teachers. A presentation of the emerging themes within and between the teachers’ narratives in relationship to the research question as identified through an analysis of the interview transcripts is discussed in the third section of the chapter. The chapter then concludes with a summary of the research findings.

Study Context

As a general rule, elementary teachers in the United States have never really taught science (Century et al., 2008). There have been several reasons as to why this has occurred. The historical reasons as to why science has traditionally been left out of the elementary curriculum include teachers not feeling confident in their training to teach science, teachers not having an interest in science, (Allen, 2006) and for some, the long held belief that elementary students are not able to learn science (Akerson & Donnelly, 2010; Quigley et al., 2010). Additionally, school districts have traditionally not budgeted for science equipment and curriculum for the elementary grades (Stamp & O’Brien, 2005).

Since the passage of the No Child Left Behind Act of 2001 (NCLB), the amount of science taught in the nation’s elementary schools has greatly diminished (Center for Education Policy, 2006; Levy et al., 2008). This has occurred due to the emphasis being placed on math and reading scores (Queenan, 2011). The schools that were most likely to diminish science
instruction were the schools that serve high poverty populations; and it was this very group that NCLB was designed to help (Jennings & Rentner, 2006). As a result, Congress passed an amendment to NCLB that required students to be tested in the area of science beginning in the 2007-2008 school year. However, science was not added to the school accountability formula (Jennings & Rentner, 2006; Miller, 2010). The school accountability formula is known as Adequate Yearly Progress or AYP. Schools who fail to meet their AYP for two or more consecutive years face steep penalties. Since the amendment failed to add elementary science to the accountability formula, most schools across the nation continue to instruct their teachers not to teach elementary science and focus solely on math and reading (Dee & Jacob, 2011; Jennings & Rentner, 2006).

This study occurred in the state of Oklahoma. Oklahoma was granted a waiver in February 2012 by President Barak Obama to opt out of the requirements of NCLB. To do so, the state had to have an approved plan in place that demonstrated how it was going to improve the education in the state. Part of Oklahoma’s plan included the implementation of the A-F Report Card. The A-F Report Card requires that school districts receive grades that are based upon three sections which include student achievement on standardized tests, student growth, and whole school improvement (Oklahoma Department of Education, 2012).

The student achievement on standardized tests section includes student performance on the Oklahoma Core Curriculum Tests (OCCT) and the End-Of-Instruction (EOI) exams for secondary students. The Oklahoma Core Curriculum Tests are only given in math and reading to students in grades three through six with the addition of geography in the seventh grade and history/government, science, and writing being added in the eighth (Oklahoma Department of Education, 2012). Much like when Oklahoma was under the requirements of NCLB and science
was not included in a district’s accountability formula, under the A-F Report Card, science is still not included; therefore, it remains out of the elementary curriculum.

As if the pressure to leave science out of the curriculum in the lower elementary grades was not great enough, under the Oklahoma Reading Sufficiency Act, all students must be reading on grade level by the end of third grade. If a student is not reading on grade level as determined by their performance on the state third grade reading test, the student is to be retained in the third grade until they can successfully pass the state third grade reading test. Additionally, students are to receive 90 minutes of reading instruction each day and begin testing in reading while in Kindergarten with up to 60 minutes of remediation each day following each reading test that is failed (Oklahoma Department of Education, 2014). These requirements can make it very difficult for any teacher to teach science in the lower elementary grades. Lisa, one of the third grade teachers in the study, best described teaching lower elementary as “it's like having 25 corks that you are trying to keep under the water all at once. That's what it's like.”

There were four teachers who took part in this study. One of the teachers teaches the second grade, two of them teach third grade, and the fourth teaches the fourth grade. All four of these teachers teach in the same suburban school district. Two of the teachers teach in the same elementary building and the other two are in separate buildings. It is also important to mention that these four teachers are just like every other teacher in the state of Oklahoma in that they are some of the lowest paid teachers in the nation with the average teaching salary coming in at just $44,128.00 (U.S. Department of Education, 2013).

There are a few key terms that must be defined here. First, OSTA (Oklahoma Science Teachers Association) is an organization for all science teachers in the state of Oklahoma regardless of the grade taught. The term “cooperating teacher” is used here to refer to a teacher
who has agreed to mentor an education major in her final semester of college while she learns
the art of teaching while in an actual classroom. The term “professional development” refers to
workshops and conferences that have been designed for teachers to attend voluntarily to improve
their teaching skills and/or give them ideas to improve learning in their classroom. The final
term that needs to be defined here is OERB. The OERB (Oklahoma Energy Resource Board)
developed useful workshops for all Oklahoma teachers nearly twenty years ago. These
workshops focus on teaching students about Oklahoma’s petroleum industry and have been
developed for all levels of elementary school as well as for all secondary core content areas.
Teachers who attend these workshops not only receive a stipend for attending, but they also
receive anywhere from $100 to $1000 worth of equipment depending on their content area.

The purpose of the current study is to investigate the past personal and professional
experiences of elementary teachers who choose to integrate science into their math and reading
instruction. Through interviews and the timelines created by the four teachers, Ashley, Ali, Lisa
and Amy retell their personal stories as they relate to their interest and passion with science. The
notes taken during the classroom observations as well as the timelines and interviews have been
used in the retelling of their stories. This next section provides an introduction to each of the
four teachers and a summary of each of their unique experiences.

Teachers’ Stories

Ashley. Ashley and her two older brothers were born and raised in central Michigan. On
days when the weather was nice, their mother very seldom allowed them to stay inside the house.
Ashley grew up during a time when parents could send their children out to play and ride bikes
all day without much worry and so Ashley and her brothers spent the majority of their childhood
playing, fishing, and swimming in the creek that ran behind their parents’ home on their two acre
plot. Ashley and her brothers would often catch small animals as they would go to the pond to drink. Ashley remembers feeling so bad for the small critters that they would catch, especially when her brothers would attempt to “blow” the animals up.

While Ashley and her family were still living in Michigan, her dad would always plant a large garden every spring. Ashley’s dad would often have Ashley help him prepare the garden for planting. She often found herself hoeing the garden as well as helping to pick the vegetables. Ashley and her brothers would then take fresh vegetables in their school lunches and Ashley would help her mother with the canning of many of the vegetables that they did not eat fresh.

As a student, Ashley does not remember having science in elementary while she lived in Michigan. However, she does recall designing her own science experiments at home just to see what would happen. One such experiment occurred in her parents’ garage. Ashley and a few of her friends decided on one cold day in Michigan to build a camp fire in the garage while her dad was at work and the car was not in the garage. Ashley and her friends very quickly learned about how fires produce smoke and how difficult it is to breath in a room full of smoke. Ashley and her friends had lit the fire with the garage door closed.

Ashley’s earliest memory of science in school occurred shortly after she and her family moved to Oklahoma. In describing this experience and with a serious look, Ashley states “I remember the science teacher that I had. She was mean. She didn’t like teaching science, and you could tell it. We had to do a science fair experiment. We were all made to do one. I didn’t know what science experiments meant, but I somehow managed to put something together.”

Ashley’s junior high experience with science was more positive. During the interview, Ashley’s face lit up as she told how she loved junior high school science because it was not just book work. She especially enjoyed junior high science because she and her class were able to
dissect animals such as worms, grasshoppers, frogs, snakes and the eyeballs from sheep. Ashley recalls the time when she and her lab partner cut into the stomach of a frog and found pieces of a small bird that the frog had eaten. She tells how she found the event very interesting and a little gross at the same time.

Unfortunately, this enjoyable experience with science during junior high was the highlight in science education as a student for Ashley. She does not recall anything special about high school science, and she does not recall completing more science courses than required for high school graduation. What Ashley remembers most about high school was how she played the flute in her high school’s top marching band and how the band earned many awards.

As a freshman in college, Ashley majored in elementary education for being an elementary teacher was all she ever wanted to be. Although Ashley enjoyed her classes, her experience in her college science course for elementary majors was not much better than her initial experience with science in the sixth grade. Her instructor was a teacher’s aid instead of a professor, and she was out of touch with elementary education. Ashley describes this teacher as “a horrible elementary science professor” who taught “a bunch of jumbled facts” that did not seem to fit together. Additionally, the labs that she learned to do in this class were not labs that she would be able to do with her own students due to costs and lack of science equipment.

While Ashley was completing her student teaching, she and her cooperating teacher would teach science; however, it was only on occasion and not anywhere near on a regular basis.

After Ashley graduated from college in the early 1990s, she was initially offered a fourth grade science teaching position. She turned the position down and accepted a position in a different district because she did not feel that she could teach elementary science. Then, came the magical summer of 2006 which completely changed how she thought about teaching and
how she taught. In the summer of 2006, Ashley was selected to take part in a two week elementary teacher workshop that was designed to teach teachers how to integrate science into math and language arts entitled “Synergizing Math Scientifically.” She agreed to participate because she knew that she would be paid $1000 just for attending the two weeks. The workshop made Ashley “fall in love with teaching science.” For the first time in her life, Ashley understood variables and she could finally explain the difference between an independent variable and a dependent variable. Furthermore, for the first time in her life, Ashley could associate them with something other than Algebra. Ashley smiles and with excitement in her voice she said “after going to that class that summer and then the follow-up classes, it was kind of life changing. I decided that I not only wanted to teach science, but I wanted it taught to the whole district.”

Today, even before you walk into her classroom, it is difficult to miss the excitement she has for teaching elementary science to her fourth graders. On the front of her classroom door is a professionally made sign that has an array of pictures that symbolize science that says “Welcome to Mrs. Green’s Super Science Lab.” Additionally, directly beside her door, are a white lab coat and a pair of pink goggles. In the back of her classroom and behind her desk hanging on the wall are several plaques. Two of the plaques were given to her when she was voted ‘Teacher of the Year’ in her building on two separate occasions. Another plaque was given to her when she was awarded the ‘Outstanding Elementary Science Teacher Award’ by the Oklahoma Science Teachers Association. The final plaque is the most prestigious award, and the one of which she is the most proud. This award is the “Presidential Award for Excellence in Math and Science.”

The “Synergizing Math Scientifically” workshop was just the first of many workshops that Ashley has attended since the summer of 2006. Ashley routinely attends professional
development that is not provided by her school district such as ToPPS and OERB workshops. There are three criteria that she uses when deciding if it is worth her time. The criteria are, is it useable in her classroom, will she receive free goods (science equipment), and will she be paid to go. Usually if two of the three are met, she declares it worth her time.

Ashley not only has developed into a great elementary science teacher, she has worked very hard to get other teachers to join her in the teaching of elementary science. She has not only tried to get them to join her, but she has worked to help them and others become effective elementary science teachers. Ashley is a member of the Oklahoma Science Teachers Association (OSTA), and she serves on the board of directors as an elementary representative. She and the board have worked very hard to develop meaningful professional development opportunities for elementary teachers when they attend the OSTA conferences. Ashley has also taken a younger teacher in her building under her wing and helped her learn to teach elementary science. This teacher is Amy who is also in this study.

Ashley has always loved science. She contributes her love for science to her years as a young girl playing with her brothers in the creek on their parents’ two acre plot of land in Michigan and the many science experiments that she would design and carry out. However, looking down and then back up, Ashley says that “I believe that I did not want to initially teach elementary science because I did not want my students to have the horrible experiences with science that I experienced in school.” As Ashley concluded her final interview, she is almost in tears as she tells how she regrets that she did not attend a workshop like the one she attended in 2006 that taught her how to teach science and how to integrate the content areas. She is very proud of the fact that she has taught elementary science for the past eight years and she deeply regrets that she has not always taught science to her elementary students. Ashley feels like she
failed her earlier students because she did not teach them to inquire about their world and she did not teach them to critically think. Ashley hopes that new elementary teachers have been taught how to teach science and she would like to find a way to help other teachers like herself teach elementary science.

Ali. Ali is the oldest of four children and she spent much of her early childhood and early elementary school years living in the Texas panhandle. Ali’s earliest memory with science was a scary moment for her. When she was around the age of four, she headed out into her parents’ yard to play with a friend in her sandbox. To her surprise, the living creature in her sandbox was not her friend, but a snake. Ali remembers being frightened by the snake and running into the house to her mother. When she returned to the sandbox with her mother, the snake was nowhere to be found.

Although Ali’s earliest memory with science was a scary moment, it did not cause her to lose interest in nature. Ali remembers going camping and hiking several times during her childhood. Ali recalls how she and her brothers would often go exploring in the woods around their campsite and how they would try to catch fish with their bare hands when there was nobody around trying to fish with fishing poles. She does not recall that they ever succeeded in fishing bare handed.

Ali’s experience outdoors did not only include hiking, camping, and that horrible experience in the sandbox with the snake, but it also included hours and hours of her and her siblings and friends playing outside. Ali does not remember science in elementary, but she does remember performing experiments with plants at home when she was in elementary. One such experiment occurred in the middle of winter while she and her family were still living in the Texas panhandle. Ali recalls planting a couple of plants in a flower pot and trying to get them to
grow in her bedroom. She also planted a few plants in her mother’s flower bed outside. She remembers how the plants in the pot in her bedroom grew in the middle of winter but those planted outside did not. Additionally, she recalls “experimenting a lot with small animals like worms and bugs” that she could catch and enjoying trying to blow things up.

Even though Ali does not recall elementary science, she does recall science in junior high. In junior high science, she remembers dissecting worms, frogs, and a rat. As Ali describes her experience with junior high science, Ali says “I was interested in it but I felt sorry for the animals that we were dissecting, but I was kinda grossed out and so I made my partner do the cutting and I did everything else.”

As Ali begins to recall her high school experiences with science, she gets a horrified look on her face. She tells of the time in biology when her teacher made her and her class watch a video of a woman giving birth. She describes how she was completely grossed out by what she witnessed that day. This experience made her think that she never wanted to have her own children, although today, she and her husband have two sons.

Ali’s high school experience did get a little better when she took a course that was half chemistry and half physics. She said that she enjoyed this class because it was a lot of lab and because she enjoyed trying to blow stuff up in the chemistry portion of the class. Although she enjoyed her chemistry/physics course, she only took the science courses that were required to graduate from high school.

As a college freshman, Ali was a physical education major. She had always wanted to be a teacher because her “aunt and uncle were, and they just looked like they had great fun at their job.” She wanted to teach PE until she started to grow concerned about obtaining a teaching job when all she could teach was PE. Due to this concern, Ali decided to become an elementary
education major. The only thing that Ali can remember about her college science professors was how much fun they made their classes. Ali really enjoyed her college science courses, and she really enjoyed student-teaching second grade with her cooperating teacher. Ali’s cooperating teacher enjoyed teaching science, and they taught it regularly.

Four years ago in Ali’s school building, there had been a teacher of which Ali was friends with that had been teaching science to fourth graders. This friend was being moved to the new elementary building that the district was opening. After a little convincing from this friend, Ali agreed to move from the second grade class that she had been teaching for several years to the fourth grade to fill this friend’s position. As Ali settled into her new position, she was starting to really develop some excellent science lessons and was really enjoying teaching science to fourth grade students. Shortly after the school year began this year, Ali’s building was suddenly short a second grade teacher. Ali suddenly found herself moving back down to teach the second grade. Although the science lessons that Ali had developed in previous years were developed for the fourth grade, Ali says she finds it fun and enjoyable developing science lessons for her second grade class.

To enhance her skills in teaching elementary science, Ali regularly attends professional development opportunities such as ToPPS and OERB workshops. Since there are several opportunities available and some not worth her time, Ali attends professional development that is new and on the cutting edge and that might give her ideas worth implementing in her class. Also, she looks for professional development that will give her free materials to take home. These free materials are usually in the form of science equipment.

On her timeline, Ali writes that she teaches elementary science “because it encourages discovery and higher level thinking. If done right, it is very hands on and fun. My students love
science and I love teaching it.” During my time in Ali’s second grade classroom, it was very evident that Ali had not missed the minds-on aspect of inquiry. Ali’s second grade students were very excited and they were having fun, but they were also being challenged to think for themselves.

In her final interview, Ali states that she loves science and that she had never connected her love for science to her teaching elementary science until she participated in this study. With a somber look, Ali describes how she believes that science and social studies should both be taught in all of the elementary grades and that they should not be left out of the curriculum because they are not tested or included in a school’s adequate yearly progress. Additionally, she expressed how she feels horrible for all the elementary students across the nation who are not being taught elementary science. She feels like she needs to do more to get other elementary teachers to teach science but she feels overwhelmed with her own classroom duties.

Lisa. When Lisa was young, her parents’ owned a cabin located along the bank of the Illinois River. Every summer, Lisa would play and go exploring in the woods along the river as well as swim and fish in the river. She loved being outdoors and enjoyed nature. She does not recall learning any science in school during her elementary years, but with excitement she does recall her parents buying her microscopes and many science kits. Lisa spent a lot of time using her microscope and looking at all of the creatures that she would catch. Lisa and her mother spent a lot of time together with her science kits. Lisa wanted to know how things worked and so every week when her mother would take her to the public library, Lisa would go directly to the books on science in the children’s library.

Lisa cannot recall a time in which she did not attend church with her family. In fact, she spent many days helping her mother babysit the young children in the church nursery. When
Lisa was in the fifth grade, she had a teacher that had taught her older brother. Lisa’s older brother had caused several problems in this teacher’s class and apparently she assumed that Lisa would as well. Lisa felt like this teacher did not like her, and she did not have a very good year that year. Lisa recalls how she loved to learn and how she loved school, but that the year she was in the fifth grade had made her hate going to school. While Lisa was in the sixth grade, she had a teacher that she really enjoyed. This teacher believed in Lisa and asked Lisa to babysit her young children on several occasions.

After seeing firsthand how a teacher can greatly inspire a young mind, Lisa decided that she wanted to become a teacher. Whenever people would ask her what she wanted to be when she grew up, Lisa begins to answer “I’m going to be a teacher.”

Lisa enjoyed her junior high science courses where she dissected frogs, cats, and pigs. With excitement in her face, Lisa described this junior high experience as being really cool but gross all at the same time. Lisa recalls having a hard time eating chicken for a long time after performing the dissections. Although she found the dissections to be somewhat gross, Lisa remembers how she found removing the eyeballs out of the frog and dissecting the eyeballs to be particularly interesting.

Lisa does not recall anything about her high school science courses or about her college science courses and professors. She however does recall how when she student–taught how her cooperating teacher did not like science and did not teach any science.

Lisa began her teaching career at a private Christian school. At this school, Lisa was required to teach elementary science. Luckily for her, the school did more than just require her to teach elementary science for they gave her every Wednesday afternoon to work on her science curriculum, and they also helped her build up her science equipment. With Lisa’s love of
science, she took to teaching science right away. Lisa remembers often teaming up with another teacher at the school to develop science lessons for their third grade classes. One such lesson that Lisa and the other teacher designed was on bugs and their different characteristics. In this lesson, they required the students to develop a bug collection that included at least twenty different bugs. She recalls how much fun the students had learning all about bugs and how much fun she and the other teacher had watching the kids have fun and then grading the students’ collections. She believes that this experience was good for her in that it inspired her to learn to teach elementary science. Smiling, she says “I had two choices. Sink or swim” and she chose to swim.

Lisa really loved teaching at this private school. However, following a horrible divorce, Lisa was forced to resign her position. Now, she teaches third grade in a school that has a free and reduced lunch rate of 90 percent and where she is the only teacher in the building that ever teaches elementary science. Now, teaching in a high poverty school, Lisa feels that it is even more important than ever that she teaches science to her third grade students.

The other three teachers in this study where given very little science equipment by their schools and even though Lisa teaches in the same district as the other three; she has not been given any science equipment. Since she does not have science equipment, she has been attempting to build her own collection of equipment. One of the main ways in which Lisa has been trying to build up her collection is by attending professional development that gives science equipment to the participants such as the ToPPS and OERB workshops. Getting free equipment from her professional development is not the only criteria that she uses when deciding rather or not to attend a particular professional development opportunity. When deciding to attend an opportunity or not, Lisa asks herself three questions: “1) Do I need to know it? 2) Will it help me
be a better teacher? And 3) Does it have a good reputation?” Of course, being paid to attend is a huge bonus.

Lisa wrote in her timeline that she teaches science because she wants to give her students a variety of experiences and that she wants them to be excited to learn. Additionally, she feels that it is very important that they know and learn about their surroundings and their world. Furthermore, when asked about her decision to teach elementary science, smiling, Lisa explains how she believes that her experiences as a child and the way in which she was raised has played a large part in her teaching elementary science today.

Lisa knows that she is the only teacher in her building who teaches science to her students. In fact, the day that I was in Lisa’s classroom, Lisa was confronted by another teacher in her building on the playground. Lisa was gathering dirt from the playground and putting it into a jar. The other teacher asked why she was gathering dirt. While smiling, Lisa explained that she needed the dirt for her science lesson that very afternoon. The other teacher asked her why she just did not make the kids read Scholastics News for their science grade like everybody else does in the building. Lisa explained to the other teacher that she loves science and that she loves to teach science and that they are not teaching science when they just give their students Scholastics News to read.

While I was observing her class that afternoon, Lisa asked the students to recall a story that they had just read that morning. This story had been about natural resources and how important they are. Lisa had her students hypothesize about what they thought they would see in their dirt. She then gave each group of two students a plate full of dirt and a hand lens. It was very interesting and funny to see just how excited these third grade students were over a plate full of dirt. Lisa had the students draw pictures of the various items that they discovered in their
Lisa addressed the plate of dirt and then concluded the lesson by helping them draw conclusions. Once such conclusion that she aided them in developing was that they needed to go to the restroom and wash their hands since worms crawl around in dirt and they are living and so therefore, they poop in the dirt.

Lisa has a deep feeling of sorrow for the students around the nation who are not being taught science in elementary. She expresses how she feels like she does not do enough outside of her classroom to get others to teach science, however, she does feel so overwhelmed by the daily duties within her own classroom involving her own students.

**Amy.** Amy’s experience growing up was a little different than the other three teachers in the study. Amy and her family lived in the city, and she does not recall spending much time outdoors as a child. Additionally, when Amy was seven, her parents went through a horrible divorce. Her mother was granted custody of her and her sister, but when she was ten; her dad kidnapped her and her younger sister during Christmas break visitation. Amy’s dad told her and her sister that since their mother had them for the past four years, that he now would have them for the next four, and so they did not quickly conclude that they had been kidnapped. It took law enforcement nearly nine months to find Amy and her sister. During this time, they were homeschooled by their father.

When Amy was with her mother and attending a public elementary school, the only science Amy remembers doing was from the book. In her timeline, Amy writes “I don’t remember anything memorable about science before junior high. In junior high, I remember we dissected a sheep’s eyeball, but again, mostly book work.” In her first interview, Amy describes her high school biology class with excitement and says “I had a great science teacher that I
remember we nicknamed Noah because she had two of everything. In her class, we dissected a lot, and I really got into.”

Amy wanted to be a teacher her entire life, so when she went off to college, she majored in elementary education. As Amy was enrolling in college for her first semester, she was steered in the wrong direction by a counselor. Instead of taking a science course that was required for her major, Amy took Zoology, a very difficult class that she did not need. Amy had an uncle, who is now a professor of philosophy, who had taken that same class and had earned a C. Amy was determined to see the course through and to earn a better grade than her uncle’s C. In her timeline, Amy writes, “My saving grace in the class was all the lab work we had to do. I never found it gross or disgusting. I loved it!” Additionally, Amy explains how she found the lab work fascinating and that she loved the hands on engaging work. Amy received an A in that difficult class and she credits the learning she received from the inquiry work she did in the class for helping her understand the material well enough to earn an A. Amy found her other college science professors and her cooperating teacher to be big on hands on activities that were meaningful to the learning of students.

Unlike the other three teachers in the study, Amy did not grow up spending hours outdoors. Instead, she spent a lot of time working. Amy does however spend a lot of time outdoors today with her husband and their two sons. Smiling and speaking of her husband and two sons, Amy explains how her husband and two sons have really gotten her outdoors and helped her learn to really enjoy the outdoors. She explained how she often goes deer hunting with her family in the fall and how she enjoys the cool, crisp air of the fall mornings as she sees the sun rise while she is sitting in a tree in a deer stand. Amy often goes fishing and camping with her family and she enjoys playing ball with her two sons and enjoys being outside watching
them play on their little league baseball teams. On a daily basis, Amy walks three to five miles, and really enjoys being out in nature as she walks. Amy has come to find nature calming and an excellent way to unwind from her day at school.

Amy contributes her teaching of science to her experiences outdoors with her family and to the experience that she had her first year of teaching with Ashley. Amy has been teaching the third grade in the same elementary school in which Ashley teaches the fourth grade. When Amy was in her first year of teaching, Ashley encouraged her to teach science. Ashley first persuaded her to attend an OERB workshop because she knew that they would provide Amy with inquiry activities and experiments to do with her students. Ashley also taught her how to integrate the various subject areas so that she could teach science.

When seeking out professional development opportunities, Amy looks for those that will give her hands on activities to teach a variety of concepts. Amy likes to get her students up and moving as well as getting them engaged in discussions with one another and with her.

Amy is a building representative for science in the lower elementary grades and she has just recently served on the state science committee that worked on the new K-12 science standards for the state. Amy feels like she needs to do more to get other elementary teachers teaching elementary science because she feels that it is important and that it helps kids understand life.

Amy teaches elementary science because she really wants her students to not only have fun in her class but to really learn and understand what she teaching them while they are having fun. Amy tells how she often receives phone calls from parents asking just what it was that they did in class that day because their child had come home and was wanting to do it at home to show their parents what they had just learned in class. Amy knows that her students are learning
because when they go to the fourth grade and Ashley gets some of her students in class, that Ashley often tells her how her students really remember what they leaned in her class the year before.

**The Teachers and their Students**

Ashley was born in central Michigan and this was where she spent her early childhood and much of her elementary years before she and her family moved to Oklahoma. Ali was born in the Texas panhandle and she spent her early childhood and a portion of her elementary years there before moving to Oklahoma. Lisa and Amy were both born and raised in the same school district in which they now teach. Additionally, all four of the teachers in this study attended junior high and high school in the same school district. Amy is the youngest and the least experienced of the four teachers and she is in her late thirties. Ashley, Ali, and Lisa are all three in their mid to late forties. Although all four of these teachers attended high school in the same school district and graduated during the mid-eighties to the mid-nineties, they each attended and graduated from different universities in the state.

The childhoods of the four teachers were much different than the childhoods of many of their current students. All four of the teachers were raised in middle class families and with the exception of Amy, by both of their parents. Many of the students in these teachers’ classrooms come from broken homes where they may or may not live with at least one of their parents. Many of these students find themselves taking on responsibilities that were not expected of the teachers when they were that young. For example, Ashley told a story of how one of her students one week was late to school three days in a row. Once this student would arrive at school, he would become upset because he had missed breakfast being served at school. On the third day in which this student was late to school, the school principal called the student into her
office to question him as to why he was late. This was when the principal and Ashley learned that this fourth grade student was having to get himself up and to school on his own and that there was very little food in the house. This student’s alarm clock had quit working and the student did not have the money to purchase a new one. That day the principal purchased a new alarm clock and gave it to the student. This fourth grade student was very grateful for the alarm clock and has not been late to school since. Unfortunately, many of the students in these four teachers’ classrooms have similar stories to this fourth grade student.

**Researcher’s Notes**

Narrative researchers are storytellers or the coauthors of the lives and experiences of their study participants. Since narrative researchers have the responsibility of constructing the story and its meaning it is important that they keep a journal (Merriam, 2002d) which creates an audit trail. The audit trail includes reflections, questions, decisions concerning problems, issues, and anything else encountered while collecting and analyzing data. In narrative studies, the audit trail is vital in describing how the data was collected and analyzed (Merriam, 2002b) especially given that the researcher’s biases could be called into question. As a high school physics teacher in the state of Oklahoma, I too, have attended the ToPPS workshops, and I have had the opportunity to work with the four participants in this study as we were all challenged by workshop leaders. As a high school physics teacher, I went into the ToPPS workshops with a deeper understanding of the content then the four study participants, and I at times worked with the study participants as they worked to increase their commend of the content. The relationships that formed during our time together at ToPPS were instrumental in establishing trust between the participants and I as the researcher.
Throughout the course of collecting and analyzing data, I took detailed notes of not only my thoughts, feelings, questions, and responses, but also of the expressions and behaviors of the participants. While the audit trail of my construction of meaning support the findings presented in the next section, it is the voices of the participants that are truly the strength of this study.

Prominent Themes

Through the participants richly personal stories related to their teaching of elementary science, their interest and motivation to teach elementary science became quite clear. The transcripts were read many times in conjunction with the journal notes and timelines as I worked to layout the unfolding events that have led the teachers to teach elementary science. The narrative configuration process was used. Once the events were laid out, I looked for themes that ran through the four stories. A theme is a phase that identities what a unit of data is about and/or what it means (Saldana, 2009), and it functions as a way to categorize data into “an implicit topic that organizes a group of repeating ideas” (Auerbach & Silverstein, 2003, p. 38). Furthermore, Saldana (2009) explains how coding is used as the transitional process between data collection and data analysis. Interview transcripts were read multiple times, and segments within them were labeled with “In Vivo codes” in order to preserve the participants’ meanings of their stories (Saldana, 2009). Once the In Vivo codes were identified for each story, they were studied and linked into themes across the four stories. For example, In Vivo codes taken directly from interview transcripts include “positive childhood event with nature”, “did own experiments as child”, and “taught to enjoy nature”. These codes led to the theme “Positive experiences with nature.” Many key concepts from the literature review as well as concepts from John Dewey’s Interest and Effect Relationship Theory and the Self-Determination Motivation Theory informed
the discovery of themes. In the remainder of this chapter, I explain the themes that arose from the storied lives of the four teachers.

**Positive Experiences with Science.** All four teachers have had experiences that were very positive and enjoyable in their life and that have spanned across a great many years. For Ashley, Ali, and Lisa, these positive experiences began at a very early age at home. For Ashley, it was the many experiences that she enjoyed as a young child playing with her brothers on their parents’ two acre plot as well as helping her dad with the garden. For Ali, it was the many hours she played outside with her friends and siblings as well as the many times in which she went hiking and camping with family. For Lisa, it was the many summer days that she spent staying in her family’s cabin along the Illinois River where she played in the river and the surrounding woods. Additionally, all three of these women spent countless hours designing and conducting their own science experiments as children, and Lisa spent hours reading books about science that her mother had checked out of the public library for her.

Although Amy’s experiences with science/nature are different from the other three teachers’ experiences, Amy has come to enjoy nature as an adult as she has spent countless hours outside playing with her two sons and spending time outdoors with her husband. Amy finds nature calming and enjoys observing all of the wonders of nature as she walks three to five miles every day.

The four teachers in the study not only have had positive experiences with science/nature outdoors and away from school, they have experienced positive events in school as students and as teachers. Ashley, Ali, and Lisa all three had positive experiences in their junior high science courses while Amy also enjoyed her junior high science courses, but found her high school biology class to be the most enjoyable. Additionally, Ali and Amy both had positive experiences
in college in their science courses. Furthermore, Ashley had a very positive experience with science in the summer of 2006 when she took part in the “Synergizing Math Scientifically” workshop. This workshop completely changed Ashley’s life and how she thought about teaching and how she thought about teaching science.

During their interviews, each of these four teachers expressed enjoyment and excitement in their faces as they described these events of their lives. They also all expressed how much they love science and their love for science shone brightly in their faces as they incorporated science into their teaching during the classroom observations. Following are quotes taken from each of the four teachers.

Illustrative quotes from Ashley

- There was a creek out behind our house that my brothers and I would play in. I remember playing with my brothers and our trucks and sand toys out near the creek and watching my brother blow up poor defenseless animals. My brothers and I would also fish and swim in that creek. My dad often kept a garden, and I would often help him with the gardening. I really loved nature. I think that kind of has a lot to do with me wanting to teach science in my classroom.

- I remember loving junior high science. It was not all book work. We dissected a lot of things like eyeballs from sheep, worms, grasshoppers, frogs and snakes. I remember this one time when we were dissecting frogs, my lab partner Michelle and I cut into the frog’s stomach and we found a small bird that had been ate by the frog. I really loved science in junior high…
• After going to that class that summer and then the follow-up classes, it was kind of life changing. I decided that I not only wanted to teach science, but I wanted it taught to the whole district.

Illustrative quotes from Ali

• My mom and my dad we went camping and hiking. I was playing with bugs and worms, just playing around outside.

• I remember dissecting worms, frogs, and a rat in middle school. I was interested in it but I felt sorry for the animals that we were dissecting, but I was kinda grossed out and so I made my partner do the cutting and I did everything else.

• The only thing that I really can remember is how much fun that my college professors made science. I really liked the classes although I found them difficult.

Illustrative quotes from Lisa

• It was like every summer we were there and I would fish and swim and play out in the woods. I think I have a real love of animals and nature. I’m not afraid to get dirty, like you see these days.

• My mom would take me to the library weekly and she would let me get whatever books I wanted. I mostly checked out books on science. I wanted to know how things worked. I loved doing all of the little experiments and learning how things worked.

• I remember we were dissecting frogs and cats and pigs. It was really cool, but it also had made me kind of grossed out. I had a hard time eating chicken for a long time, after doing that. I remember we pulled out the frogs' eyes and dissected them. We thought that was pretty cool.
Illustrative quotes from Amy

- They have really gotten me outside and my husband has taught me to enjoy the outdoors. I now walk three to five miles every day and I really enjoy nature. I find it calming. I think this is part of the reason why I like to teach science.

- I didn’t realize how boring until I got to junior high and high school and they were doing labs. We were dissecting. For me, being an indoor girl, you would think I would be squeamish. I loved it. That's what I excelled at when I took zoology in college. The lab is what got me my A. I absolutely loved it.

Neutral/Negative Experiences with Science. All four of the teachers in this study not only have experienced some great experiences throughout their lives, but they have also experienced some negative experiences as well as experiences that they really could not recall that related to science. Amy is the only one of the four teachers that remembers anything about elementary science, and the only memory she has of it was how boring it was. To quote Amy “All I really remember about science in grade school was that it was all from the book. We never did any hands-on things.”

Ashley’s earliest memory with school science was not pleasant. In her story, Ashley tells how her first experience with science in school occurred about the time she was in the sixth grade. This was her first experience with having to rotate teachers through the school day as she learned different subjects. Ashley describes her first encounter with school science and her first science teacher in the following quote. “I remember the science teacher that I had. She was mean. She didn’t like teaching science and you could tell it. We had to do a science fair experiment. We were all made to do one. I don’t know what science experiments meant, but I somehow managed to put something together.” Additionally, Ashley had a horrible experience
with her college science instructor who taught a bunch of jumbled up facts and labs that elementary science teachers did not have the equipment to perform with their students. These experiences for Ashley were so impactful that even though she had loved science since she was a young girl, she did not want to teach elementary science because she did not want her students to have such negative learning experiences.

Lisa and Ashley do not remember really anything about their high school science courses. Lisa also does not really remember anything about her college science courses, but she does however, remember how her cooperating teacher did not like science and did not teach science.

Ali’s negative experiences with science occurred the time when she went out into her sandbox when she was about four years old and found a snake in the sandbox instead of her friend. She also remembers being horrified when she had to watch a video of a woman giving birth during her high school biology class.

**Seeks Meaningful Professional Development.** Oklahoma teachers are required by law to receive professional development each year that they are actively teaching. Schools across the state routinely furnish their teachers with at least the minimum amount required. For many teachers, the professional development provided by their employing district is the only professional development in which they take part. The problem with this is that in most schools, the professional development is a one-size-fits all program, meaning all teachers from Pre-K through those who teach the seniors are put in the school auditorium to listen to a speaker for the whole entire day. Professional development provided by the districts are rarely tailored to meet a group of teachers individual needs.

For Ashley, Ali, Lisa, and Amy, the one-size-fits all professional development provided by their employing district is not all of the professional development that they routinely receive each
year. These four teachers routinely seek out professional development that meets their particular individual needs. Although the criteria used by the four teachers are not necessarily the same, there are two common themes that run through their criteria.

The first common theme for professional development is that it must be relevant to their classroom. In other words, they must be able to gain new approaches to teaching content, ideas for new activities, and/or they must be able to improve on their own existing understanding of particular concepts.

These four teachers are serious about improving their content knowledge in the area of science. All four of these teachers were recruited because they had participated in ToPPS (Teachers of Physics and Physical Science). By participating in ToPPS, they submitted themselves to spending a week during the summer of 2012 studying the concepts of work and energy and momentum, and then, another week in the summer of 2013 studying the concepts of electricity and capacitors with high school physics and physical science teachers. It is important to note here that some of these physics teachers teach AP Physics, and so these elementary teachers were working and studying alongside teachers who already had a working knowledge of the content being studied. It is also important to note that these elementary teachers never hesitated to ask the secondary teachers for help when they struggled to understand.

The second common theme for professional development is that they must be given free materials to use in their classroom. This may sound a little selfish, but these teachers are not provided materials to teach science and the last time that the district adapted new science textbooks for elementary science was fourteen years ago. For the most part, the materials that these four teachers have to use in teaching science to their elementary students are the materials that they receive when they attend professional development outside of their district.
These four teachers not only seek out and take part in meaningful professional development, but they also participate in teachers’ organizations and in their building committees. Ashley, Ali, and Lisa are all members of their district’s teachers’ organization, and Ashley is also a member and serves on the board of the OSTA (Oklahoma Science Teachers Association). Additionally, Ashley has severed on several state science committees, and Amy is the representative for science in her building for the lower grades and has spent the last year or so serving on the state committee charged with writing the new K-12 Oklahoma Science Standards.

**Influence and Support from Others.** Although all four of these teachers have a deep love for science as individual people, they all were influenced by someone else to teach elementary science. Ashley, who had such horrible experiences with school science courses that she actually turned down a teaching job in the early 1990s because she would be required to teach fourth grade science, was greatly influenced by the “Synergizing Math Scientifically” workshop in the summer of 2006. She had originally attended more for the thousand dollar stipend then for the actual development. However, she walked away from those two weeks with much more. She learned how to integrate science into her math and language arts instruction, and she was given equipment to help her on her way. This two week workshop not only taught Ashley how to integrate the subjects, but it gave her the confidence that she could teach elementary science and not inflict those horrible school science experiences she had experienced as a student on her own students.

Ali’s influential person was a close friend who had been teaching elementary science herself. This friend was changing positions and encouraged Ali to accept her old position. She told Ali that she knew that Ali could do it and that Ali would love teaching elementary science. Ali found that her friend was right, she does love it. She loves teaching elementary science so
much that this year when she found herself moving down to teach a second grade class after the school year had already begun, that she could not leave science out of her curriculum. Instead, she is just finding different ways to teach science so that her students can understand science and learn to love it as much as she does.

Lisa’s influence to teach science did not come from just one person. Instead, she gained her start in teaching elementary science when she was required to teach science as she taught in a private Christian academy. While teaching in this school, Lisa was given the supplies that she needed to teach science. She was also given every Wednesday afternoon to work on her curriculum. Additionally, Lisa was able to form a working relationship with another teacher that helped her in her early days of teaching elementary science. Although Lisa does not currently have the supplies to use in teaching elementary science, nor is she given the time to work on her curriculum, Lisa has been able to take many of the ideas that she learned while teaching science in the private school as well as ideas she has received from her professional development to continue to teach elementary science to her students. She now just has a few obstacles to do so.

Amy teaches in the same school building with Ashley. When visiting with Ashley, Ashley said that she seen something special in Amy when Amy was first hired for her first year of teaching. Ashley also said that Amy just has a special way about her when she teaches. Ashley took Amy in under her wing and helped her learn how to integrate science into her math and language arts instruction.

These four teachers have not only been influenced by others to teach elementary science, but they also rely on one another for strength, ideas, and for equipment. These four teachers are great friends who gain strength from one another. They also use one another as sounding boards as they think of ways to effectively incorporate new ideas into their science curriculum. Also,
because the equipment that these four teachers have to use in their science teaching comes from their professional development, they often find themselves sharing equipment with one another.

**Regret/Wants to do more.** Although all four of these teachers feel overwhelmed with all of the demands placed on them as elementary teachers, they all feel like they are not contributing enough to elementary science. They all agree that the elementary students that are not being taught science are being robbed of a very important learning experience, and they wish that they could do more to get other teachers to teach elementary science. Each one of the four teachers had very somber faced as they made the following statements.

*Illustrative quote from Ashley*

- I wouldn’t change any of the past eight years. Before that, I wish I would have gone to a workshop like I went to in 2006 way before I did. I didn’t teach them how to discover things on their own and how to do inquiring things and how to critically think. The only thing I would change is to go back and hopefully new teachers would get that kind of training to start with, so that they don’t have that same feeling that I have of robbing folks, kids without these science experiences. Personally, I feel like I need to be more outside my classroom. Get other teachers to do what I do, every day, naturally. I don’t really know how to do that.

*Illustrative quote from Ali*

- I teach elementary science because it’s fun and because it encourages discovery and higher level thinking. I think that we all need to be teaching elementary science and social studies… we should not be leaving them out because they are not tested in the lower grades. I hate it for the other kids that they are not getting science and I feel like I need to do more to get others to teach it…but I feel overwhelmed with all of the demands
being placed on me as a teacher. I just don’t know how I can really work with others to get them doing it.

*Illustrative quote from Lisa*

- I am glad I am teaching it. The kids just get so excited about it and it really does help them learn math and their language arts. It just makes things so much more fun. I am really heartbroken that kids across the state are not getting to learn science. I don’t feel like I'm doing enough. I think I need to do a little better….. Sadly, I think, science and social studies are the last that you really can focus on because there's not part of AYP. You can integrate it and get it all in, and have them interested in it. There's too many things expected of us.

*Illustrative quote from Amy*

- I feel like I need to do more to get others on board and excited to teach science. Science is so important and it helps kids to understand life.

**Summary of Findings**

Recalling memories of their lives as each of the four teachers retold their stories, revealed some commonalities of their lived experiences. The first commonality to be revealed was that each one of them had experienced nature directly, and these experiences were positive. Of course, each teacher’s experiences with nature was unique, but they all had the common thread of experiencing the outdoors directly and growing to love being out in nature. The second commonality was that they all had experienced some neutral/negative experiences with science in school. The impact of these experiences affected the four teachers in different ways, but they also had shown the teachers the way in which they did not want to teach their own students. It was not surprising to find that the third commonality is that these four teachers routinely seek out
meaningful professional development that meets certain prescribed criteria. The fourth commonality found in the four stories is that all four of the teachers were all influenced by someone else to teach elementary science, and they greatly depend on one another for strength, ideas, and for science equipment. Additionally, they have all been greatly supported by their families. The final commonality that runs through these four stories is that although these four teachers are currently doing what they can to teach elementary science, they all have regret for the students they did not teach science, and they do not know how to get other elementary teachers involved in teaching elementary science. Each of the four teachers has feelings of sorrow for the current elementary students across the nation who are not being taught science.
Chapter 5: Discussion of the Research Findings

Revisiting the Problem of Practice

Teachers are the heart of every classroom regardless of the newest and most current educational mandates of which they must rise up to meet. Teachers are only human and the skills that they process, their interests, their personal beliefs, their strengths and even their weaknesses affect not only what they teach but how they teach. Since past experiences, regardless of rather or not they are personal or professional, can greatly affect the interests, beliefs, strengths, and weaknesses of a teacher, they cannot be ignored. The past experiences of teachers help to make each individual teacher who they are, and they greatly influence their decisions as teachers and as individuals.

Historically and as a whole, elementary teachers have not been known to teach a lot of science, nor have they taught it well. Under the current educational reforms and mandates that sometimes seem to change daily, the typical elementary teacher focuses sole on surviving the current math and language arts/reading mandates, and they leave subjects such as science, social studies, and the arts completely out of their curriculum. This practice of leaving science out of the curriculum is damaging especially considering it is during these early elementary years that the young minds of children are molded, and their interest in science can be fostered and grown. This interest in science is more important than ever as the number of jobs requiring science continues to increase as the number of qualified individuals continues to decrease.

Although the elementary teachers in this study attended school with other current elementary teachers who do not teach science, the teachers in this study do not fit the mold of today’s elementary teacher. Instead, they elect to teach science to elementary students even though they are under a great amount of pressure not to. The teachers in this study not only have
had very positive experiences with science and continue to have positive experiences, but they have also had negative experiences with science as well. The four teachers in the study use inquiry to teach their elementary science, and they find their strength to continue on against external pressure from one another as well as from their own families and other influences. The four participants greatly support and validate one another as they share their ever so precious science equipment. These teachers believe that science is important and they believe that their young students can learn science. They hold such strong beliefs concerning their students and science, that they regret that not every child is learning science as a young elementary student.

**Review of Methodology**

This study was specifically designed to address the following research question:

What past personal and professional experiences have led participates to incorporate science into their elementary math and reading instruction?

To answer this question, a narrative inquiry was conducted in which the experiences of four teachers were investigated through the use of in-depth, semi-structured interviews, the creation of timelines, and through classroom observations. Each of the participants teaches elementary science to their students who are either in the second, third, or fourth grade in a small suburban school district in Oklahoma. The teachers’ stories of their lived experiences were studied for significant themes that help to explain why they teach elementary science. Teacher created timelines were used to support the interview data and researcher written journal entries were used to record the researcher’s observations throughout and positionality within the data collection and analyzes process. A narrative configuration was used due to its use of a “thematic thread that lays out happenings as parts of an unfolding movement that culminates in an outcome” (Polkinghorne, 1995, p. 5). Triangulation of sources through timelines, interviews, and journal
entries as well as validation strategies such as member checking were used to secure the trustworthiness of the findings.

Discussion of Major Findings

Throughout this study, four elementary teachers shared their life experiences that have led them to teaching elementary science. Through a careful analysis of interview transcripts, the following themes emerged: Positive Experiences with Science; Neutral/Negative Experiences with Science; Seeks Meaningful Professional Development; Influence and Support from others; and Regret/Wants to do more. Each of these themes is discussed below.

Positive Experiences with Science. The positive experiences that each of the four teachers have had with science throughout their lives have had a great impact on their decision and desire to teach science. Ashley, Ali, Lisa, and Amy all four contribute their willingness and desire to teach elementary science to their positive experiences with science. They have grown to love science and they see how science relates to everything they do and many decisions they make. They have come to realize how much their positive science related experiences has contributed to who they are and how they think today. They cannot imagine their lives without these experiences, and they cannot bear to not share science and their love for science with each of their students.

Neutral/Negative Experiences with Science. Although each of the four teachers have had great experiences with science that have led them to elect to teach elementary science, they have also had experiences that at first led them to not teach science. The teachers were afraid to teach science initially because they feared inflicting their horrible experiences with science in school on their own students. This was especially true for Ashley. Ashley recalled having such horrible science teachers on two different occasions that she felt the best way for her to help
students enjoy science, was for her not to teach it. Due to their horrible or at least uneventful experiences in science courses, these four teachers feared if they attempted to teach science, they would not help their students enjoy science, but instead they would turn them away from it. This fear of inflicting their own horrible experiences on their students was a very valid fear when one considers that teachers often teach like they themselves were taught.

**Seeks Meaningful Professional Development.** Although all four teachers in the study take part in the professional development provided by their employing school district, it is the quality professional development they each seek out that has been very instrumental in aiding all four of them in their teaching of elementary science. For the most part, these four teachers did not learn how to teach science from their university training. Instead, they learned how to properly teach elementary science and have it be meaningful to each of their students through attending professional development that was tailored to teach teachers how to teach science. These teachers have also increased their knowledge of science and their understanding of science concepts through these workshops as well as learned labs they could perform with their own students. These teachers have not only learned labs that they could perform with their own students, but they have also developed their own labs as a result of their new learnings and understandings from these workshops. Additionally, these workshops have given these teachers the equipment necessary for them to properly teach elementary science.

**Influence and Support from others.** Ashley, Ali, Lisa, and Amy cannot recall a time in which they have not been supported by their own families. As Ashley, Ali, and Lisa grew from young toddlers into young women, their parents fostered their interest in science through family activities and through their purchasing of items that their children would use in their science experiments. Their parents simply supported their daughters’ interests in science. Although
Amy’s experiences were a bit different, her mother supported her in everything of which she had interest. Additionally, her uncle gave her support and even challenged her to do better than he did in a difficult science course. Today, these women continue to receive support from their families as they also receive support from each other. These four women are a tightly knitted group. They strengthen each other as their lives intertwine daily and as they share ideas, stories, science lab equipment and meaningful professional development opportunities. They have influenced one another in their science teaching and they have also been influenced by others.

**Regret/Wants to do more.** Every one of the four teachers in this study work hard every day to share their love of science and their love of learning with each of their students. However, each feels as though they are not doing enough to get others to teach science and they regret that they have not always taught science themselves. They feel they robbed their students that they did not teach science, and they feel teachers, who do not teach their elementary students science, continue to rob their students of a very valuable and meaningful learning experience.

**Discussion of the Findings in Relation to the Theoretical Framework/Literature Review**

This study was informed by John Dewey’s Interest and Effort Relationship Theory and the Self-Determination Motivation Theory. These theories served as a lens through which to investigate and understand the lived experiences of elementary teachers who elect to teach elementary science while they are under increasing pressure to leave it out of the curriculum. The question that has driven this study and its literature review is “What past personal and professional experiences (childhood experiences involving science, experiences with influential people as they relate to science, preservice training including the student-teaching experience, and chosen professional development) have led participates to incorporate science into their elementary math and reading instruction?”
The National Science Education Standards define inquiry based learning as a comprehensive teaching method in which students’ understanding of science is developed by actively combing scientific knowledge with reasoning and thinking skills (National Research Council, 1996). Inquiry based teaching is thought to be the most effective teaching method because the students’ minds are very much engaged as they search for understanding (Wood, 2009).

The four teachers in this study developed much of their understanding and love for science though inquiry. Ashley, Ali, and Lisa all described in their stories how they were always outdoors playing, and how they were always designing and conducting their own science experiments because they wanted to see just what would happen. They were naturally curious about their world, and they wanted to understand it from a young age.

Amy did not share any childhood experiences in which she investigated her surroundings through inquiry like the other three teachers did, but she did share her experiences in some of the most difficult science courses that she took. In sharing these events, Amy describes how the courses were so much fun and how she earned her A in a difficult Zoology course because of the lab work. In other words, the course learnings were meaningful to her since she understood how the science concepts fit together because she was learning through inquiry. She was not learning “a bunch of boring jumbled up science facts” that somehow just did not seem to relate to one another. According to Kindfield & Singer-Gabella, (2010), a bunch of jumbled up science facts that do not seem to relate to one another is just what many elementary teachers received in their college science courses. Many elementary teachers were not taught science in such a way that it made sense; therefore they have not been able to fit the many pieces together in their own minds.
There was not one of the four teachers who could recall having meaningful science in elementary. In fact, Amy was the only one who could even recall having science, and for her, it was just from the book. The fact that none of these four women could recall having any meaningful science in elementary is a testament to the statement that elementary science has never really been able to take hold in the United States (Century et al., 2008). So, if these women never really had any meaningful science experiences in school until junior high or high school, why did their interest in science continue?

For Ashley, Ali, and Lisa, their inquiry into their surroundings did not end when they started to school. Instead, they continued to investigate their natural world outside of school as they continued to camp, hike, play in the woods, etc. For these three women, their pursuit in understanding their world was their interest. They were “engaged, occupied, taken up with, concerned in, absorbed by, carried away by, this objective subject-matter” (Dewey, 1913, 2012, p. 90) called science outside of school as they continued to grow and develop.

According to John Dewey and his Interest and Effort Theory, an interest is “not some one thing; it is a name for the fact that a course of action, an occupation, or pursuit absorbs powers of an individual in a thorough going way” (Dewey, 1913/2012, p. 65). Ashley, Ali, and Lisa were simply occupied with science as young girls, and this occupation grew in junior high although it appears to have gone dormant in high school as they developed other interests.

Studies have shown that students often lose interest in science by the fourth grade especially when their elementary educations have failed to nurture and support their interest in science (Mertz, 2008). Amy remembers only being taught science from a book while in elementary, and she described it as being boring. Additionally, Amy never shared any stories of how she would explore her natural world as a young child. Instead, she described herself as a
city girl. According to Dewey and his Interest and Effort Theory, Amy would have been born naturally interested in her natural surroundings. Furthermore, the literature supports the idea she most likely would have lost interest in science by the time she was in the fourth grade since she was not receiving a quality elementary science education. However, for Amy, her interest in science was awakened since she had science instructors who taught through inquiry and thus allowing Amy to make connections between science concepts and develop an interest in science that was further developed by her husband and two sons. The statement that these four teachers have each had positive experiences with science, and thus, they have developed a strong interest in science, and therefore, they put forth the effort to teach elementary science is supported by Dewey’s Interest and Effort Theory even thou, Amy’s lack of science experience as a young child contradicts Dewey’s belief that interest in the natural world would primarily develop though childhood. These four teachers have a great interest in science, and thus, they do not mind the extra effort required to teach science.

Many literature sources describe elementary teachers as not being interested in science (Allen, 2006; Darling-Hammond, 1997; Kindfield & Singer-Gabella, 2010; Levy et al., 2008). Although this may be true for some, it is difficult to imagine this is true for all of the thousands of elementary teachers across the nation who are leaving science out of the elementary curriculum. The four women in this study who have such a strong desire to share their love of nature with their elementary students, and their life experiences cannot be anomalies! It is difficult to believe that many of the thousands of elementary teachers who leave science out of the curriculum did not have similar experiences to the experiences of the teachers in the study, especially when one considers that none of these teachers had a positive elementary science experience. Furthermore, Amy who teaches science does not describe an experience with
science until she is in junior high and Ashley is able to describe multiple horrible experiences with her science courses. Additionally, Plourde (2002) describes how the attitude and behavior of a student teacher’s cooperating teacher can have a large impact on the student teacher’s decision to teach elementary science. Ashley and Lisa did not necessarily have a great experience with their cooperating teacher and science while Ali and Amy did. Ali and Amy, neither one, went right into teaching elementary science. Instead, like Ashley and Lisa, they required an additional influence.

Allen (2006); Darling-Hammond (1997); Kindfield & Singer-Gabella (2010); Levy et al., 2008, each not only describe how most elementary teachers lack an interest in science, but they also acknowledge the fact that most are not trained to teach science. The lack of training to teach science appears to be a critical factor as to why the three of the four teachers in the study did not teach science on their own initially. Only Lisa, who was required to teach science, taught it during her first year of teaching without someone else encouraging her to do so.

The conclusion that the training to teach science is a critical factor in an elementary teacher teaching science is supported by the Self-Determination Motivation Theory. According to the Self-Determination Motivation Theory, there are three basic psychological needs that must be met for psychological growth and well-being. The basic psychological needs that must be met are the needs for competence, relatedness, and autonomy (Deci & Ryan, 2000; Deci et al., 1991).

Under the Self-Determination Motivation Theory, the first basic need that must be met is the need of competence. Competence is the ability to achieve desired outcomes, the feelings of effectiveness, and mastery of one’s environment (Deci & Ryan, 2000; Deci et al., 1991). For the elementary teachers to teach elementary science, they must not only feel competent in their
understanding of science, but they must also be competent in their ability to teach science. Interest in science alone is not enough. The stories recreated from the four teachers in this study demonstrate this. They all had an interest in science so deep, they described it as a love for science, however, it was not until they were shown how to teach science primarily through their meaningful professional development, that they actually begun to teach it.

This first basic need of competence also confirms how the negative experiences with science and, in particular, with science courses can cause a science interested elementary teacher to not teach science. All four of these teachers had experiences with science during school that was either so boring or uneventful they cannot recall them, or they were so horrible they would like to forget them. Ashley especially expressed how she loves science, but she initially did not want to teach elementary science because she did not want to give her own students the horrible experiences she experienced with science courses. Simply stated, she was not feeling competent in her own ability to provide her students with an enjoyable elementary science experience.

Under the Self-Determination Motivation Theory, the second basic need that must be met is the need of relatedness. Relatedness refers to the closeness and connection in which one feels to one’s everyday world (Deci & Ryan, 2000; Deci et al., 1991). Each one of the four teachers continues to meet the second basic psychological need of relatedness through remaining close to their love of nature and through the support and encouragement they each receive from the other members of the group. All four teachers admit they rely heavily on one another for strength and for acceptance. They therefore do not feel like they are alone in teaching elementary science. Furthermore, they all receive support and assurance from their families. The idea that influence and support from others is critical in elementary teachers teaching science is, therefore, supported by the Self-Determination Motivation Theory.
The third of three basic needs that must be met is autonomy. Autonomy refers to being in control of one’s own actions or making decisions for one’s self according to one’s interest (Deci & Ryan, 2000; Deci et al., 1991). In this period of high-stakes tests, teachers often feel as though they have no control over what occurs in their own classrooms. For these four teachers, integrating science into their curriculum is a way in which they feel as though they have some control. They feel like the decision to teach elementary science and teach it through inquiry is their decision and furthermore, they feel like the way they teach the other content areas in which they are required to teach is also their decision. They are in total control of their classroom, and what occurs in their classroom. They do not feel like they have lost all control of what they teach and how they teach it.

When all three of a teacher’s basic psychological needs are met, they experience motivation that is autonomous whether it is in the form of intrinsic motivation, identified motivation, or integrated motivation. Regardless of the type of autonomous motivation experienced, the individual experiences a self-endorsement of their actions (Deci & Ryan, 2008). Additionally, if it is autonomous motivation, the teacher is either interested, sees value in the activity, and/or they are able to internalize the reasons for engaging in the activity. Thus, the outcome of the activity is maximized (Deci, Ryan, 2008; Deci et al., 1991; Milyavskaya & Koestner, 2011; Moran et al., 2012; Vallerand et al., 2008; Vansteenkiste et al., 2006).

All four teachers in this study appear to be experiencing a little of all three types of autonomous motivation. Since their motivation to teach elementary science is autonomous, they are very persistent (Frederick-Recascino, 2002 as cited in Moran et al., 2012; Koestner & Losier, 2002 as cited in Moran et al., 2012). This confirms the fifth theme of regret/wanting to do more. Ashley, Ali, Lisa, and Amy all four not only have an interest in teaching elementary science, but
they all value it and internalize the reasons for engaging in it. For them, they see elementary science teaching as important, and they cannot image depriving their own students of an elementary science education; therefore, they feel for the students who are being deprived of an elementary science education.

Limitations

This study has been successfully carried out with fidelity; however, there are several limitations that need to be noted. A major limitation of this study is the limitation that comes with all narrative studies. Since this study is narrative, and therefore relies heavily on the memory and storytelling of events that may have occurred in the participants’ distant past, and because experience is not directly observable, it is possible that events could be remembered incorrectly or told incorrectly without the researcher being able to identify such problems (Polkinghorne, 2005). A second major limitation is researcher bias. The researcher attempted to keep bias out of the study through using journaling, and through using member checking methods to ensure accuracy of data. However, it is not always possible to keep researcher bias completely out of the study. Limitations that are unique to this study are data was being collected from only four individual elementary teachers, and all participants are women from the south central portion of the United States who all teach in the same school district and who all are in their late thirties to mid to late forties. Additionally, the state in which the study took place remains primarily rural, and agriculture remains a large industry. Due to the limitations of this study, it will be difficult for the findings to be generalized for other environments such as large urban areas.
Conclusion

This study was designed to investigate the past personal and professional experiences of elementary teachers who elect to teach math and reading through the use of science content. In the recreation of the lived stories of the four study participants, there were several major findings that should be eye opening not only to school administrators and current teachers, but also to colleges of education, secondary science teachers, and college science professors. At a time in which the United States is not producing enough qualified college graduates in STEM areas to fill the thousands of STEM positions across the country, the findings of this study speak volumes in aiding understanding as to why many bright and interested young adults decide not to enter science related fields even when these bright young adults have an interest in science and the potential to succeed in a science related field. In studying elementary science education and the stories of the very people who are teaching elementary science, this study shows and links together, many of the inadequacies of the American education system from the colleges and universities who train teachers to each individual elementary and secondary classroom.

This study reveals how important it is that young people receive quality educational experiences that are positive and that help them truly understand the content as well as aids them in developing connections from one concept to another. In the case of learning science content, this study shows how important it is that students learn content through inquiry. Inquiry creates the positive experiences of learning that allows students to really engage their minds and aids them in making the connections from one piece of information to another. The positive experiences each of the study participants experienced greatly exhibits the importance of this. The experiences they remember and the experiences that they contribute a great deal of their
science knowledge to are those in which they were learning through inquiry regardless of where they occurred.

This study also reveals how damaging negative experiences involving science in school can be to the futures of students regardless on which level of education the negative experiences occur. Each teacher in the study shared at least one negative experience they had experienced in their science courses. Additionally, for each of these teachers, it was their negative experiences that were partially to blame for them feeling like they were not competent enough in science to initially teach elementary science to their own students.

These first two findings should speak to school administrators and all current teachers. For school administrators, these two findings should serve as a remainder how they should be verifying they have the best people teaching the nation’s future generation of leaders. It should also remind them of how they need to be the leaders in their districts and in their buildings and aid their teachers in developing curriculum and delivering instruction in such a way that each student truly learns. For current teachers, these first two findings should serve as a reminder of how they need to get away from the boring textbooks and worksheets and work to ensure that they provide each one of their students with the most positive and meaningful learning experiences possible. If they do not, they may very well be the one that turns a student off of learning or at least causes a student to feel incompetent in something that they truly have a great deal of interest in learning.

The third finding of this study should be a wake-up call to all planners and providers of teacher professional development as well as to the nation’s colleges of education. Elementary teachers have not been prepared to teach elementary science, and given the experiences that the four teachers in the study shared, one has to wonder how well many secondary science teachers
have been prepared to teach science. For current teachers, meaningful professional development that has been tailored to meet the needs of a specific group of teachers could be very beneficial in helping these teachers close the gaps in their own learning and understanding of how to teach content. For colleges of education, this study points out the need for them to study their own curriculum to ensure they are training all future elementary teachers to teach science, and they are training all future secondary science teachers to teach science as well. Additionally, the third finding of this study points out the need for colleges and universities to ensure that their science instructors and professors know more than just their content, but that they also know how to teach in such a way, that their students, some of whom are future teachers, actually understand the content and how different concepts relate to one another.

The findings of this study demonstrate the importance of networking and the feelings of acceptance for teachers as well as the effects of positive influences on a teacher’s career decisions. For decades, teachers have routinely gone into their classrooms and shut the door. They have not shared what occurs in their classrooms nor have they shared their strengths and weaknesses, ideas, or concerns with other teachers. For the teachers in this study, the ability to share their strengths and weaknesses as teachers as well as their ideas and concerns with other likeminded teachers has been instrumental in them being able to continue being lone rangers in their buildings. These teachers are validated by the group as they continue to help one another. They also received validation as a teacher when those who influenced them to teach elementary science did so. This finding is significant given the traditional practice of teachers shutting their classroom doors to the world. For teachers to be successful, they must be able to be members of groups such as professional learning communities that will give teachers validation as well as aid them in strengthening their weaknesses.
Teachers who teach elementary science find teaching science rewarding especially when they witness the enjoyment in the faces of their students as they connect their learning to their own world. These teachers feel so strongly about the importance of elementary science education that they cannot imagine themselves denying their students of the opportunity. They also feel so strongly about elementary science education that they feel for the students who are not receiving an elementary science education, and they regret they have not always taught it themselves. Perhaps the lesson here is that the many people in education that hold strong to the belief that young children cannot learn science should spend a week in one of these teachers’ classrooms; for if they did, they would see that these children are learning science, having fun, and most importantly they are making connections to their learnings in math and reading/language arts.

The insights into the past personal and professional experiences of the four elementary teachers in this study who have elected to teach elementary science invite further research. In conducting further research into the lived experiences of elementary science teachers, perhaps the secret of growing future scientists and future primary/secondary science teachers will be uncovered.

Future Studies

Based on the findings of this study, there are a few recommendations for future research that has potential to add to the understanding of the development of elementary science teachers. The first suggestion is the study needs to be expanded to include a larger and more diverse sample. All four teachers in the present study are Caucasian women who are in their late thirties to late forties and who all teach in the same suburban school district. Since the sample size was small and the four teachers are women who are very similar in age, it is difficult to determine if
younger and less experienced elementary teachers were better trained by their universities to teach science than the study participants, especially given that training to teach science was found to be a contributor in this study. Additionally, if a more diverse population of teachers was studied, it is quite possible that their experiences with science could be quite different from those of the study participants. These different experiences could either support or not support the conclusion that both the positive and the negative experiences have led these teachers to teach elementary science. Furthermore, if the study sample was larger and more diverse, the results of the study would be more generalizable.

A second suggestion for further study is to include teachers from different sized school districts and in different locations. All four of the current study participants teach in the same suburban school district. The conditions of which they teach under are very similar even though they are in different elementaries. Additionally, all four of the study participants are a part of one another’s network or support group. Since they are all in one another’s network or support group and their daily lives are so intertwined, it is difficult to determine just how much the support from others and the close networking abilities contributes. It is difficult to determine how teachers who teach elementary science in a rural district gain their support and obtain enough equipment when they may very well be the only teacher teaching science in their entire county.

Elementary teachers are the first teachers in which a student encounters along their educational journey. It is up to the elementary teachers to build a strong foundation of knowledge for secondary and tertiary teachers to aid students in building upon. If students enter secondary courses without a firm foundation, they are forever behind in the game of learning and therefore behind in the game of life. Since the responsibilities of elementary teachers are so great, it is of
the upmost importance that they are properly trained by colleges of education to perform their
tasks correctly, and it is the responsibility of their employing district to furnish them with the
necessary supplies and support to perform their jobs. Hopefully, this study will lead further
investigations into how to develop a very well rounded elementary teacher. Additionally,
hopefully, those who are charged with developing these teachers and supporting them will take
note.

Significance of the Study

This study is not only important to science education and the development of future
STEM professionals, but it is also important to the field of education. This study is important in
the field of science education as it is up to those working in science education to prepare and
train the future STEM professionals. This task is no easy task, and it is one that is quickly
becoming more critical and more difficult every year.

Past studies have found that children very often lose interest in science by the fourth
grade if their elementary educations are not fostering its development (Mertz, 2008).
Additionally, the number of jobs that require college degrees in the STEM fields continue to
increase by five percent each year while the number of degrees earned by Americans continues
to decrease by twenty percent each year in math and science and eight percent each year in
engineering (National Science Board, 2004). Furthermore, learning and understanding science
content is cumulative.

If the interest that children naturally have in science is not nurtured by their elementary
educations, how can the United States ever begin to put Americans to work in STEM positions
that require degrees in science? The answer is simple, they cannot. In order for the United
States to begin to develop and build the strong STEM workforce that it had in the years
following the Russian launch of Sputnik and the STEM workforce that was the first to place a man on the moon, it must begin to invest in its elementary science education. What this study has shown is that many elementary teachers simply do not currently have the skills to teach elementary science effectively and meet all of the many demands placed on them. The good news is that this problem can be fixed. For current elementary teachers, the problem can be fixed by providing them with the necessary professional development opportunities that will not only help them build their own science knowledge base and understanding but that will also help them learn to teach elementary science and incorporate it into their other content. For future elementary teachers, colleges of education can make the necessary changes to their curriculum to ensure all future elementary teachers are learning science content knowledge in a meaningful way, and that they are learning how to teach science to elementary students in a meaningful way. Additionally, school districts need to ensure that their elementary teachers are given the necessary supplies and supports to teach science in a meaningful and productive way. If similar educational events in Ontario Canada do not teach anything else, they do teach that when students are taught a broad curriculum where subject matter is integrated that their teachers and students are not only happier, but most importantly, their students learn and develop so much more.

In the general field of education, this study highlights some shortcomings of the educational system as well as obstacles faced by all public school teachers and their administrators, for one must remember that today’s teachers were yesterday’s students. By recreating the life stories of the four participants, this study shows how there are some great teachers out there that truly know and understand their content as well as how to teach the content. This study also shows how there are teachers at all levels of education lacking in their
knowledge of either content or how to teach the content and at times, both. Each of the four
teachers in this study had teachers from both categories. They had some great teachers, and they
had teachers that they would just soon forget. What this highlights is the need for colleges of
education to take a good long look at their curriculums and how they train their teacher
candidates for all levels of education. What this study also shows is how teachers must be
supported and validated by others. This study also further highlights a widely known fact in
education and that is current teachers are under a tremendous about of stress as mandates
continue to be piled on them while mandates are not being removed. Teachers are being
overstressed and have entered survival mode.
References


doi:10.1007/s11422-010-9282-6

Center on Education Policy (2006). *From the capital to the classroom: Year 4 of the No Child Left Behind Act*. Washington D.C.


APPENDIX A

Types of Motivation

<table>
<thead>
<tr>
<th>Most Extrinsic</th>
<th>Extrinsic Motivation</th>
<th>Controlled</th>
<th>Type of Motivation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>External</td>
<td>Reward or Praise</td>
<td></td>
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<tr>
<td>Least Extrinsic</td>
<td></td>
<td>Introjected</td>
<td>To avoid guilt or anxiety</td>
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<td></td>
<td></td>
<td>Autonomy</td>
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<td></td>
<td></td>
<td>Identified</td>
<td>Person sees value in the given activity</td>
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<tr>
<td></td>
<td></td>
<td>Integrated</td>
<td>Person has internalized the reasons for engaging in the behavior</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Intrinsic</td>
<td>Something is done for pleasure or enjoyment</td>
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</tr>
</tbody>
</table>

Information taken from Moran et al., 2012.
Dear Participants of ToPPS

I am Andrea Acre and I am currently teaching secondary science for Elk City Public Schools located in Elk City Oklahoma. I am also a doctoral student at Northeastern University in Boston Massachusetts. That being said, I am currently seeking participants for my doctoral study. I was given your email address by Dr. Steve Maier the director of ToPPs at Northwestern Oklahoma State University.

Through my doctoral study, I am seeking to identify any similar past personal and professional experiences shared by elementary teachers who elect to incorporate science content into their math and reading instruction. To investigate these past experiences, I am seeking participants who are willing to participant in 2 one-on-one interviews, which will take approximately 45 minutes to an hour of your time each. If you agree to participate you would also be asked to complete a timeline outlining your life since early childhood. Each question in the interviews will be related to your personal past and professional experiences as they relate to your desire to teach science to elementary students. If you agree to participate you will be asked to provide me with a copy of at least one of your science lessons or science lesson plans. Additionally, you will need to be willing to allow me to observe you teaching a science lesson in your classroom.

If you agree to take part in this study, we would meet in person on two separate occasions. We would meet at a location that we both agree upon for the completion of the interviews. All interviews will be audio recorded and notes will be written. However, I will be the only person who will know who provided which set of data. Additionally, all information will be kept confidential.
If you agree to participate in this study, you will be asked to sign an informed consent form when we meet for the first interview. For your convenience I have attached a copy of the form in this email. Your participation is completely voluntary. If you begin, you may quit at any time.

Once the interviews have been completed; they will be transcribed. Once transcribed, the typed copy of your interview will be emailed to you for you to review and verify its correctness. There will be two other times in which I will ask you to check the data collected from you for accuracy.

If you have any questions at any time please do not hesitate to contact me. Additionally, if you are willing and able to participate in this study, please send me an email as soon as possible stating your intentions.

Sincerely

Andrea Acre

acre.a@husky.neu.edu

580.886.5027
Appendix C

Northeastern University - College of Professional Studies/Education

Name of Investigator(s): Principal Investigator: Dr. Atira Charles, Student Researcher: Andrea Acre

Title of Project: Elementary teachers past experiences: A narrative study of the past personal and professional experiences of elementary teachers who use science to teach math and reading.

Informed Consent to Participate in a Research Study
You are being invited to take part in a research study. This form will tell you about the study. Additionally, if you have any questions at any time regarding the study, please do not hesitate to ask the student researcher using the contact information provided. When you are ready to make a decision, you may tell the student researcher if you want to participate or not. You do not have to participate if you do not wish. If you decide to participate, the student researcher will ask you to sign this statement and will give you a copy to keep.

Why am I being asked to take part in this research study?
You are being asked to participate in this study because you have been identified through your involvement with ToPPS (Teachers of Physics and Physical Science) as an elementary teacher who teaches math and reading through science.

Why is this research study being done?
The purpose of this study is to study the past personal and professional experiences of elementary teachers who teach math and reading through the use of science content.

What will I be asked to do?
If you decide to take part in this study, you will be asked to complete a short timeline of your life since early childhood and bring it with you to the first interview. You will also be asked to meet with the student researcher twice to complete (2) different interviews. Each interview will take approximately 45 minutes to an hour to complete. The questions included in the interviews are related to your experiences as a child such as your school activities, your parents’ attitudes toward your involvement in science as well as your lived everyday experiences that relate to science. Questions in the interview are also related to your experiences during your preservice training, including your student-teaching experience, your current teaching experience, as well as your elected professional development. You will be asked to allow the researcher to observe you teaching a science lesson and asked to provide a copy of that lesson or lesson plan to the researcher.
Where will this take place and how much of my time will it take?
The interviews will take place in a location and at a time that is agreed upon by you and the student researcher. Each interview will take between 45 minutes to an hour. The timeline will take you about thirty minutes or so at home to complete. The classroom observation will occur in your classroom and will last however long your science instruction happens to be on the day of the observation.

Will there be any risk or discomfort to me?
There are not any foreseeable risks to you if you decide to take part in this study. All information obtained from you in this study will be kept confidential. There are no psychological, financial, social, legal, or physical harm that can occur as a result of your participation.

Will I benefit by being in this research?
There will be no direct benefit to you for taking part in this study. However, the information gained through this study may help in developing ways to better help present and future elementary teachers develop in the area of elementary science teaching.

Who will see the information about me?
Only the student researcher will know who contributed each interview, lesson plan, timeline, and observation. Additionally, only the student researcher will take and view the written notes. Furthermore, only the student researcher will see the information gleaned from the interviews. No reports or publications will use information that can identify participants in any way.

The recorded interviews, written notes from the interviews and classroom observations, timeline, and lessons provided by the participants will remain secure with the student researcher until the study is completed. Once the study is completed, all recorded interviews, written notes, participant provided lessons; and timelines will be destroyed. In rare instances, authorized people may request to see research information about you and other people in this study. This is done only to insure that the research is properly carried out. The only people who would be granted access to the information are people who are authorized by organizations such as the Northeastern University Institutional Review Board.

Can I stop my participation in this study?
Your participation in this research is completely voluntary. You do not have to participate if you do not wish to and you can refuse to answer any question. Even if you begin the study, you may quit at any time. If you do not participate or if you decide to quit, you will not lose any rights, benefits, or services.
Who can I contact if I have questions or problems?
If you have any questions about this study, please feel free to contact Ms. Andrea Acre at 580.886.5027 or acre.a@husky.neu.edu. You may also contact the student researcher’s advisor, Dr. Atira Charles at 1.850.412.7753 or a.charles@neu.edu.

Who can I contact about my rights as a participant?
If you have any questions about your rights in this research, you may contact Nan C. Regina, Director, Human Subject Research Protection, 960 Renaissance Park, Northeastern University, Boston, MA 02115. Tel: 617.373.4588, Email: n.regina@neu.edu. You may call anonymously if you wish.

Will I be paid for my participation?
There will be no payment for participating.

Will it cost me anything to participate?
Each participant will be responsible for their own transportation to and from the interview site. No other costs will be associated with taking part in this study.

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<table>
<thead>
<tr>
<th>Signature of person agreeing to take part</th>
<th>Date</th>
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<tr>
<th>Signature of person who explained the study to the participant above and obtained consent</th>
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| Appendix D  
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<tr>
<th>Timeline</th>
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<tbody>
<tr>
<td>Please list important details about your childhood (Earliest memory until the time you entered middle school.)</td>
</tr>
<tr>
<td>Please list important details about your experiences with science from Kindergarten through your senior year of high school.</td>
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<tr>
<td>Please list important details about your middle school and high school experience.</td>
</tr>
<tr>
<td>Please list important details concerning your college years, including why you became an elementary teacher, attitudes of your professors and cooperating teacher toward elementary science.</td>
</tr>
<tr>
<td>Please list and/or describe the professional organizations you belong to and your professional networking experiences.</td>
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<tr>
<td>Please describe the professional development that you choose to take part in and what criteria do you use to determine if it is worth your time.</td>
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<tr>
<td>Question</td>
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<tr>
<td>-------------------------------------------------------------------------</td>
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<tr>
<td>Please describe any key experiences or encounters that influenced your decision to teach elementary science?</td>
</tr>
<tr>
<td>Why do you teach elementary science?</td>
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</tbody>
</table>
Appendix E
Questions for First Interview
1. Tell me about your childhood from the earliest experiences you can recall up until the time you entered middle school.
   a. What did you and your family enjoy doing together?
   b. What did you and your friends enjoy doing together either at home or at school?
   c. What was your elementary classroom experience like?
   d. Describe your experiences with science while in grade school?

2. Tell me about your years in middle school and high school?
   a. What school activities were you involved in?
   b. What were your experiences like in science courses?
   c. What types of messages did you seem to receive from teachers and adult family members concerning your interest in science?

3. Can you tell me about your college years?
   a. Was elementary education your initial major?
   b. Why did you decide to become an elementary teacher?
   c. What was your experience like in your college science classes?
   d. What was the attitude of your college instructors toward teaching science in elementary education?
   e. What was your experience like when you student-taught?
   f. What was the attitude of your cooperating teacher toward the teaching of science to elementary students?

4. Can you tell me about the professional organizations you belong to and your professional networking experiences?
   a. What professional organizations are you a member of? How do they support elementary education?
   b. Do you ever attend any of the organizations’ conferences? Why or why not?
   c. What types of professional networks are you apart of and how do they support elementary education?
5. Please describe your current professional experiences?
   a. When you seek out professional opportunities, what criteria do you look for as you decide which opportunities are worth your time?
   b. Given that ToPPS was developed with secondary science teachers in mind, why did you choose to participate in the program?
   c. What type of professional development does your district provide?
   d. What is your administration’s attitude and opinion toward elementary science education?
   e. Have you ever experienced any negative consequences because you choose to teach elementary science either from your administration, other teachers, or parents or your students?

6. Can you please describe any key experiences or encounters that influenced your decision to teach elementary science?
   a. Was there a very influential person who influenced your decision?
   b. Was there a particular event in your life such as the explosion of the space shuttle Challenger that influenced your decision?
Appendix F
Questions for Second Interview

1. Given the experiences that you have shared with me, how do you understand your decision to teach science to elementary students?

2. How do you feel about your decision to teach elementary science up to this point?

3. Given what you have reconstructed in these interviews, how do you feel about your contribution to elementary science education?

4. Are there any details that you would like to add to the information that you have provided?